Agnico Eagle Mines Limited

HOPE BAY PROJECT
2021 Nunavut Water Board Annual Report

AGNICO EAGLE

Agnico Eagle Mines Limited
145 King St E
Toronto, ON M5C 2Y7
Tel: (416) 947-1212
info@agnicoeagle.com

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Prepared by
Agnico Eagle Mines Limited

Prepared for
Nunavut Water Board

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Executive Summary – English

Hope Bay is a gold mining and exploration Project located on a property approximately 20 km × 80 km along the south shore of Melville Sound in Nunavut, Canada, and continued to be operated by TMAC Resources Inc. (TMAC) in 2021. On February 2, 2021 TMAC was purchased by Agnico Eagle Mines Limited (Agnico Eagle) and became a wholly owned subsidiary of Agnico Eagle. Effective as of January 1st, 2022, Agnico Eagle and TMAC amalgamated and continued under the Agnico Eagle name. Accordingly, by operation of law and without any further acts or steps necessary, TMAC ceased to exist and continued as Agnico Eagle, and Agnico Eagle possessed all of the property, rights, privileges and franchises and is subject to all liabilities, including civil, criminal and quasi - criminal, and all contracts, disabilities and debts of TMAC. This report to the Nunavut Water Board (NWB) has been prepared to summarize the Project activities and monitoring conducted under Agnico Type A Water Licences 2AM-DOH1335, 2AM-BOS1835, Type B Water Licences 2BB-MAE1727, 2BB-BOS1727, and the exploration Type B Water Licence 2BE-HOP1222 for 2021.

In response to the health risks associated with the COVID-19 pandemic, Agnico continued the implementation of rigorous protocols and hygiene measures in order to keep its workforce and communities safe. A reduction of workforce was done in October-November 2021 following positive COVID-19 cases identified on site. Return to normal operations was initiated in November 2021. In 2021 logistical, operational and travel restrictions imposed by the COVID-19 pandemic influenced activity-based monitoring. However environmental protection and compliance at Hope Bay remained a top priority.

Commercial operations continued for most of 2021 at Doris with ongoing efforts to stabilize mill throughput and optimize gold recovery. In 2021 the mill processed 262,466 tonnes (t) of ore and poured 64,583 ounces of gold. Following the acquisition Agnico continued processing ore at a reduced rate and achieved steady state processing and improved gold recovery. In October the mill was shutdown to optimize underground development and stockpile ore for the mill.

Underground mining operations continued at Doris Mine, while Madrid underground and surface operations, including mining of the Naartok East Crown Pillar trench, were suspended in February 2021. At Doris, Agnico focused on producing from developed stopes and bringing ore to surface. A grouting program at Doris helped maintain the inflows of water over the course of 2021.

The Roberts Bay Discharge system was recommissioned in May with the addition of a coagulant dosing system to manage total suspended solids in mine water. Discharge to Robert’s Bay commenced in accordance with MDMER in May 2021 and was suspended in November due to the coming into force of the MDMER toxicity testing for *Arcatia tonsa*.

Civil construction activities at Doris included maintenance conducted on airstrip and construction of a core storage laydown. Earthworks were conducted at the Madrid North portal laydown in early 2021 to excavate an area of the laydown with higher ammonia and chloride signatures. This material was removed prior to freshet 2021 and placed on the west boundary of the Naartok East Crown Pillar.

In the fall, Agnico concluded another successful sealift operation including the purchase and delivery of diesel fuel as well as explosives and reagents to support mining and milling activities. Hazardous waste was successfully backhauled without incident. A total of 57 sea cans of hazardous waste and 418 sea cans of non-hazardous solid waste were disposed off site. Waste disposal, fuel usage and chemical storage stayed consistent with previous years.

Three spills were reported to the Nunavut Spill Line, CIRNAC Inspector and KIA Major Projects office. The remaining spills that occurred during 2021 were minor in nature, occurring on camp pads and infrastructure, with quick response and clean up resulting in negligible impact to the receiving environment.

Water use in 2021 was conducted in accordance with the Type A Water Licence 2AM-DOH1335 for Doris -Madrid, the Type A Water Licence 2AM-BOS1835 and the Type B Water Licences 2BB-BOS1727 for Boston, the Type B Water Licences 2BB-MAE1727 for Advanced Exploration at Madrid, and the Type B Water Licence 2BE-HOP1222 for regional exploration. The referenced water licences include provisions for sampling programs that involve recording data related to the volume of water extracted for any purpose, testing of effluents (e.g., treated sewage effluents) discharged to the environment, and monitoring water quality within specific Project areas (e.g., surface discharge downstream of construction areas, storm water from an engineered containment structure, sewage, and oily water effluent, etc.). Water usage in 2021 was conducted within approved limits. There were no changes to surface water management practices at site. Due to limited access to the Boston site during the summer period, efficient use of helicopter time ensured that the site was accessed for monitoring and de-watering requirements of any water containing structures. On June 18, 2021, seepage was identified emanating from the downstream toe of the Madrid North Contact Water pond located at the Madrid North site. The Nunavut Spill Line was notified via email of a release of an estimated 350 m^3 of contact water. Despite this unplanned event, water met discharge criteria in the licence.

An application for renewal of Licence 2BE-HOP0712 is in preparation for 2022. This water licence lists the terms and conditions for the use of water and management of waste in conducting mineral exploration activities in the Hope Bay Belt and in the operation of Windy Camp

In 2021, Agnico Community Consultation activities continued to be severely constrained by public health measures enacted by the Government of Nunavut Department of Health pursuant to the Nunavut public health emergency declared in response to the COVID-19 global pandemic. The Agnico Cambridge Bay office was closed to the public early in the pandemic and therefore it was not possible for the public in Cambridge Bay to physically engage with Agnico staff, although electronic lines of communication remained open.

As demonstrated above, Agnico strives to continually achieve compliance with the various regulatory requirements and maintain community relationships. Environmental monitoring in accordance with the existing Water Licences, Framework Agreement, Project Certificate, authorizations, management plans and environmental effects monitoring plans will continue during 2022. Agnico is pleased to submit the details of this report to the Nunavut Water Board.

ᓇᐃᓪᓕᒋᐊᕐᓯᒪᔪᑦ ᐅᖃᐅᓯᑦ – Inuktitut (North Baffin)

Hᐆᑉ ᐸᐃ ᐱᓕᕆᐊᖅ ᐱᒋᔭᐅᔫᒥᑦᑐᖅ 20 ᑮᓚᒥᑖᓪᓗᐊᓂᒃ x 80 ᑮᓂᑖᓪᓗᐊᓄᑦ ᐅᖓᓯᒃᑎᕆᔪᖅ ᓂᕆᐊᓂᑦ ᓯᒡᔭᒥᑦ ᒥᐅᓪᕙᐅᓪ ᓴᐅᓐ ᓄᓇᕗᑦ, ᑲᓇᑕᒥᑦ, ᐊᒻᒪ ᐊᐅᓚᖅᑎᑕᐅᖏᓐᓇᖅᑐᖅ TMAC Resources Inc.-ᑯᓐᓄᑦ (TMAC) 2020-ᒥᑦ. ᐊᕗᓐᓂᕙᒃ (ᕙᕗᐊᕆ) 2, 2021-ᒥᑦ TMAC-ᑯᑦ ᓂᐅᕙᖅᑕᐅᓚᐅᖅᑐᑦ ᐊᒃᓃᑯᒃᑯᓐᓄᑦ ᑭᓯᐊᓂ TMAC-ᑯᑦ ᑕᐃᒪᐅᔪᑦ ᓱᓕ ᒪᓕᒐᓕᕆᓂᒃᑯᑦ ᐊᒻᒪ ᓇᖕᒥᓂᕆᔭᐅᓕᖅᑐᖅ ᐊᒃᓃᑯᒃᑯᓐᓄᑦ. ᐱᔪᓐᓇᐅᑎᓗᒃᑖᖏᑦ, ᐱᔭᒃᓴᐅᑎᖏᑦ, ᐊᑭᓕᒃᓴᖏᑦ TMAC-ᑯᑦ ᑕᐃᒪᐅᖏᓐᓇᖅᑐᑦ ᓱᓕ ᑖᑉᑯᓇᓂ ᑭᓯᐊᓂ ᐅᑉᐸᓘᓐᓃᑦ ᑲᑎᑎᑕᐅᓯᒪᓕᖅᐸᑦ ᐊᒃᓃᑯᒃᑯᓐᓄᑦ 2021-ᒥᑦ. ᐅᓂᑉᑳᖅ ᓄᓇᕗᒻᒥ ᐃᒪᓕᕆᔨᒃᑯᓐᓄᑦ ᐱᓕᕆᐊᖑᔪᖅ ᓇᐃᓈᖅᓯᒪᓂᐊᕐᓗᒋᑦ ᐱᓕᕆᐊᕐᒥᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ ᐊᒻᒪ ᖃᐅᔨᓴᐃᓂᖏᑦ TMAC-ᑯᑦ ᒪᓕᒡᓗᒍ Type A ᐃᒪᕐᒧᑦ ᓚᐃᓴᖕᓯ 2AM-DOH1335, 2AM-BOS1835, Type B ᐃᒪᕐᒧᑦ ᓚᐃᓴᖕᓯ 2BB-MAE1727, 2BB-BOS1727, ᐊᒻᒪ ᕿᓂᖅᓴᐃᓂᕐᒧᑦ Type B ᐃᒪᕐᒧᑦ ᓚᐃᓴᖕᓯ 2BE-HOP1222 ᐅᑭᐅᖅ 2020-ᒧᑦ.

2020-ᒥᑦ ᐃᓂᓕᐅᕆᓂᕐᒧᑦ, ᐊᐅᓚᖅᑎᑦᑎᓂᕐᒧᑦ ᐊᒻᒪ ᐃᖏᕐᕋᔭᖕᓂᕐᒧᑦ ᑭᒡᓕᖃᕐᓂᐅᔪᑦ ᓄᕙᒡᔪᐊᕐᓇᖅ-19 ᐱᔾᔪᑎᒋᐸᓗᒍ ᖃᓄᐃᓕᕐᓂᐅᔪᓂᒃ ᖃᐅᔨᓴᐃᓂᖃᖅᑎᑦᑎᓚᐅᖅᑐᖅ. ᑭᓯᐊᓂ ᐊᕙᑎᒥᒃ ᒥᐊᓂᖅᓯᓂᕐᒧᑦ ᐊᒻᒪ ᒪᓕᒃᑕᐅᓂᖓ Hᐆᑉ ᐸᐃᒥᑦ ᓱᕗᓪᓕᖅᐸᐅᑎᔭᐅᓯᒪᐃᓐᓇᖅᑐᖅ.

ᒪᓕᖕᓂᐊᕐᓗᒋᑦ ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᕐᒧᑦ ᐅᓗᕆᐊᓇᕐᓂᐅᔪᑦ ᓄᕙᒡᔪᐊᕐᓇᖅ-19 ᐱᔾᔪᑎᒋᐸᓗᒍ, TMAC-ᑯᑦ ᐊᑐᓕᖅᑎᑦᑎᓚᐅᖅᑐᑦ ᐋᓐᓂᐊᕐᓇᕐᒥᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐸᕐᓇᐅᑎᒥᑦ Hᐆᑉ ᐸᐃᒧᑦ ᓇᑦᑎᐊᑦ (ᒫᑦᓯ) 12, 2020-ᒥᑦ. ᓇᑦᑎᐊᑦ (ᒫᑦᓯ) 17, 2020-ᒥᑦ, TMAC-ᑯᑦ ᑐᓴᖅᑎᑦᑎᓚᐅᖅᑐᑦ ᓄᖅᑲᖓᑎᓐᓂᐊᕐᓗᒋᑦ ᓄᓇᕗᒻᒥ ᐱᓕᕆᔾᔪᑎᓐᓄᑦ ᐋᓐᓂᐊᕐᓇᒥᑦ ᑐᓂᓯᕐᑯᔾᔮᕆᓪᓗᑎᒃ ᓄᓇᓕᖕᓄᑦ ᐊᒻᒪ ᐱᐅᓯᕆᐊᖅᓯᓚᐅᖅᑐᑦ ᑎᖕᒥᓲᕐᒧᐊᖅᑳᖅᑎᓐᓇᕆᑦ ᖃᐅᔨᓴᖅᑕᐅᑉᓗᑎᒃ ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᔪᓕᕆᔨᒧᑦ ᐊᑐᓂ ᖃᑉᓗᓈᓂᖕᖔᖅᑐᓂᒃ ᐃᑭᒪᔪᓂᒃ. ᖃᑉᓗᓈᓂᖕᖔᖅᑐᑦ ᐱᓕᕆᔩᑦ ᐊᓯᐊᓄᑦ ᑎᖕᒥᓲᕐᒧᐊᖄᑦᑕᖅᑐᑦ ᒥᒃᓵᕆᐊᖅᑎᓪᓗᒍ ᒪᕐᕈᐃᖅᑕᕐᓂᖅ ᐱᓇᓱᐊᕈᓯᕐᒥᑦ ᐊᑕᐅᓰᖅᑕᓕᖅᐸᑦ ᑕᖅᑭᒥᑦ, ᑭᖑᓂᐊᒍᓪᓗ ᑭᐳᖃᑦᑕᐅᑎᑉᓗᑎᒃ ᐱᓕᕆᔩᑦ ᐱᖓᓱᑦ ᐱᓇᓱᐊᕈᓯᑖᒃᑯᑦ. ᐱᒻᒪᕆᐅᓗᐊᖏᑦᑐᑦ ᐱᓕᕆᔩᑦ ᐊᒻᒪ Hᐆᑉ ᐸᐃᒧᐊᖅᑕᕐᓃᑦ ᓄᖅᑲᖅᑎᑕᐅᓚᐅᖅᑐᑦ 2020-ᒥᑦ.

ᐊᑕᐅᑦᑎᒃᑰᖅᓱᓂ ᐅᔭᕋᒃᑕᕆᐊᕐᒥᑦ ᐊᐅᓚᖅᑎᑦᑎᓂᕐᓄᑦ, TMAC-ᑯᑦ ᐊᔪᕐᓇᖅᑐᒥᒃ ᐃᓯᒪᓕᐅᓕᓚᐅᖅᑐᑦ ᒥᒃᓵᓂᐊᕐᓗᒋᑦ ᐊᐅᓚᖅᑎᑦᑎᓂᖓᓪ ᐊᒻᒪ ᐱᓕᕆᔨᖏᑦ ᐱᐅᓚᖑᓂᖓᓄᑦ. ᕿᓂᖅᓴᐃᓃᑦ Hᐋᑉ ᐸᐃᒥᑦ ᐊᒻᒪ ᐱᕙᓪᓕᐊᓂᓗᒃᑖᑦ Madrid ᐅᐊᖕᓇᒥᑦ ᓄᖅᑲᖅᑎᑕᐅᓚᐅᖅᑐᑦ. 2020-ᒥᑦ, TMAC-ᑯᑦ ᐊᒥᓲᔪᖕᓂᕆᐊᓚᐅᖅᑕᖏᑦ ᐱᓕᕆᔨᖏᑦ ᐊᒻᒪ ᑳᓐᑐᕋᒃᑲᖅᑐᑦ ᐅᔭᕋᒃᑕᕆᐊᕐᒥᑦ 120 ᖃᓂᖓᓄᑦ, ᐃᓂᖃᕈᖕᓇᕐᓂᖓᓄᑦ ᓄᓇᓕᐊᓛᑉ 345 ᐃᓄᖕᓄᑦ. ᐃᖃᓗᒃᑑᑦᑎᐊᖅ, ᓄᓇᕗᒻᒥᑦ ᑎᑎᕋᕙᒃ ᐅᒃᑯᐊᖅᓯᒪᓚᐅᖅᑐᖅ ᐃᓄᒃᑖᓄᑦ ᐱᓕᕆᔩᑦ ᐊᖏᕐᕋᖏᓐᓂᑦ ᐱᓕᖃᑦᑕᕐᓗᑎᒃ; ᐊᒻᒪ ᐅᒃᑯᐃᖅᓗᑎᒃ ᑭᖑᓂᐊᒍᑦ 2020 ᐊᑕᐅᑦᑎᒃᑰᕐᓗᑎᒃ ᐊᓯᖏᓐᓂᒃ ᐱᓕᕆᕝᕕᖕᓂᑦ ᐅᒃᑯᐃᔭᖅᑐᓂᒃ. ᐱᓕᕆᔩᑦ ᑐᕌᓐᑐ, ᐋᓐᑎᐅᕆᔪ ᑎᑎᕋᕝᕕᖕᒥᑦ ᐊᖏᕐᕋᖕᒐᓐᓂᒃ ᐱᓕᖃᑦᑕᐃᓐᓇᖅᑐᑦ.

ᓂᐅᕙᐊᒃᓴᓕᕆᓂᕐᒧᑦ ᐊᐅᓚᖅᑎᑦᑎᓃᑦ ᑲᔪᓯᔪᑦ 2020-ᒥᑦ ᑑᑭᔅ-ᒥᑦ ᐋᖅᑭᐅᒪᑎᕐᓗᒍ ᓯᖃᓕᑎᕆᕙᖕᒧᐊᖅᑎᕆᓃᑦ ᐊᒻᒪ ᐱᐅᓯᕆᐊᖅᓯᒪᓂᖏᑦ ᒎᓗᑖᖅᑐᕐᓃᑦ. 2020-ᒥᑦ ᓯᖃᓕᑎᕆᓂᖃᓚᐅᖅᑐᑦ 382,811 ᑕᓐᓃᒃ (t) ᐅᔭᕋᒃᑕᖅᑕᐅᔪᑦ ᑯᕕᔭᐅᑦ 108,724 ᐊᐅᓐᓯᐅᑉᓗᑎᒃ ᒎᓗᐃᑦ, ᐊᒻᒪ ᐱᓕᕆᐊᖑᑦᑎᐊᖅᓯᒪᔪᖅ 108,724 t-ᖑᔪᑦ ᓴᐃᔭᓇᐃᑦᒧᑦ. ᐊᒥᓲᔪᖕᓂᕆᐊᖅᑳᖅᑎᓪᓗᒋᑦ ᐱᓕᕆᔨᖏᑦ, TMAC-ᑯᑦ ᐅᔭᕋᒃᑕᖅᑕᐅᔪᓂᒃ ᐱᓕᐅᕆᓂᖃᓚᐅᖅᑐᑦ ᒥᒃᓵᓂᐊᖅᓯᒪᔪᓂᒃ ᐊᒻᒪ ᑎᑭᐅᑎᓂᖃᖅᓗᑎᒃ ᐱᓕᐅᕆᓂᕐᓂᒃ ᐊᒻᒪ ᐱᐅᓯᕆᐊᖅᓯᒪᔪᓂᒃ ᒎᓗᑖᖅᑐᕐᓂᕐᒥᒃ.

ᕈᐊᐳᑦ ᐃᒪᖓᓄᑦ ᑯᕙᑎᑦᑎᓂᕐᒧᑦ ᐋᖅᑭᐅᒪᔪᖅ ᐱᕆᐊᖅᑎᑕᐅᓚᐅᖅᑐᖅ ᑕᖅᕿᓐᓇᕐᔪᐊᕐᒥᑦ (ᔭᓄᐊᕆ) ᐊᒻᒪ ᑯᕙᓯᓂᖅ ᐱᕆᐊᓚᐅᖅᑐᖅ ᒪᓕᒡᓗᒋᑦ MDMER ᐊᕗᓐᓂᕙᖕᒥᑦ (ᕙᕗᐊᕆ)ᐊᑯᓐᓂᕈᕐᕙᖕᒧᑦ (ᐃᐳᕆᓪ) 2020-ᒥᑦ. ᑯᕙᑎᑦᑎᓂᖅ ᕈᐊᐳᑦ ᐃᒪᖓᓄᑦ ᓄᖅᑲᖅᑎᑕᐅᓚᐅᖅᑐᖅ ᐊᑯᓐᓂᕈᕐᕙᒃ (ᐃᐳᕆᓪ) 2020-ᒥᑦ ᑐᖑᔪᖅᑐᖅᑕᖅᑲᓕᖅᓯᒪᓂᖓᓄᑦ. ᐃᒪᕐᒥᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᑯᕙᑎᑦᑎᕙᒃ (ᑯᕙᑎᑦᑎᕙᒃ 3) ᐃᓕᔭᐅᓚᐅᖅᑐᖅ ᑑᓇᔅᒥᑦ ᐱᐅᓯᕆᐊᕐᓂᐊᕐᓗᒍ ᑕᐃᒪᐅᔪᖅ ᐃᒪᕐᒥᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐋᖅᑭᐅᒪᔪᖅ.

ᐃᓄᖕᓄᑦ ᑐᕋᖕᒐᔪᓂᒃ ᓴᓇᕗᓪᓕᐊᓂᕐᓂᑦ ᐃᓚᐅᔪᑦ ᐊᖏᒡᓕᒋᐊᖅᑕᐅᓂᖓ TIA-ᒥᒃ ᐅᑎᖅᑎᑎᕆᓂᖅ, ᐱᓕᕆᐊᖑᐸᓗᓂ ᒥᑦᑕᕐᕕᒃ ᐊᒻᒪᓗ ᐃᓕᔭᐅᐸᓗᑎᒃ ᐱᖕᒐᓱᑦ ᐃᒪᕐᒥᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᑯᕕᑎᑦᑎᕙᕕᑦ ᖃᓂᑕᖕᒐᓂᑦ Madrid-ᒥᑦ ᐊᒃᑕᑰᖅᑕᐅᔪᑦ ᐅᔾᖃᓄᑦ ᑐᙵᕕᖕᒥᑦ.

ᓄᓇᓕᕆᓃᑦ ᑲᔪᓯᓚᐅᖅᑐᑦ Madrid ᐅᐊᖕᓇᒥᑦ ᐱᒋᐊᓵᖅᑎᓪᓗᒍ 2020 ᐃᑲᔪᖅᓱᒍ ᓈᖅᑐᖅ ᑲᓇᖕᓇᒥᑦ Crown Pillar ᐊᒻᒪᓗ Madrid ᐅᐊᖕᓇᒥᑦ ᓄᓇᐅᑉ ᐃᓗᐊᓂᑦ ᐱᐊᓂᒃᐸᓪᓕᐊᓂᖅ. ᒪᓂᖅᑲᒃᓴᐃᓚᐅᖅᑐᑦ ᐊᒻᒪᓗ ᖃᓪᓕᖅᑐᐃᐸᓗᑎᒃ ᓈᖅᑐᖅ ᑲᓇᖕᓇᒥᑦ Crown Pillar-ᒥᑦ ᐅᖓᑕᐅᑦᑎᓯᒪᔪᑦ ᖃᓕᓅᓕᖅᑐᖅᑕᐅᔪᑦ ᐊᒻᒪᓗ ᐱᓕᕆᐊᖑᓂᖏᑦ Madrid ᐅᐊᖕᓇᒥᑦ ᐃᒪᖅ ᐊᑐᖅᑕᐅᔪᒧᑦ ᑕᓯᕋᔭᖏᑦ.

ᓄᓇᐅᑉ ᐃᓗᐊᓂᑦ ᐅᔭᕋᒃᑕᕆᐊᓕᕆᓃᑦ ᑲᔪᓯᓚᐅᖅᑐᑦ ᑑᕆᕐ ᐅᔭᕋᒃᑕᕆᐊᕐᒥᑦ, Madrid ᓄᓇᐅᑉ ᐃᓗᐊᓂᑦ ᐊᒻᒪᓗ ᖗᖕᒐᓂᑦ ᐊᐅᓲᖅᑎᑦᑎᓃᑦ, ᐃᓚᐅᐸᓗᓂ ᐅᔭᕋᒃᑕᕆᐊᓕᕆᓂᖏᑦ, ᓄᖅᑲᖅᑎᑕᐅᓚᐅᖅᑐᖅ ᓇᑦᑎᐊᑦ (ᓛᑦᓯ) 2020-ᒥᑦ. ᑑᕆᕐ-ᒥᑦ, TMAC-ᑯᑦ ᑕᐅᑐᒐᖃᓚᐅᖅᑐᑦ ᐱᓕᐅᕆᕙᓪᓕᐊᓂᕐᒥᒃ ᐱᓕᕆᐊᖑᓯᒪᔪᒥᑦ ᓴᓂᕋᕐᓂᑦ ᐊᒻᒪᓗ ᐅᔭᕋᒃᑕᖅᑕᐅᔪᑦ ᓄᓇᐅᑉ ᖗᖕᒐᓄᐊᖅᑎᕆᓂᕐᓂᒃ. ᓯᒥᒃᑐᐃᓂᖅ ᑑᕆᕐ-ᒥᑦ ᐃᒪᕐᒥᒃ ᐃᓗᐊᓄᑦ ᑯᕕᔪᓂᒃ ᒥᒃᓱᑎᑦᑎᕚᓪᓕᑦᑎᐊᓚᐅᖅᑐᖅ 2020-ᒥᑦ.

ᐅᑭᐊᒃᓵᒥᑦ, TMAC-ᑯᑦ ᖃᐅᔨᓚᐅᖅᑐᑦ ᐊᓯᐊᓂᒃ ᐱᐊᓂᑦᑎᐊᖅᑐᒥᒃ ᐅᒥᐊᕐᔪᐊᓂᒃ ᐊᐅᓛᖅᑎᑦᑎᓂᕐᓄᑦ ᐃᓚᐅᐸᓗᑎᒃ ᓂᐅᕕᕐᓂᖏᑦ ᐊᒻᒪᓗ ᐊᒡᔭᖅᑕᐅᓂᖓ ᐅᖅᓯᐊᓗᒃ ᐊᒻᒪᓗ ᖏᖅᑕᖅᑐᐃᑦ ᐊᒻᒪᓗ ᐊᑯᐸᓪᓕᖅᑎᕈᑏᑦ ᐅᔭᕋᒃᑕᕆᐊᕐᒧᑦ ᐊᑐᖅᑕᐅᓂᐊᖅᑐᓂᒃ ᐊᒻᒪᓗ ᓯᖃᓪᓕᑎᕆᓂᕐᓄᑦ. ᓄᓇᒃᑰᕈᑎᕐᔪᐊᑦ ᐊᑐᖅᑕᐅᓯᒪᔪᑦ ᓈᖅᑐᖅ ᑲᓇᖕᓇᒥᑦ Crown Pillar-ᒥᑦ ᐅᑎᖅᑎᑎᕆᓂᕐᒧᑦ ᐲᖅᑕᐅᓚᐅᖅᑐᖅ ᐅᔭᕋᒃᑕᕆᐊᕐᒥᑦ ᐅᒥᐊᕐᔪᐊᕐᒧᐊᖅᑕᐅᐸᓗᑎᒃ.

ᐅᓗᕆᐊᓇᖅᑐᖃᖅᑐᑦ ᐊᒃᑕᑯᐃᑦ ᐃᓂᐅᔪᓄᐊᖅᑕᐅᑦᑎᐊᓚᐅᖅᑐᑦ ᖃᓄᐃᓕᓂᖃᙱᓐᖓᑎᒃ. ᐊᒃᑖᕆᓃᑦ, ᐅᖅᓱᐊᓗᒃᑐᕐᓃᑦ ᐊᒻᒪᓗ ᐊᑯᐸᓪᓕᖅᑎᕈᑎᓂᒃ ᑐᖅᑯᖅᓯᒪᔪᑦ ᐊᔾᔨᒋᔭᐃᓐᓇᖅᑕᖏᑦ ᐅᑭᐅᑦ ᐊᓂᒍᖅᑐᓂᑐᑦ. 8 ᑯᕕᔪᑦ ᐅᖃᐅᓯᐅᓚᐅᖅᑐᑦ ᓄᓇᕗᒻᒥᑦ ᑯᕕᔪᖃᖅᐸᑦ ᐅᖃᓗᒃᕕᐅᕝᕕᖕᒧᑦ, ᐃᒪᕐᒧᑦ ᓚᐃᓴᓐᓯᒥᒃ ᖃᐅᔨᓴᐃᔨᑦ ᐊᒻᒪᓗ ᕿᑎᕐᒥᐅᓂᑦ ᐱᓕᕆᐊᕐᔪᐊᓄᑦ ᑎᑎᕋᕐᕕᖕᒧᑦ. ᐊᒥᐊᒃᑯᔪᑦ ᑯᕕᔪᑦ 2020-ᒥᑦ ᒥᑭᔫᑕᐅᓚᐅᖅᑐᑦ, ᓄᓇᓕᐊᓖᕐᒥᑦ ᑐᙵᕕᖕᒐᓃᕐᓱᑎᒃ ᐊᒻᒪᓗ ᐱᕐᑯᑎᓂᑦ, ᐅᐸᓗᐊᕝᕕᐅᑲᐅᑎᒋᐸᓗᑎᒃ ᐊᒻᒪᓗ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᑲᐅᑎᒋᓚᐅᕐᓂᖕᒋᓐᓄᑦ ᐅᔾᔨᕐᓇᖅᑐᖃᓚᐅᖕᒋᑦᑐᖅ ᐊᒃᑐᖅᓯᓂᐅᔪᓂᒃ ᐊᕙᑎᒧᑦ.

ᐊᒪᕐᒥᒃ ᐊᑐᖅᑕᐅᔪᒥᒃ ᖃᐅᔨᓴᐃᓂᖃᓚᐅᖅᑐᑦ 2020-ᒥᑦ ᒪᓕᒃᓱᒍ Type A ᐃᒪᕐᒧᑦ ᓚᐃᓴᓐᓯ 2AM-DOH1335 ᑑᕆᕐᒧᑦ, Type A ᐃᒪᕐᒧᑦ ᓚᐃᓴᓐᓯ 2AM-BOS1835 ᐊᒻᒪᓗ Type B ᐃᒪᕐᒧᑦ ᓚᐃᓴᓐᓯ 2BB-BOS1727 ᐹᑦᑖᓐᒧᑦ, Type B ᐃᒪᕐᒧᑦ ᓚᐃᓴᓐᓯ 2BB-MAE1727 ᓯᕗᓪᓗᒃᓯᒪᔪᖅ ᕿᓂᖅᓴᐃᓂᕐᒧᑦ Madrid-ᒥᑦ, ᐊᒻᒪᓗ Type B ᐃᒪᕐᒧᑦ ᓚᐃᓴᓐᓯ 2BE-HOP1222 ᖃᓂᑦᑐᒥᑦ ᕿᓂᖅᓴᐃᓂᕐᒧᑦ. ᑖᑉᑯᓇᓂ ᐃᒪᕐᒧᑦ ᓚᐃᓴᓐᓯᓂᑦ ᐃᓚᐅᔪᑦ ᒪᓕᒐᐃᑦ ᐆᒃᑐᕋᐃᓂᕐᓄᑦ ᐃᓚᐅᐸᓗᑎᒃ ᑎᑎᕋᖅᑕᐅᓂᖏᑦ ᓈᓴᐅᑏᑦ/ᑎᑎᖅᑲᐃᑦ ᖃᓄᑎᒋᐅᓂᖓᓄᑦ ᐃᒪᖅ ᐱᔭᐅᔪᖅ ᓱᓇᑐᐃᓐᓇᓄᑦ ᐱᔾᔪᑕᐅᔪᓄᑦ, ᐆᒃᑐᕋᖅᑕᐅᓂᖏᑦ ᑯᕕᔪᑦ (ᓲᕐᓗ, ᐱᓕᕆᐊᖑᓯᒪᔪᖅ ᖁᕐᕕᖕᒥᙳᖅᑐᒥᑦ ᑯᕕᔪᑦ) ᑯᕕᔪᑦ ᐊᕙᑎᒧᑦ, ᐊᒻᒪᓗ ᖃᐅᔨᓴᐃᓂᖅ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᖓᓄᑦ ᐱᓕᕆᕝᕕᐅᔪᓂᑦ (ᓲᕐᓗ, ᖗᖕᒐᓂᑦ ᑯᕕᔪᖅ ᑕᐅᓄᖓ ᓴᓇᕝᕕᐅᔪᒧᑦ, ᒪᖁᒃᑐᒥᑦ ᐃᒪᖅ ᐱᔪᖅ ᓱᓇᑐᐃᓐᓇᓕᐅᕆᓂᒃᑯᑦ ᑐᖅᑯᖅᓯᓯᒪᕝᕕᖕᒧᑦ ᐋᖅᑭᐅᒪᔪᒥᑦ, ᖁᕐᕕᖕᒥᙳᖅᑐᒥᑦ, ᐅᖅᓱᐊᓗᓕᖕᒥᑦ ᐃᒪᖅ ᑯᕕᔪᖅ, ᑕᒪᒃᑯᐊᕋᓗᐃᑦ). ᐃᒪᕐᒥᒃ ᐊᑐᕐᓂᐅᔪᖅ 2020-ᒥᑦ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᑐᖅ ᓈᒻᒪᒋᔭᐅᔪᓄᑦ ᑮᓕᐅᔪᓄᑦ. ᐊᓯᐊᙱᕐᓂᖅᑕᖃᓚᐅᖏᑦᑐᖅ ᐃᒪᕐᒥᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᓂᒃ ᐅᔭᕋᒃᑕᕆᐊᕐᒥᑦ. ᑮᓕᖃᕐᓂᖕᒐᓄᑦ ᐹᑦᑖᓐᒧᐊᕈᖕᓇᕐᓂᕐᒧᑦ ᐊᐅᔭᒃᑯᑦ, ᖁᓕᒥᒨᓕᖕᒥᒃ ᐃᓂᐅᔪᒧᐊᖃᑦᑕᓚᐅᖅᑐᑦ ᖃᐅᔨᓴᐃᓂᐊᕐᓗᑎᒃ ᐊᒻᒪᓗ ᐃᒪᐃᔭᐃᓂᕐᒧᑦ ᐱᔭᕆᐊᖃᖅᑐᓂᒃ ᓱᓇᑐᐃᓐᓇᓂᒃ ᐋᖅᑭᐅᒪᔪᓂᒃ ᐃᒪᖃᖅᑐᓂᑦ. ᒪᓐᓃᑦ (ᔫᓂ) 14, 2020-ᒥᑦ, ᑯᕕᔪᕐᒥᒃ ᖃᐅᔨᓚᐅᖅᑐᑦ ᑕᐅᓄᖓ ᑰᒃᑐᒥᑦ Madrid ᐅᐊᖕᓇᒥᑦ ᐊᑐᖅᑕᐅᔪᖅ ᐃᒪᖃᐅᓯᕝᕕᖕᒥᑦ Madrid ᐅᐊᖕᓇᐅᑉ ᐃᓂᖓᓃᑦᑐᖅ. ᒪᓐᓃᑦ (ᔫᓂ) 15, 2020-ᒥᑦ, ᓄᓇᕗᒻᒥᑦ ᑯᕕᔪᖃᖅᐸᑦ ᐅᖃᓗᒃᕕᐅᕝᕕᒃᑯᑦ ᖃᐅᔨᑎᑕᐅᓚᐅᖅᑐᑦ ᖃᕆᑕᐅᔭᒃᑯᑦ ᑎᑎᕋᕝᕕᐅᐸᓗᑎᒃ ᑯᕕᔪᖅ ᖃᓄᑎᒋᐅᓂᖓ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᒥᒃ 264m³ ᐊᑐᖅᑕᐅᔪᖅ ᐃᒪᕐᒥᑦ. ᐸᕐᓇᐅᑕᐅᓯᒪᙱᒃᑲᓗᐊᖅᑎᓪᓗᒍ, ᐃᒪᖅ ᑯᕕᑎᑕᐅᔪᒧᑦ ᐊᑐᖅᑕᐅᔪᒥᑦ ᓚᐃᓴᓐᓯᒦᑦᑐᒧᑦ ᑎᑭᐅᑎᓯᒪᓚᐅᖅᑐᖅ ᐃᓚᐅᖏᓐᖓᑎᒃ ᑲᑎᙵᒋᑦ ᑕᒫᓂᖅᓴᖅᑐᑦ ᓯᑎᔪᐃᑦ (TSS).

ᓄᓇᓕᖕᒥᑦ ᑐᓴᐅᒪᑎᑦᑎᓃᑦ 2020-ᒥᑦ ᑕᐅᑐᒐᖃᓚᐅᖅᑐᑦ ᐱᑦᑕᐅᔫᒃᑯᑦ ᐃᓚᐅᑎᑦᑎᓂᕐᒥᒃ ᐊᒻᒪᓗ ᐊᑑᑎᖃᕐᓂᒃᑯᑦ ᐊᒻᒪᓗ ᐃᓄᐃᑦ ᒥᒃᓵᓄᑦ ᐅᖃᐅᔾᔨᓂᕐᒧᑦ ᑲᑎᒪᔩᕋᓛᑦ ᐱᔾᔪᑎᒋᐸᓗᒍ TMAC ᐊᐅᓛᖅᑎᑦᑎᓂᖓᑦ, ᐱᓕᕆᐊᒃᓴᓄᑦ ᐊᒻᒪᓗ ᑳᓐᑐᕌᒃᑎᑦᑎᓂᕐᓄᑦ ᐊᒻᒪᓗ ᐅᖃᖅᑎᒋᓗᒋᑦ TMAC-ᑯᑦ ᐊᕙᑎᒥᒃ ᖃᐅᔨᓴᐃᓂᖕᒋᓐᓂᒃ ᐊᒻᒪᓗ ᐃᖃᓗᓕᕆᓂᕐᒧᑦ ᐋᖅᑭᒃᓯᓂᐅᔪᓂᒃ. TMAC-ᑯᑦ ᑎᑎᕋᕐᕕᖓᑦ ᐃᖃᓗᒃᑑᑦᑎᐊᕐᒥᑦ ᐅᒃᑯᐊᖅᓯᒪᓚᐅᖅᑐᖅ ᐃᓄᓗᒃᑖᓄᑦ ᓄᕙᒡᔪᐊᕐᓇᖅ-19 ᐱᒋᐊᓵᖅᑎᓪᓗᒍ ᑕᒪᐃᓐᓇᒎᓗ ᐊᔪᕐᓇᓚᐅᖅᑐᖅ ᐃᖃᓗᒃᑑᑦᑎᐊᕐᒥᐅᓂᒃ TMAC-ᑯᑦ ᐱᓕᕆᔨᖏᓐᓂᒃ ᖃᓄᐃᓕᐅᕈᓘᔭᖅᑲᑎᖃᕐᓂᕐᒥᑦ, ᖃᕆᑕᐅᔭᒃᑯᑦ ᐊᑐᖅᑕᐅᔪᑦ ᑐᓴᖅᑎᑦᑎᓃᑦ ᐅᒃᑯᐃᖕᒫᖅᑎᑕᐅᖏᓐᓇᖅᓱᑎᓪᓕ.

TMAC-ᑯᑦ ᐊᑐᐃᓐᓇᕐᓂᐊᖅᑐᑦ ᒪᓕᒋᐊᓕᖕᓂᒃ ᐊᔾᔨᒌᙱᑦᑐᓂᒃ ᒪᓕᒡᕐᒧᑦ ᐱᓯᕆᐊᖃᖅᑎᑕᐅᔪᓂᒃ ᐊᒻᒪᓗ ᓄᓇᓕᖕᒥᑦ ᐱᓕᕆᖃᑎᖃᐃᓐᓇᕐᓗᑎᒃ. ᐊᕙᑎᓕᕆᓂᕐᒥᒃ ᖃᐅᔨᓴᐃᓂᖅ ᒪᓕᒃᑯᒋᑦ ᑕᐃᒪᐅᔪᑦ ᐃᒪᕐᒧᑦ ᓚᐃᓴᓐᓰᓂᑦ, ᐱᓕᕆᐊᕐᒧᑦ ᐋᖅᑭᐅᒪᓂᖕᒐᓄᑦ ᐊᖏᖃᑎᒌᒍᑏᑦ, ᐱᓕᕆᐊᕐᒧᑦ ᓇᓗᓇᐃᒃᑯᑏᑦ, ᐱᔪᖕᓇᖅᑎᑦᑎᔾᔪᑏᑦ, ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐸᕐᓇᐅᑏᑦ ᐊᒻᒪᓗ ᐊᕙᑎᒥᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᕐᒧᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐸᕐᓇᐅᑏᑦ ᑲᔪᓯᓂᐊᖅᑐᑦ 2021-ᒥᑦ. TMAC-ᑯᑦ ᕿᕝᕙᐊᓲᒃᑐᑦ ᐊᕙᑎᓕᕆᔾᒃᑯᓐᓄᑦ ᑐᓂᓯᔪᓐᓇᕐᒪᑕ ᓇᓗᓇᐃᔭᖅᓯᒪᔪᓂᒃ ᐅᓂᑉᑳᒦᑦᑐᓂᒃ ᐊᒻᒪᓗ ᓂᕆᐅᒃᑐᑦ ᐃᓚᓕᐅᑎᕙᓪᓕᐊᓂᖓᓂᒃ ᐊᒡᓃᑯᒃᑯᓐᓄᑦ 2021-ᒥᑦ ᐃᑲᔪᕐᓂᖕᒋᓐᓄᑦ ᐱᕙᓪᓕᐊᓂᖓᓄᑦ Hᐆᑉ ᐸᐃ ᐱᔭᒃᓴᐅᑎᖃᕐᓂᒃᑯᑦ ᐃᒃᐱᒍᓱᖕᓂᖃᖅᓱᑎᒃ ᐱᔪᕆᐊᖃᕐᓂᐅᔪᓂᒃ ᐋᖅᑭᒃᑕᐅᓯᒪᔪᓂᒃ ᐊᕙᑎᓕᕆᔾᒃᑯᓐᓄᑦ.

Atanguyup Titikgakgaikhimayunik Havakhautit – Inuinnaqtun

Kapihiliktuumi Havaaghaq nayugalik nanminiqmi aktigiyuq 20 km-nik x 80 km-nik hivuraani hinaani Melville Sound-mi Nunavunmi, Kanatami, aulapkaqtitauvaghunilu TMAC Resources Inc.-kunnit (TMAC) 2020-mi. February 2-mi, 2021-mi TMAC-kut niuviqtauhimayuq Agnico Eagles Uyaraghiuqvianit (AEM) kihimi TMAC-kut tajja maligaliqiyikkut nanminiuyuq tajjalu nanminiriliqtait Agnico-kut. Tamangnik pilaarutit, havaaghat, akiliqtaghait TMAC-kut munarivagait TMAC-kut kihimi katitkumik Agnico-kut hivunighami 2021-mi.

2020-mi parnaiyainiq, aulapkainiqmut aullaaqtaqtunullu nutqaqtittiyut Qalakyuarnaq-19-mit ayuqhautauyut havaktunik-munaqhiyunik. Kihimi avatiniq munaqhiqyut maliguaqtullu Kapihiliktuumi irinigiyaulluaqtut.

Kiutjutigiplugu aanniaqtailiniqmut amirnautinik Qalakyuarnaq-19-mut, TMAC-kut aullaqtittihimayut taapkuninnga Hangutaqtunik Aanniarutinik Munaqtit Parnaiyautainik Kapihiliktuumi March 12-mi, 2020-mi. March 17-mi, 2020-mi, TMAC-kut tuhaqtittihimayut ihumaliugainik taimaa havaguiqtittillagahuaqtait Nunavunmiut-havaktit amirnaiqpaallirahuaqhugu hangutaqtuq qalak inuilrumut nunallaarnut Nunavunmi aullaqtittiplutiklu havauhiqnik taimaa ihivriuqhiplutik tingminahuaqnik hivuraaniqmiunit aanniaqtuliqiyimit. Hivuraaniqmiunik havaktinik agyaqtaqtut ikighivaalliqhimayut malruiqtunit 1 week-mi taimaa atauhiiliqhutik tatqiqhiutimi, kinguanilu havaktit kaipiktaqpaktut pingahunik Santinik havaghutik. Tamangnik ihariagiyaunngittut havaaghat pulaaqtillu Kapihiliktuumut nutqaqtitauhimayut 2020-mi.

Maliguaqhutik amihuuyut uyaraghiuqtit, TMAC-kut ayuqnaqtumik ihumaliuqhimayut taimaa mighivaalliriamik ikighivaalliriamiklu havaktiit ihuaqnighakkut. Nalvaaqhiuqtit havaangit Kapihiliktuumi hanayullu havaangit Madrid North-mi nutqaqtitauhimayullu. Nunam iluani hanahimmaaqpaktut Doris-mi ikighivaalliqhimaplutik taapkua TMAC-kut ihumagilluaqhugit hauyauhimayunit uyaraghiuqtut kuluniklu qaanganunngaqtiniriniqmik. Marliliqhiyut Doris-mi ihuaqutauqpiaqtuq kuvihuiqpaalliutaugami imaqmik ukiumi 2020-mi. 2020-mi, TMAC-kut ikighivaalliqhimayait havaktiit kaantulaaktillu havakvingnit taimaa 120-nguyunik, havaqviqaqhutik inighalingmik 345-nik inungnik. Iqaluktuuttiaqmi, Nunavunmi havakviat umighimavaktuq inungnut havaktiillu havaghutik aimaviinit; angmatqighutik nungutinnagu 2020 malighugit ahiillu nanminiit. Havaktiit talvanngat Toronto, Ontario-mi havakvianit huli aimavingnit havakpaktut.

Manighiuqtit havaangit aulahimmaaqtut 2020-mi Doris-mi uyaraktaqtait qipliqhiiplugit kulutaqpaallirahuaqhutik. 2020-mi, qipliqhiviit hanahimayut 382,811 tonnes-nik (t) uyarangnik kuvihiplutik 108,724 ounces-nik kulunik, ihuaqtukkullu iniqhittiaqhutik 17,886 t-nik tuqunaqtunik cyanide-nik uyaraktarvingnik. Ikighivaalliqhugit havaktiit, TMAC-kut uyaraghiuqhimmaaqpaktut kayumiikpaalliqhutik kihimi aulattiaqhutik kulutaqpaktut.

Roberts Kangiqhuani Imaiyaqviat hanahimayuq aullaqtitaupluni January-mi anialattiplutik Roberts Kangiqhuanut maliqhugu MDMER February-mit talvunga August 2020-mut. Anialattiyut Roberts Kangiqhuanut nutqaqtitauhimayuq August 2020-mi nauvalliayunut kingungnut ukiuq tamaat. Imautighanik (Pakpaut 3) iliuraqtauhimayuq Doris-mi ihuaqhivaalliriamik imautainut ingilrutit.

Hanayunit iniqhihimayait taapkua ilaaqtuqhugu TIA-nit uhiiyaqvianit, manigighaqhugu milvik iliuraiplutiklu pingahunik imautinut pakpautinik kikliani Madrid-mi hiqquplugaqnit.

Nunaliqivaktut talvani Madrid North havakvianit 2020 atulihaaqtumi ikayuqhugu Naartok Kivalliqhianit Itiqtarvianit Madrid North-mi nunam iluanunngaqtumi. Hanaplugu manighiplugu amiqnaiyaqhugulu Naartok Kivalliqhianit Itiqtaqvianit qaanga hanaplugulu Madrid North-mi Imautait Tahiraq.

Nunam iluani uyaraghiuqtut havakpaktut Doris Uyaraghiuqvianit, talvanittauq Madrid-mi nunam iluani qaanganilu havaghutik, uyaraghiuqhutiklu Naartok Kivalliqhianit Itiqtarvianit, nutqaqtitauhimayt March 2020-mi.

Ukiaghami, TMAC-kut naammaktumik umiakkut agyaqtaqhimayut niuviqhutik agyaqtauplunilu uqhugaq qagaqtautillu ikighatillu ingilrutighait uyaraghiuqtut qipliqhaiyullu. Pualritit ingilrutit atuqtauhimayut talvani Naartok Kivalliqhianit Itiqtarvianit uyaraghiuqvianit ahivaqtauhimayuq havakvingnit umiakkut.

Qayangnaqtut kuvvikkuit ihuaqtukkut utiqtitauhimayut ayuqnaittumik. Kuvvikkuit, uqhughat atuqtaghat ikkighatillu tutquumaviat aajjikkutauyuq hivuanit ukiunit. 8-nguyut kuvihimayut naunaiqhitiyauhimayut talvunga Nunavunmi Kuviyuqarniqqat Hivayautaat, Imaqmik Laisiutinik Ihivriuqhiyimut talvungalu KIA-kut Angiyut Havaaghat havakvianut. Kuvihimayuttauq ahiit 2020-mi mikiyut, kuviplutik allarutinut havakvingnilu, kiuhinariqpaghutik halummaqhinariqpaghutiklu mihingnaittumik kuvivianut.

Imaq atuqtauyuq 2020-mi ihivriuqhimayuq malighugu taamna Type A Imaqmut Laisiutit 2AM-DOH1335 Doris-Madrid-mut, Type A Imaqmut Laisiutit 2AM-BOS1835 taamnalu Type B Imaqmut Laisiutit 2BB-BOS1727 Boston-mut, Type B Imaqmut Laisiutit 2BB-MAE1727 taapkununnga Nalvaaqhiuqpaalliqtunut Madrid-mi, taamnalu Type B Imaqmut Laisiutit 2BE-HOP1222 aviktuqhimayumi nalvaaqhiuqtunut. Ilittuqhitilgit imaqmut laisiutinit titiraqhimayulik qauyihaiyut ikayuutainut ilauplutik taapkua naunaitkutanik titiraqtut ilaupluni aktinianut imaiyaqhimayuq hunanutkiaq, qimilruughugit kuvviit (taapkuatut, avuliqhugit annakkuit) kuviyauhimayut avatinut, munaqhugulu immap qanuriningania nanikiaq Havakvingnit (taapkuatut, qaangani kuviralattiyut qurluqtumik hannavingnit, hilam imautainik hanahimayumit imautimit, kuvviqnit, uqhuqyualiklu kuvvikkuit, qanuqlu). Imaqmik atuqtut 2020-mi ihivriuqtauhimayuq angiqhimayunit havakvingnit. Aallannguqtuqanngittuq qaanganit imaqmik munaqhiyut havauhiinik havakvingnit Ayuqnautinut pulaaqtariamik Boston havakvianik auyami, ihuaqtukkut atuqhutik halikaaptakkut pulaaqpaghimayaat havakvik munariplugulu imaiyaqtughallu havaaghainik kitunikiaq immiqtaqtunik hanahimayunit. June 14-mi, 2020-mi, qaangani kuviralattiyumik qurluqtumik hannaviat putuguanit talvani Madrid North Imautait Tahiraa talvani Madrid North havakvianit. June 15-mi, 2020-mi, Nunavunmi Kuviyuqarniqqat Hivayaut naunaiqhitihimayut qaritauyakkut titirakkut taimaa anialattiyumik 254 m^3 halummaqhitimik imaqmik. Ahiagut taamna naahurinnaittuq, imaq anialattiyauyuq naammagiyauyuq laisiutainit kihimi taapkua naallugit hiamitittut naptuyut (TSS).

Nunallaaqnik katimaqatigihimayait 2020-mi ihumagilluaqpagait katitpallianiq naammaktukkut ihuaqtukkul nunallaarmiullu taapkualu Inuit Avatinik Unniqtuiyit Katimayiralaangit mighaagut TMAC-kut havaangit, havaaghait kaantulaaktaghaniklu katimatjutigilugilu TMAC-kut avatinik munaqhiyut mighaagut iqalliqiyillu havaaghainut. TMAC-kut Iqaluktuuttiaqmi havakvianit umighivaktuq qalakyualihaaqhutik talvuuna inuit Iqaluktuuttiaqmi katimattailivaktut TMAC-kut havaktiillu, kihimi alruyaqtuqtukut tuhaqtittigiikpaktut.

TMAC-kut maliguattiaqhimmaarahuaqpagait aallatqiik aulapkainiqmut maliktaghat ilagiittiarahuaqhugit nunallaarmiut. Avatinik munaqtiuyuq malighugit tajja atuqtauyuq Imaqmut Laisiutit, Havaaghanut Angirutit, Havaaghanut Ilitaritjutit, angirutit, atannguyait parnaiyautait avatinullu mihingnautinik munaqhiyut parnaiyautait aulavangniaqtut 2021-mi. TMAC-kut quviahuktut tunihiyaamik naunaitkutanik talvunga Nunavunmi Avatiliqiyit Katimayiinut naahurittiaqhutik katitpalliayaamik taapkualu Agnico Eagle Uyaraghiuqtit 2021-mi ikayuqtighat hanayunik Kapihiliktuumi munarittiaqhugit ihumagittiaqhugillu pitquyauhimayut taapkunannga Nunavunmi Avatiliqiyit Katimayiit.

HOPE BAY PROJECT
2021 Nunavut Water Board Annual Report

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Acronyms and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

ABA	Acid-base accounting
AEMP	Aquatic Effects Monitoring Program
Agnico	Agnico Eagle Mines Limited
ANFO	Ammonium nitrate/fuel oil
AP	Acid Production Potential
AWR	All weather road
BTD	Below the Dyke
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
CPR	Crown Pillar Recovery
CPRT	Crown Pillar Recovery Trench
CSR	Corporate Social Responsibility
CWP	Contact Water Pond
CWS	Canada-wide Standards
DCN	Doris Central
DCO	Doris Connector
DNO	Doris North
DWV	Doris West Valley
DNSEMC	Doris North Project Specific Committee
EC	Electrical conductivity
ED&T	Economic Development and Transportation
FEIS	Madrid-Boston Final Environmental Impact Statement
GN	Government of Nunavut
HCT	Humidity cell test
HR/SR	Human Resources/Social Responsibility
IIBA	Inuit Impact and Benefits Agreement

ISET	Indigenous Skills and Employment Training
KIA	Kitikmeot Inuit Association
KSEMC	Kitikmeot Socio-Economic Monitoring Committee
LTA	Landfarm Treatment Area
m	Metre
MDMER	Metal and Diamond Mining Effluent Regulations
ML/ARD	Metal leaching and/or acid rock drainage
MMER	Metal Mining Effluent Regulations
NEF	Nunavut Economic Forum
NIRB	Nunavut Impact Review Board
NP	Neutralization Potential
NWB	Nunavut Water Board
NWS	Naartok West
OPEP	Oil Pollution Emergency Plan
OPPP	Oil Pollution Prevention Plan
ORP	Oxidation-reduction potential
PAG	Potentially acid generating
PCP	Pollution Control Pond
the Project	the Hope Bay Project
pXRF	Portable X-ray fluorescence
QA/QC	Quality assurance and quality control
QIA	Qikiqtani Inuit Association
RBDS	Roberts Bay Discharge System
SCP	Sediment Control Pond
SDS	Safety data sheets
SFE	Shake flask extraction
SNP	Surveillance Network Program
SOP	Standard Operating Procedure
t	Tonnes

TDGA	*Transportation of Dangerous Goods Act*
TDS	Total dissolved solids
TIA	Tailings Impoundment Area
TIC	Total inorganic carbon
TMAC	TMAC Resources Inc.
TSS	Total suspended solids
WAD	Weak acid dissociable
WRIA	Waste rock influenced area
WRSA	Waste Rock Storage Area
WWTF	Wastewater treatment facility

1. Introduction

Hope Bay is a gold mining and exploration Project located on a property approximately 20 km × 80 km along the south shore of Melville Sound in Nunavut, Canada, and continued to be operated by TMAC Resources Inc. (TMAC) in 2021. On February 2, 2021 TMAC was purchased by Agnico Eagle Mines Limited (Agnico Eagle) and became a wholly owned subsidiary of Agnico Eagle. Effective as of January 1st, 2022, Agnico Eagle and TMAC amalgamated and continued under the Agnico Eagle name. Accordingly, by operation of law and without any further acts or steps necessary, TMAC ceased to exist and continued as Agnico Eagle, and Agnico Eagle possessed all of the property, rights, privileges and franchises and is subject to all liabilities, including civil, criminal and quasi-criminal, and all contracts, disabilities and debts of TMAC.

This report to the Nunavut Water Board (NWB) has been prepared to summarize the Project activities and monitoring conducted under Agnico Type A Water Licences 2AMDOH1335, 2AM-BOS1835, Type B Water Licences 2BB-MAE1727, 2BB-BOS1727, and the exploration Type B Water Licence 2BE-HOP1222 for 2021. Concordance tables referencing where in this report the requirements of the reporting outlined in each of the referenced water licences has been met are presented in Appendix A.

The referenced water licences include provisions for sampling programs that involve recording data related to the volume of water extracted for any purpose, testing of effluents (e.g., treated sewage effluents) discharges to the environment, and monitoring water quality within specific Project areas (e.g., surface discharge downstream of construction areas, storm water from an engineered containment structure, sewage and oily water effluent, etc.). These data are summarized and referenced on the completed NWB Annual Report Forms, included as Appendix B, and all monitoring data are provided in Appendix D of this report.

2. Regulatory Framework and Legal Matters

The key regulatory and legal documents that relates to this report are the Project Type A and B Water Licence(s), however this report is presented in context of other applicable regulatory authorizations and schedules. Agnico holds, or will soon hold, the permits and authorizations required to carry out the future work scope. A listing of the key regulatory instruments that allowed for work to be completed in 2021 is provided in Table 2-1.

Table 2-1. Key AEM Permits/Licences and Approvals

Name	Approval No.	Scope / Purpose	Term / Duration	Expiration Date
Nunavut Impact Review Board (NIRB) Project Certificate	009	Authorization for Madrid-Boston to proceed, provided certain conditions and requirements are incorporated in the various regulatory permits and authorizations issued by the regulatory agencies with permitting authority for the Hope Bay Project. The Project includes the construction of all required surface Infrastructure and operation of three new mines at Hope Bay: Madrid North, Madrid South and Boston.	Life of Doris Project	None
NIRB Project Certificate	003	Authorization for Doris to proceed provided certain conditions and requirements are incorporated in the various regulatory permits and authorizations issued by the regulatory agencies with permitting authority for the Hope Bay Project.	Life of Doris Project	None
NWB Type A Water Licence Amendment No.2	2AM-DOH1335	Water Licence for Doris and Madrid project that authorizes the construction, operation and reclamation of the Doris, Madrid and the all- weather road of the Hope Bay Project. Licence scope includes Amendment No.1.	22 years	March 2035
NWB Type A Water Licence Amendment No.1	2AM-DOH1323	Water Licence for Doris with a 10-year term that authorizes the construction, operation and reclamation of the Doris Project. Licence was renewed (with certain amendments) in November 2016. – Superseded by Amendment No. 2 2AM-DOH1835.	10 years	August 2023
NWB Type A Water Licence Amendment	2AM-BOS1835	Water Licence for the Phase 2 Boston Site that authorizes the construction, operation and reclamation of the Boston Project.	17 years	March 2035
Type B Water Licence for the HBVB including a camp at Windy Lake	2BE-HOP1222	Water Licence that allows for the use of water and disposal of waste associated with regional exploration program including drilling and camp operations.	10 years	June 2022
Type B Water Licence for bulk sample exploration at Boston	2BB-BOS1727	Water licence that allows for the use of water and the disposal of waste for the Boston Advanced Exploration Project. Licence was renewed in July 2017, was formerly 2BB-BOS1217.	10 years	July 2027

Name	Approval No.	Scope / Purpose	Term / Duration	Expiration Date
Type B Water Licence for Madrid Advanced Exploration Amendment No.2	2BB-MAE1727	Water licence that allows for the use of water and the disposal of waste for an undertaking classified as Mining and Milling as per Schedule II of the Regulations for the Madrid Advanced Exploration Project (Amended in 2018).	10 years	May 2027
Framework Agreement		Framework Agreement provides comprehensive land tenure governing the issuance of surface exploration licences, advanced exploration leases, commercial leases, and compensation associated with tenure. Framework Agreement includes a belt-wide Land Use Licence, an Inuit Impact and Benefits Agreement (IIBA) and a Water and Wildlife Agreement. Framework Agreement was signed in March 2015 for belt-wide land tenure.	20 years	March 2035
Water and Wildlife Agreement		Included as a Schedule to the Framework Agreement, this Agreement details compensation to be provided to the Kitikmeot Inuit Association (KIA) and Inuit beneficiaries for negative effects that may occur to wildlife harvesting and water as a result of mining related activities across the Belt.	20 years	March 2035
Amended and Restated Inuit Owned Lands Commercial Lease	KTCL 313D001	Commercial Lease for use of designated lands associated with the Hope Bay Volcanic Belt (HBVB) area. Currently, lands have been designated that encompass Doris. Expansion to include other areas of the HBVB is administrative in nature. Original Commercial Lease was amended and restated in March 2015 as a means to obtain surety of belt-wide land tenure.	20 years	March 2035
Inuit Impact and Benefits Agreement		Included as a Schedule to the Framework Agreement, this Agreement details the benefits to be provided to the KIA and Inuit beneficiaries from the Hope Bay Project, including compensation, employment and contracting opportunities. The IIBA originally signed in association with Doris was revised in March 2015 and expanded in scope to encompass belt-wide activities.	20 years	March 2035
KIA Advanced Exploration Agreements	KTAEL15C002	Agreements as per the terms of the Framework Agreement enabling advanced exploration at Boston.	5 year renewable annually thereafter for up to 20 years	March 2022 (renewal in progress)
KIA Land Use Licences		Enables exploration activities across the Hope Bay Belt as per the terms of the Framework Agreement.	1 year automatic renewable for 20 years	March 2023
DFO authorization	NU-02-0117.2	Construction of the jetty in Roberts Bay.		December 2009

Name	Approval No.	Scope / Purpose	Term / Duration	Expiration Date
DFO authorization	NU-1000-0028	Changes to the Doris jetty.		July 2012
DFO authorizations	NU-02-01117.3	Construction of the Doris Tailings Impoundment Area (TIA) north dam.	Life of Mine	None
Navigable Waters Permit	8200-02-6565	Installation of the jetty in Roberts Bay.	N/A	N/A
Navigable Waters Permit	2018-600028	Approval for Jetty in Roberts Bay	N/A	N/A
Navigable Waters Permit	2018-600006	Approval for Marine Outfall Berm	N/A	N/A
Jetty Lease	77A3-1-2	Foreshore lease from the Crown for construction and operation of the Roberts Bay Jetty.	30 years	June 2047
Marine Outfall Berm	77A/3-3-2	Lease from Crown for construction and operation of Roberts Bay Marine Outfall Berm.	30 years	July 2048
Amendment to Schedule 2 of the Metal Mining Effluent Regulations (MMER)	Registration SOR/2008-216	Designation of Tail Lake as a tailings impoundment.	Life of Mine	None

3. Summary of Project Activities for 2021

3.1 CONSTRUCTION AND OPERATIONS

Doris

- Workforce reduction due to COVID-19 pandemic continued until January 2021, with slow ramp up of activities. Reduction of workforce was done in October-November 2021 following positive COVID-19 cases identified on site. Began to return to normal operations in November 2021.
- Underground mining operations continued at Doris Mine.
- Northern workforce continued to remain at home to eliminate risk of COVID-19 transmission to communities.
- Milling operations continued at reduced rate with one rotation processing ore and opposite rotation conducting maintenance.
- Maintenance conducted on airstrip.
- Coagulant dosing system for treating underground effluent for total suspended solids commissioned in the Water Treatment Plant in April. Recommenced effluent discharge to Robert's Bay in accordance with MDMER in May.
- Discharge to Robert's Bay was suspended in November due to the coming into force of the MDMER toxicity testing for *Arcatia tonsa*.
- Retrieval of 800m of submerged dewatering pipeline from Roberts Bay completed.
- Initial steps to retrieve and relocate Roberts Bay Discharge System diffuser were completed. Final reattachment of the diffuser delayed until 2022 due to equipment issues and safety concerns related to conducting the work during sealift fuel/materials offload.
- Installation of heated parking structure for emergency vehicles.
- Construction of laydown space for designated core storage north of Quarry 2.
- Began installation of metallurgy lab expansion at the Mill.
- Construction of millwright shop located on south side of Mill building.
- Installation and commissioning of air quality monitors in Doris Air Quality monitoring building.
- Completed sealift operation with delivery of supplies, diesel fuel, explosives and reagents to support mining, milling and exploration activities.
- Hazardous waste was backhauled without incident.

Madrid

- Continued underground decline development until February 2021. Operations at Madrid North were suspended once Agnico acquired the Hope Bay property to allow for a thorough review of the proposed work plan.
- Removal of ammonia/brine impacted area of the Madrid North portal laydown was completed prior to freshet 2021. This included completing excavation of the impacted area on the east side of the

portal laydown. Material from this excavation was placed on the west boundary of the Naartok East Crown Pillar Recovery trench.

In 2021 logistical, operational and travel challenges continued during the ongoing COVID-19 pandemic which influenced some activity-based monitoring. However environmental protection and compliance at Hope Bay remained a top priority.

In response to the health risks associated with the COVID-19 pandemic, Agnico continued the implementation of rigorous protocols and hygiene measures in order to keep its workforce and communities safe. A reduction of workforce was done in October-November 2021 following positive COVID-19 cases identified on site. Return to normal operations was initiated in November 2021. In 2021 logistical, operational and travel restrictions imposed by the COVID-19 pandemic influenced activity-based monitoring. However environmental protection and compliance at Hope Bay remained a top priority.

Commercial operations continued for most of 2021 at Doris with ongoing efforts to stabilize mill throughput and optimize gold recovery. In 2021 the mill processed 262,466 tonnes (t) of ore and poured 64,583 ounces of gold, and successfully treated 19,249 t of concentrate with cyanide solutions. Following the acquisition Agnico continued processing ore at a reduced rate and achieved steady state processing and improved gold recovery. In October the mill was shutdown to optimize underground development and stockpile ore for the mill.

The Roberts Bay Discharge system was recommissioned in May with the addition of a coagulant dosing system to manage total suspended solids in mine water. Discharge to Robert's Bay commenced in accordance with MDMER in May 2021 and was suspended in November due to the coming into force of the MDMER toxicity testing for *Arcatia tonsa*.

Civil construction activities at Doris included maintenance conducted on airstrip and construction of a core storage laydown. Earthworks were conducted at the Madrid North portal laydown in early 2021 to excavate an area of the laydown with higher ammonia and chloride signatures. This material was removed prior to freshet 2021 and placed on the west boundary of the Naartok East Crown Pillar.

Underground mining operations continued at Doris Mine, while Madrid underground and surface operations, including mining of the Naartok East Crown Pillar trench, were suspended in February 2021. At Doris, Agnico focused on producing from developed stopes and bringing ore to surface. A grouting program at Doris helped maintain the inflows of water over the course of 2021.

In the fall, Agnico concluded another successful sealift operation including the purchase and delivery of diesel fuel as well as explosives and reagents to support mining and milling activities. Hazardous waste was successfully backhauled without incident. A total of 57 sea cans of hazardous waste and 418 sea cans of non-hazardous solid waste were disposed off site. Waste disposal, fuel usage and chemical storage stayed consistent with previous years.

Exploration activities were suspended in September 2021 following a fatality involving a helicopter. All other helicopter work were also suspended pending initial investigation results. This temporary suspension and the onset of winter impacted the completion of the hydrology and remote camera programs.

Site layouts and aerial photos for the Belt are provided in Appendix C of this report and provide details of the existing camps, infrastructure and equipment at site.

3.2 EXPLORATION

The 2021 Exploration and Geoscience program at Hope Bay consisted of both underground and surface diamond drilling. The 2021 exploration program at Doris included drilling high-grade targets in the Below the Dyke (BTD) extension for mineral resource expansion and drilling in the Doris Central (DCN), Doris West Valley (DWV). The 2021 exploration program at Madrid included drilling Naartok West (NWS-HBM) and Naartok East (HBM) for further resource and mine developments but as well for extension and exploration purposes. A total of 83642.4 meres in 453 diamond drill holes was completed in 2021.

3.2.1 Drilling

Underground diamond drilling occurred throughout the year in 2021. The diamond drilling program focused on expansion of the high-grade zones within the Doris BTD, conversion and infill drilling in the Doris West Valley (DWV), Doris North (DNO) and infill drilling in the Doris Connector North (DCN) to support mine planning. Several geotechnical holes were also drilled to determine water inflows and were used to grout water making structures. A total of 348 underground diamond drillholes totaling 47,947 metres completed in 2021.

Agnico Eagle Mines Limited contracted Geotech Ekutak Drilling Services Ltd. to complete the diamond drilling on the Hope Bay Belt for both underground and surface operations in 2021. On surface, no drill setup or associated items were placed within 31 meters of any waterbody during the open water season and no spills were reported into water bodies. Water quality monitoring was performed on runoff from drill sites and water used for drilling to ensure the respective Water License Criteria were met. Drill cuttings and mud were contained within a recirculation system and were transported or pumped and stored in approved containment areas including the TIA at Doris.

Surface diamond drilling activities for the 2021 Exploration and Geoscience program occurred throughout the year in 2021, with a brief hiatus from October-November due to the COVID-19 pandemic. Diamond drilling mainly focused on targets proximal to the Doris and Madrid deposits. Some limited regional drilling was conducted at a regional scale (4 holes - 1179m). All drill sites on surface were reclaimed following the decommissioning of drills. A total of 105 surface diamond drill holes totalling 35,695.4 meters was completed in 2021.

4. Summary of Project Plans for 2022

4.1 CONSTRUCTION AND OPERATIONAL WORK PLANS FOR FUTURE YEAR (2022)

The following activities are planned for the Doris site and associated permitted infrastructure for 2022. Activities for the recently announced Care and Maintenance will be reported under a separate cover.

4.1.1 Doris

- Maintenance of Roberts Bay Discharge System
- Construction of Cemented Rockfill Plant on existing Doris footprint
- Upgrades to existing Process Plant
- Construction of additional Water Treatment Plant
- Start construction of South Dam Raise
- Construction of quarry
- Construction of Wind turbines

4.1.2 Madrid

- Installation of mitigation measures for existing Madrid Contact Water Pond
- Re-commence Madrid North underground development which includes:
  - Installation of gensets
  - Construction of Maintenance Shop
  - Installation of fuel tank with secondary containment

4.1.3 Boston

- No development is planned for Boston

4.2 EXPLORATION WORK PLANS FOR FUTURE YEAR (2022)

Exploration activities for 2022 will include surface and underground diamond drilling. Surface drilling will mainly focus on exploration and extension drilling on both Doris and Madrid Deposits. Some near mine regional drilling will also occurs during the summer fly season. Care and Maintenance activities will be reported under a separate cover.

Surface diamond drilling planned for 2022 will consist of approximately 44,900 metres on Doris (BTD_EXT, BCO, BCN, WV), 47,800 metres on Madrid (Naartok West, Naartok East, Rand, Suluk) and 9,400 metres on Regional near mine exploration targets.

Underground drilling will consist of Delineation, Conversion and Exploration drilling within the Doris Deposit (BCO, BLOB, BTD, DCN, DCN BTD, DCO and WV). Underground drilling will consist of 84,082 metres. The exploration component of these meters will explore extensions on strike North and South but also on depth.

5. Water Use and Waste Disposal

During 2021, water management at Hope Bay Project Site was in line with the authorized Type A Water Licence for Doris and Madrid 2AM-DOH1335, the Type B Regional Exploration Licence 2BE-HOP1222, and the Type B Water Licence for Boston 2BB-BOS1727. No activities occurred under the Type A Water Licence 2AM-BOS1835 for Boston or the Type B Water Licence 2BB-MAE1727 for Madrid, therefore no water was used or waste produced from activities associated with these licences.

An overview of the sampling programs for each of the sites (Doris, Windy, Madrid and Boston) including site photographs showing the locations of monitoring sites as well as annual water sampling programs for the Hope Bay Project are provided in Appendix D of this report.

5.1 DORIS-MADRID

A summary of monitoring conducted for Doris and Madrid under the Type A Water Licence 2AM-DOH1335 is presented in Appendix D.1 of this report as outlined in Schedule I.

Water for domestic use at Doris is obtained from Windy Lake. Water is drawn from the lake at the freshwater intake and trucked to Doris Camp. The Doris Lake pumphouse was not supplying domestic water to Doris Camp in 2021.

Sewage and greywater produced onsite is processed in the sewage treatment plant at Doris in line with Part F Item 5 of the Type A Water Licence 2AM-DOH1335. Sludge produced by the treatment plant is disposed of within the TIA as outlined in the existing Hope Bay Project Domestic Waste Water Treatment Management Plan.

All containment berm water is sampled for water quality against the discharge criteria of the licence. Water that meets the standards for discharge is released in accordance with the licence following a notification to the Inspector; water that does not meet the licence criteria is treated onsite until it is remediated to acceptable levels for discharge to the tundra, is discharged to the TIA, and/or is managed as approved by the Inspector.

Runoff and contact seepage at site is managed in accordance with the approved Quarry Management and Monitoring Plan and Water Management Plan for the Doris Site.

During 2021, Agnico collected data from the following active or seasonally active monitoring stations: TL-1, TL-2, TL-5, TL-6, TL-7a, TL-7b, TL-9, TL-11, TL-12, ST-1, ST-2, ST-4, ST-5, ST-6a, ST-6b, ST-7, ST-7a/MMS-4b, ST-8, ST-9, ST-11, ST-12, MMS-1, and MMS-9.

Monitoring at stations ST-3 (Landfill Sump), ST-13 (Doris Contact Water Pond Pad U), MMS-4a (Freshwater intake at Windy Lake North), and MMS-8 (Madrid North Fuel Storage Facility) did not occur, as these facilities were not constructed as of 2021.

Monitoring at ST-10 (Doris Site runoff from sediment controls) and MMS-9 (Madrid Site runoff for sediment controls during construction) was not conducted as no new infrastructure was constructed at Doris or Madrid in 2021.

The Madrid North Concentrator was not constructed in 2021, therefore no effluent was discharged to the TIA from this facility and no monitoring occurred at station MMS-7. No monitoring at station MMS-10 (Madrid Mine Water Discharge) occurred as no mine water was pumped from Madrid underground workings in 2021.

No activities occurred at Madrid South in 2021. Monitoring at stations MMS-2 (Madrid South Primary Contact Water Pond), MMS-3 (Madrid South Secondary Contact Water Pond) and MMS-5 (Madrid South Fuel Storage Facility) did not occur as these facilities were not constructed as of 2021.

Monitoring of the TIA was undertaken at monitoring station TL-1. Monitoring of the tailings deposited into the TIA continued at monitoring stations TL-5 and TL-6 in 2021. Monitoring of detoxified tailings backfilled underground was completed at monitoring stations TL-7a, TL-7b and TL-11. As described in the Hope Bay Water Management Plan, the sedimentation pond (ST-1) was used as a collection pond for the water that accumulated in the pollution control pond (ST-2) and the three underflow sumps (ST2-S1, ST2-S2 and ST2-S3). The water collected in ST-1 was then transferred to the TIA by pipeline. The sedimentation pond was also used to transfer water from the landfarm (ST-4) and fuel storage facility berms (ST-5 and ST-6b) to the TIA. Water from the Madrid North Contact Water Pond (MMS-1) was also transferred to the TIA through the sedimentation pond. Dewatering of the TIA to Roberts Bay through the Roberts Bay Discharge System began in July and continued until November 2021.

All monitoring was conducted in accordance with the Hope Bay Project Quality Assurance and Quality Control Plan (2021).

Agnico uses external certified laboratories to carry out all analyses reported in the monthly and annual reports. The QA/QC data produced by ALS Canada Ltd. and Bureau Veritas Laboratories Inc. are used to determine the accuracy and precision of results in these reports.

Analytical results for all monitoring stations can be found in Appendix D.1.

5.1.1 Water Balance and Water Quality Model

In 2021 commercial operations continued at Doris and monitoring continued at the associated SNP stations. Water quality source terms, climate data, mine water dewatering rates, processing rates and TIA storage curves were reviewed and/or updated in the water and load balance model, with 2017 to 2021 data, to compare against the predicted TIA water quality and water elevation. Results of the Water and Load Balance Assessment, including relevant supporting data, internal modelling results and adaptive management strategies, have been summarized in the Doris Mine Annual Water and Load Balance Assessment found in Appendix E.

5.1.2 Tailings Impoundment Area

The North Dam which ensures containment of reclaim water in the TIA was completed in 2012. The South Dam which ensures containment of tailings solids was completed in 2018. The total tonnage of tailings solids deposited in 2021 was 0.25 Mt. As of December 2021, 74% of the licensed 2.5 Mt TIA tailings capacity has been utilized (1.9 Mt). The water level at the end of December 2021 was 31.8 masl. The full supply level of the TIA is 33.5 masl. This equates to approximately 1.77 Mm3 of additional water storage capacity available in the reclaim pond. Approximately 9,883 tonnes of detoxified tailings were placed underground as backfill.

5.2 WINDY – 2BE-HOP1222

The Type B Water Licence No. 2BE-HOP1222 issued by the NWB details the sampling and analysis requirements for the Surveillance Network Program (SNP). Windy Camp and the Patch Lake Laydown facility were not in use in 2021; therefore, sampling stations associated with camp operations and fuel storage facility are not being used or monitored. Tables in Appendix D.2 of this report summarize the results of sampling undertaken as part of the monitoring program detailed in Part J of 2BE-HOP1222.

Water is obtained from Windy Lake (ST-7a/MMS-4b) for use at Doris Camp under 2AM-DOH1335 and as allowed under 2BE-HOP1222. Water is taken up through a screened intake and sunken heat-traced line by a permanent pump house, which is used as needed to fill a water truck that transports the water to Doris Camp for use.

The camp water treatment and wastewater treatment facility (WWTF) permitted under this licence was not operational in 2021, therefore no sampling was conducted at monitoring stations HOP-1 (freshwater intake), HOP-2 (WWTF discharge), or HOP-3 (point of entry of WWTF discharge to Windy Lake). Water was utilized from Windy Lake for domestic consumption at Doris Camp and the monitoring station ST-7a/MMS-4b (HOP-1) was sampled for the monitoring criteria under the Doris Water Licence 2AM-DOH1335. For the ST-7a/MMS-4b results see the 2AM-DOH1335 Appendix D.1. The Landfarm at Windy Camp (HOP-4) has been dismantled, so no sampling was conducted at this monitoring station.

The bulk fuel storage tanks at Windy Camp were moved to Doris Camp in winter 2009 for use there, and the bulk fuel storage berm (HOP-5) was dismantled in 2012. The bulk fuel storage berm at Patch Lake laydown (HOP-6) was also dismantled in 2012. No sampling was conducted at either of these monitoring stations.

No sampling occurred at monitoring stations HOP-7A and HOP-7B (located in Quarries A and B, respectively) during 2021 as no discharge of water was required from these areas during the year. Sampling was conducted at HOP-7D (located in Quarry D).

No on-ice exploration drilling was conducted in the licence area in 2021, therefore no sampling was conducted as outlined in Part F Item 7 and Part J Item 7 of the licence. This surface exploration drilling was suspended in March due to the COVID-19 pandemic.

Water used for exploration drilling was taken from Windy Lake in accordance with Part C Item 1 of the 2BE-HOP1222 Licence. Water is supplied to a water tank at the drill, and recirculation to cool equipment occurs through this tank. A summary of monitoring activities conducted under this licence is provided in Appendix D.2.

No additional details on water use or waste disposal were requested by the Board in 2021 related to the Project. No artesian flow occurrences were encountered in 2021.

5.3 MADRID – 2BB-MAE1727

The Type B Water Licence No. 2BB-MAE1727 issued to Agnico by the NWB details the sampling and analysis requirements for the SNP. No activities were conducted under this licence in 2021. Activities conducted at Madrid North in 2021 were monitored under the Type A Water Licence 2AM-DOH1335. A summary of monitoring activities conducted under this licence is provided in Appendix D.3.

No additional details on water use or waste disposal were requested by the Board in 2021 related to the Project. No artesian flow occurrences were encountered in 2021.

5.4 BOSTON – 2BB-BOS1727

The Type B Water Licence No.2BB-BOS1727 details the sampling and analysis requirements for the SNP program. The Boston Camp was closed in December 2019 and remained inactive during 2021.

No water was used from Aimaokatalok (Spyder) Lake (BOS-1a) or from Stickleback Lake (BOS-1b) for domestic use at Boston Camp, to support surface exploration drilling activities or any other purpose in 2020. No samples were collected from monitoring stations BOS-1a or BOS-1b in 2020.

The Sewage Treatment Facility (BOS-3) was not active in 2021 as the camp was not operational and no samples were collected at monitoring station BOS-3 as outlined in Part D Item 14 and 15, and Part J Item 9 of the licence. Monitoring was not conducted for monitoring station BOS-4 (treated effluent prior to entering into Aimaokatalok (Spyder) Lake), as no effluent was discharged from the Sewage Treatment Plant in 2021.

Water management occurred at the Containment Pond (BOS-2) and the Bulk Fuel Storage Facility (BOS-5) in 2021. Water accumulation in the Bulk Fuel Storage Facility (BOS-5) was transferred to the Containment Pond (BOS-2). No water was discharged to tundra from this facility in 2021.

Dewatering of the Portal (BOS-9) was not conducted in 2021.

Dewatering of the Landfarm Treatment Area (LTA; BOS-6) was not required in 2021. The LTA was decommissioned in 2019 and no water quality sampling was conducted for this facility.

Water quality sampling of seepage/runoff from the ore stockpiles and camp pad to the tundra (BOS-8) was conducted in 2021.

A summary of water quality monitoring for the Boston Site under this licence 2BB-BOS1727 is provided in Appendix D.4.

No additional details on water use or waste disposal were requested by the Board in 2021 related to the Project. No artesian flow occurrences were encountered in 2021.

5.5 BOSTON – 2AM-BOS1835

The Type A Water Licence No. 2AM-BOS1835 issued to Agnico by the NWB details the sampling and analysis requirements for the SNP program. No activities were conducted under this licence in 2021. Activities conducted at Boston Camp were monitored under the Type B Water Licence 2BB-BOS1727. A summary of monitoring activities conducted under this licence is provided in Appendix D.5.

6. Solid Waste Disposal

At present Waste Management for the Hope Bay Project is currently divided into the following management areas:

- Non-hazardous Waste Management;
- Landfarm Management; and
- Hazardous Waste Management.

6.1 NON-HAZARDOUS WASTE MANAGEMENT

Agnico has an existing Non-hazardous Waste Management Plan (Section 12) which covers information pertaining to management of non-hazardous waste generated at Doris, Madrid, Boston and the regional exploration leases in the Hope Bay Greenstone Belt. The Hope Bay Project Non-hazardous Waste Management Plan has been developed to ensure that proper documentation, tracking and handling strategies are in place to monitor compliance and take corrective actions as necessary. In general, non-hazardous waste is generated by the camp(s), the kitchen and various on-site facilities and contracting groups. Management of non-hazardous waste includes recycling, treatment, and disposal of waste streams based on their specific characteristics. Incineration is used as a volume reduction treatment on-site for most non-hazardous domestic waste streams.

In 2021, waste produced at site was collected and consolidated at the Doris Waste Management area by the waste management department (includes waste produced during activities at Madrid and Boston). Agnico is authorized to dispose of all non-hazardous solid waste in a landfill on site under the existing Type A Water Licence; however to date a landfill has not been built. Therefore in 2021, all non-hazardous solid waste that could not be incinerated on site was stored on site for later landfilling or back haul to an approved facility off site. A total of 418 sea cans of non-hazardous waste were backhauled for disposal off site in approved sites.

6.1.1 Camp Incinerators

Agnico's Type A Water Licence 2AM-DOH1335, Type B Water Licence 2BE-HOP1222 and Type B Water Licence 2BB-BOS1727 issued by the NWB allows for the incineration of approved waste streams.

In August 2019, a new CY-100-CA incinerator located in Quarry 2 was commissioned for use in the Doris development area. This incinerator has the capacity to burn three 150-185kg batches per day and was used for waste incineration throughout 2021.

There was no incinerator operated at the Windy Camp and no domestic waste produced at Windy Camp in 2021.

There was no incinerator operated at the Boston Camp and no domestic waste produced at Boston Camp in 2021.

Food waste and paper is incinerated as per the Incinerator Management Plan (2019) for the Hope Bay Project. This plan outlines Agnico's approach to domestic waste stream segregation and incinerator management as it pertains to all the Hope Bay Project developments. The objective of the plan is to enable the operation of domestic waste incinerators to be undertaken in a safe, efficient and environmentally compliant manner. The Incinerator Management Plan strives to ensure that:

- Only appropriate burnable material enters the incinerator waste stream;
- Animal attractants are promptly incinerated;
- The incinerator is operated in a manner that reduces harmful emissions;
- Residual ash is handled and disposed of properly; and
- Compliance monitoring and reporting associated with incinerator operations are undertaken.

As recommended by the Nunavut Environmental Guideline for the Burning and Incinerations of Solid Waste, written records are kept of date and volume of burnt waste.

As per Schedule B, Item 12 of Type A Water Licence 2AM-DOH1335, Agnico is required to report the results of Incinerator Stack Testing when available compared to the Canada-wide Standards (CWS) for Dioxins and Furans and the CWS for Mercury.

In 2021, Agnico waste management operators have attempted to optimize incineration conditions to address past exceedances. A stack test to assess the techniques applied was planned for 2021 with equipment shipped to site for September 2021. However, due to a fatality at site, and a series of COVID-positive employees, all site visits were cancelled. The stack testing has been postponed to 2022. Based on the outcome of the investigation Agnico will evaluate if source control or ‘end-of-pipe’ pollution control technologies is the preferred approach to address exceedances. Agnico will continue to maintain good combustion practices in parallel with improved waste sorting practices to reduce the formation of hazardous compounds during incineration in the interim.

6.1.2 Open Burning

The disposal method for untreated wood, cardboard and paper products generated on-site is open burning. This method reduces the volume of inert waste disposed of in the landfill. The landfill has yet to be constructed at the Doris Site.

A total of 811m^3 of clean wood and 687 m^3 of cardboard was open burned in 2021.

All other waste is sorted and stored in sea cans at the Waste Management facility and is either backhauled for disposal or stored until the Landfill is constructed.

6.2 LANDFARM MANAGEMENT

Agnico is permitted to operate a landfarm facility at the Doris and Boston sites to treat hydrocarbon contaminated materials. Agnico’s Hydrocarbon Contaminated Material Management and Monitoring Plan (Section 12) describes the Doris and Boston facility design as it relates to storage and management of hydrocarbon contaminated materials, including soils and water generated at the site and associated facilities. This plan presents the management and monitoring obligations for each facility as modules A and B, respectively.

Hydrocarbon contaminated water and snow is either stored on-site for shipment off-site to an approved facility or treated with the use of an oil separation (absorbent) treatment system (if required) on site and then verified through laboratory analysis to meet discharge criteria prior to discharge to the environment. Hydrocarbon contaminated soils (including waste rock and ore) are treated in the Doris Landfarm or placed in the Doris underground mine for permanent storage.

The Doris Landfarm Facility is located on previously disturbed area approximately 0.6 km north of the existing Doris Camp Area, at approximately 432,573 Easting and 7,559,542 Northing (UTM NAD 83, Zone 13). The Facility is located in a restricted area of the site and is situated between the existing all-weather road and Quarry 2.

Hydrocarbon contaminated water, snow and soils (including crush rock) can be treated using on-site facilities at Doris or can be relocated off site to an appropriate remediation/disposal facility.

Only material containing the following hydrocarbons is farmed at the Doris Landfarm facility:

- Diesel fuel;
- Jet fuels (Jet A, Jet A-1); and
- Gasoline.

All other materials are deemed inappropriate for landfarming and will ultimately be placed in the Doris Mine for permanent storage in accordance with the approved Hope Bay Project Hazardous Waste Management Plan or packaged for offsite disposal at a licensed remediation/disposal facility.

The Boston Landfarm Treatment Area (LTA), is located at the Boston Camp Site, south west of the tank farm. In 2017, reclamation commenced for the LTA at Boston with the excavation and stockpiling of contaminated materials into mega-bags for future treatment or shipment offsite to an approved facility. In March 2019, contaminated soil was backhauled from the LTA to Doris Camp via a winter track and disposed of this material underground in the Doris Mine as approved in the Hope Bay Project Hazardous Waste Management Plan. The Boston LTA was decommissioned in 2019 and no additional materials will be placed in this facility. Hydrocarbon contaminated materials generated from future activities conducted at Boston will be packaged for backhaul to Doris until a new LTA facility is constructed. No hydrocarbon contaminated material was generated at Boston or transported from Boston in 2021.

6.3 HAZARDOUS MATERIAL MANAGEMENT

Agnico has a Hazardous Waste Management Plan aimed at ensuring that hazardous waste collection, segregation, handling, storage, transport and disposal procedures are promptly and efficiently carried out, thus minimizing the risk to the site workforce and the environment, as well as reducing the financial cost to the Project (Section 12). A total of 57 sea cans of hazardous waste were disposed of at site.

The Hazardous Waste Management Plan requires in general that all hazardous materials will be shipped offsite for disposal at an approved site. The Hazardous Waste Management Plan describes the purpose-designed hazardous waste management facility. Based on the principles of reduction, reuse and recycling, the plan addresses hazardous waste streams in terms of their risks, storage and labelling, transportation, and disposal, including:

- waste glycol (antifreeze);
- waste solvents;
- waste batteries;
- fluorescent tubes;
- penetrable wastes (sharps);
- waste lubricating oils;
- waste aerosols;

- medical wastes and sewage treatment plant sludge;
- applicable incinerator and wood ash;
- contaminated rags, absorbents and soil;
- residue last contained ammonium nitrate packaging; and
- explosives products and explosives residue containers.

6.3.1 Waste Back-haul

Waste materials back-hauled off site are regulated by the *Transportation of Dangerous Goods Act* (TDGA). In 2021, empty cargo aircraft were utilized for waste backhaul from the Doris Camp throughout the year. Waste oil backhauled on empty cargo aircraft was received by Buffalo Airways Ltd. in Yellowknife for recycling in waste oil heaters at that facility. All other waste backhauled on empty cargo aircraft was received by KBL Environmental Inc. in Yellowknife for final remediation and disposal. In September 2021, hazardous waste was backhauled by sealift to the Port of Cote Ste Catherine, Quebec and received by Groupe Ungava. for final remediation and disposal. Table 6-1 summarizes the type and volume of hazardous wastes that were transported offsite for final remediation/disposal in 2021.

Table 6-1. Hazardous Wastes Transported Offsite in 2021

Non-Hazardous and Hazardous Waste Type	Volume (m^3)
Used Oil	76
Used Glycol	18
Sodium Cyanide Solid (Residue)	963
Used Oil and Polymer	1
Waste Leachate Mix	19
Solids c/w Lead Oxide (Assay Crucibles)	199
Used Petroleum Grease	1
Sodium Hydroxide Solid (Residue)	232
Copper Sulphate Pentahydrate Solid (Residue)	199
Lead Acid Batteries	33
Sodium Metabisulfite Solid (Residue)	266
Kitchen Grease	11

6.4 LANDFILL

Agnico is authorized to dispose of all non-hazardous solid waste in a landfill on site as per Type A Water Licences 2AM-DOH1335 and 2AM-BOS1835. To date, a landfill has not been constructed. All waste that cannot be incinerated on site is backhauled to an approved facility for disposal or is stored on site for future landfilling. Because a landfill has not been constructed, no landfill management report has been prepared. Agnico will continue to manage solid waste produced in Hope Bay according to three waste management plans:

- Non-Hazardous Waste Management Plan;
- Hazardous Waste Management Plan; and
- Incinerator Management Plan.

These plans describe how various streams of waste are managed.

7. Aquatic Effects Monitoring Program

The Hope Bay Project (the Project) is a gold mining development in the West Kitikmeot region of mainland Nunavut. The Project property is approximately 153 km southwest of Cambridge Bay on the southern shore of Melville Sound and contains a greenstone belt (the Belt) that runs 80 km in a north south direction varying in width between 7 km and 20 km. The Project is operated by Agnico Eagle Mines Ltd. (Agnico) who acquired it through the purchase of TMAC Resources Inc. (TMAC) on February 2, 2021.

The Project consists of three developments: Doris, Madrid, and Boston. Construction of the Doris Mine and associated infrastructure began in 2010, and commercial operations began in 2017. Construction of mining infrastructure at the Madrid North development began in April 2019, followed by a transition to operations in August 2019 with mining of the Naartok East Crown Pillar trench. All mining and development activity was suspended at Madrid North in March 2020 and did not re-commence for the duration of 2020. Mining activity remained suspended throughout 2021 except for a brief period of activity at the Madrid North portal in January and February. As of December 2021, construction had not begun at the Madrid South or Boston developments.

This report presents the results of the 2021 Aquatic Effects Monitoring Program (AEMP), the third year of implementation of the approved Belt-wide Hope Bay Project: Aquatic Effects Monitoring Plan (the Plan; TMAC 2018). The primary goals of the AEMP are to evaluate potential Project effects on the surrounding freshwater environment during the construction and operation of the Project, verify predictions from the Madrid-Boston Final Environmental Impact Statement (FEIS; TMAC 2017b), support current and future Fisheries Act Authorizations, and provide a mechanism to respond to potential Project effects in the freshwater environment through the Response Framework. This framework sets environmental thresholds that, if exceeded, would trigger further investigation and/or mitigation.

The 2021 AEMP includes lakes adjacent to proposed infrastructure that have the greatest potential to receive non-point-source inputs such as runoff or dust (i.e., Doris and Patch lakes) and lakes that could be affected by water loss due to permitted water withdrawal and groundwater seepage into the mines through underground workings (i.e., Windy, Glenn, Patch, Imniagut, P.O., Ogama, Doris, and Little Roberts lakes). Aquatic components evaluated in 2021 included the following: fish habitat (water level and ice thickness), under-ice dissolved oxygen concentration, water temperature, water quality, and phytoplankton biomass. Statistical and/or graphical analyses were undertaken to determine whether there were any apparent effects of Project activities on these aquatic components in the monitored lakes.

Table 7-1 presents a summary of the overall findings of the evaluation of effects for the 2021 AEMP, as well as the corresponding section in this report in which to find the discussion of the evaluation of effects for each monitoring component. No adverse Project-related effects to fish habitat (water level and ice thickness), under-ice dissolved oxygen concentrations, water temperature, water quality, or phytoplankton biomass were detected in the exposure lakes (i.e., lakes with the potential to be influenced by the Project). Accordingly, no low action level responses were triggered for any assessed variable in the 2021 AEMP.

Table 7-1. Summary of Evaluation of Effects for 2021 AEMP

Variable	Exposure Lakes Included in Evaluation of Effects	Conclusion of Effect	Low Action Level Triggered?	AEMP Report Section
Fish Habitat (Water Level and Ice Thickness)	Windy Lake, Glenn Lake, Patch Lake, Imniagut Lake, P.O. Lake, Ogama Lake, Doris Lake, Little Roberts Lake	No Effect	No	3.1; Appendix B
Physical Limnology (Dissolved Oxygen and Temperature)	Windy Lake, Patch Lake, Doris Lake	No Effect	No	3.2
Water Quality	Windy Lake, Patch Lake, Doris Lake	No Effect	No	3.3
Phytoplankton Biomass (as Chlorophyll *a*)	Patch Lake, Doris Lake	No Effect	No	3.4

8. Geochemical Studies

8.1 DORIS AND MADRID MINES

This section summarizes the operational geochemical monitoring results for the Doris and Madrid North Mines, including waste rock, flotation tailings slurry and detoxified tailing solids from the Doris Mill, quarry rock used for infrastructure and road construction and seepage monitoring programs of waste rock, construction rock and underground mine backfill (detoxified tailings). Detailed discussion and interpretation of geochemical data for the Doris and Madrid North Mines is presented in Appendix F of this report.

8.1.1 Waste Rock

Waste rock monitoring for the Doris and Madrid North Mines (except for waste rock from the Naartok East CPR) is outlined in *Waste Rock, Ore and Mine Backfill Management Plan* (TMAC 2019), which is a part of Licence 2AM-DOH1335 Amendment No. 2. The program includes inspection and geochemical monitoring of the waste rock solids from the underground mine and Doris CPR and routine monitoring of the Pollution Control Pond (PCP). Geochemical monitoring of waste rock from Naartok East CPR is documented in *Classification of Waste Rock in Support of Segregating Construction Rock from Naartok East Crown Pillar Recovery, Madrid North* (SRK 2019). SRK (2019) includes a field geochemical classification method and associated criteria to identify waste rock that is non-potentially acid generating (PAG) and with low potential for neutral pH arsenic leaching and recommendations for operational implementation of the field-based geochemical characterization program that identifies waste rock that is suitable for use as construction rock.

In 2021, waste rock produced from underground mining at Doris was kept underground and used as backfill or placed in the surface waste rock stockpile on Pad T. In addition, waste rock was removed from the surface waste rock stockpile on Pad T and placed as backfill in stopes of the Doris mine.

In 2021, mining included development of the underground decline in January and February. During this period underground waste rock was produced and placed as backfill in the NE CPR.

8.1.1.1 Underground Doris Mine

Underground geological inspections were conducted by at the working face by AEM qualified geologists. The data were recorded in geological inspection logs and maps. Waste rock intersected by the Doris underground workings in 2021 was geologically described as 95% mafic volcanics with trace sulphide and 1 to 2% quartz-carbonate veining; 4% sericite altered mafic volcanics with up to 1% sulphide and 2 to 5% quartz-carbonate veining; and 1% diabase dyke with trace to 1% sulphide and trace quartz-carbonate veining.

8.1.1.2 Waste Rock Stockpile (Pad T)

The waste rock observed on Pad T was a mixture of approximately 90% chloritic green mafic metavolcanics (1a), 8% light tan colored sericite altered mafic metavolcanics (1as), <1% white quartz veins (12q), <1% dark gray diabase (11c), and <0.5% light brown felsic dyke (rock code undefined). SRK collected five samples (three of mafic metavolcanics (1a), one of altered mafic metavolcanics (1as), and one diabase (11c)) from the surface waste rock stockpile on Pad T. For mafic metavolcanics samples (1a), total sulphur ranged from 0.20 to 1.4% and median levels of 0.27%. The sample with 1.4% total sulphur contained 1% to 2% visible sulphides and was selected to characterize a high sulphur sample. TIC and Modified NP content was high ranging from 203 to 321 kg $CaCO_3$/t and 154 to 186 kg $CaCO_3$/t, respectively. All samples were classified as non-PAG based on TIC/AP and NP/AP. The one sample of altered mafic metavolcanics (1as) had a total sulphur content of 0.21%. TIC and Modified NP content was 319 and 159 kg CaCO3/t, respectively. The sample was classified as non-PAG based on TIC/AP and NP/AP. The one sample of diabase (11c) had a total sulphur content of 0.33%. TIC and Modified NP content was 168 and 161 kg CaCO3/t, respectively. The sample was classified as non-PAG based on TIC/AP and NP/AP. Trace element content was below the screening criteria for all samples except for arsenic, sulphur, and tungsten in the mafic metavolcanics (1a) sample containing 1.4% sulphur. Total metal concentrations for all other samples were less than ten times the average crustal abundance for basalt indicating no appreciable enrichment. SFE tests on a sample each of mafic metavolcanics (1a), altered mafic metavolcanics (1as), and diabase (11c) had alkaline pH (7.8 to 8.9). Nitrate concentrations and chloride values ranged from 7.3 to 43 mg/L and 79 to 394 mg/L, respectively and are indicative of blasting and drilling brine residuals present on waste rock surfaces, and possibly also naturally saline groundwater that is present in areas of the mine.

Two mafic volcanic (1a) waste rock samples collected from Pad T in 2021 had similar sulphur content compared to the Type A, UG monitoring and CPR sample sets; one mafic volcanic sample was sampled as an end-member and biased high in sulphur. The sample of altered mafic metavolcanic (1as) collected in 2021 had similar sulphur, TIC, and NP content compared to the previous UG monitoring and CPR sample sets. The diabase (11c) sample collected from Pad T in 2021 was on the upper end of the range of geochemical characteristics (sulphur, arsenic) seen in the Type A and UG waste rock sample sets.

The geochemical behaviour of the waste rock is monitored through the annual seep survey along the downgradient toe of the waste rock and ore stockpile area and routine monitoring of the Pollution Control Pond (PCP).

8.1.1.3 Underground Madrid North Mine

The geochemical sampling and testing frequency of the underground waste rock is a minimum of one sample per 20,000 tonnes of rock. AEM did not collect a sample during development of the underground because 3,682 t of waste rock was produced. Based on geological inspections of the decline by AEM, waste rock was logged as 99% mafic metavolcanics (1) with the balance (1%) logged as quartz-carbonate veining.

8.1.1.4 Waste Rock as Backfill

SRK completed a surface geological inspection of a stockpile of waste rock placed as backfill along the western edge of the NE CPR. The stockpile contained waste rock placed in 2021 from the Madrid North underground mine and construction rock excavated as part of the reclamation of the Madrid North Portal Pad. Construction rock excavated from the Madrid North Portal Pad was within the flow path of hypersaline seepage and was waste rock sourced from the NE CPR that was geologically logged at the Portal Pad as mafic metavolcanics with sediments (1aj/1oj) and sedimentary units (5, SRK 2021b). As per the Waste Rock, Ore and Mine Backfill Management Plan (TMAC 2019), SRK collected one sample of waste rock from the surface stockpile of waste rock placed in the NE CPR based on the range of rock types identified during the geological inspection.

Based on the visual inspection by SRK, the majority (99%) of waste rock was chloritic green mafic metavolcanics (1a) with lesser (1%) quartz-carbonate veining (12). The mafic metavolcanics were unoxidized, dark blackish green and weakly foliated with <1% medium-grained disseminated pyrite, no fizz on the groundmass, and moderate fizz on rare <0.5 cm white quartz-carbonate veins. The absence of sedimentary units suggests that the source of waste rock inspected was from the underground mine and was not the NE CPR waste rock excavated from the Portal Pad, which were logged as sedimentary units.

Rinse and paste pH indicate the one sample was non-acidic. The rinse EC value is within the range of values of Portal Pad rock (5th to 95th percentile values of 90 to 320 uS/cm, n=10; SRK 2021b) and Doris underground waste rock (e.g. 87 to 6,700 uS/cm, SRK 2021a and 2022). Total sulphur and sulphide were 0.20% and 0.17%, respectively. TIC and Modified NP were 130 kg CaCO3/t and the sample was classified as non-PAG. The sample was classified as not enriched for all parameters compared to the screening criterion. The stockpile also contained saline construction rock that was removed from the Portal Pad in 2021, however on the basis of geological inspection that indicated an absence of sedimentary units (1aj/1oj/5), the sample is interpreted to be underground rock.

8.1.2 Tailings

The geochemical monitoring program for flotation tailings slurry and detoxified tailings includes the following monitoring stations: process plant tailings water discharge (TL-5), flotation tailings solids (TL-6), detoxified tailings solids (TL-7A) and detoxified tailings filtrate (TL-7B). In 2021, the process plant operated on a reduced schedule between January 1 and October 5 whereby the process plant operated for three weeks for every six-week period. Between mid-October and December 31, the process plant did not operate. In total, 253,160 t (dry weight equivalent) of flotation tailings were deposited in the Doris TIA in 2021 and 10,006 t of detoxified tailings were placed as backfill in Doris Mine.

8.1.2.1 Sampling and Testing Program

The 2021 monitoring program for TL-5 included geochemical characterization of nine monthly samples of tailings process supernatant collected from January to September with a duplicate sample collected in January. The 2021 monitoring program for TL-6 included geochemical characterization of six composite samples of flotation tailings in January, March, April, May, August, and September. Samples representing February and June were not collected when the plant was not operating. The July sample was discarded by AEM in error before it could be analyzed. The 2021 monitoring program for TL-7A included geochemical characterization of nine samples of detoxified tailings solids. A sample was collected each month between January and September. Nine samples of filtrate (TL-7B) from the detoxified tailings were collected from January to September. Results of this SNP monitoring are presented in Appendix D.1 of this report.

8.1.2.2 Results

Monthly monitoring of TL-5 and TL-7B is summarized as follows:

- pH was stable in both TL-5 (8.1 to 8.4) and TL-7B (8.5 to 8.7).
- Sulphate concentrations ranged from 1,300 to 3,000 mg/L in TL-5 and from 13,000 to 20,000 mg/L in TL-7B, both of which are within the range of historical data.
- Sodium ranged between 1,600 and 2,900 mg/L in TL-5 and between 7,200 and 11,000 mg/L in TL-7B. TL-B concentrations were within the range of previous data. Sodium concentrations at TL-5 were equivalent to 2020 and generally higher than concentrations reported mid-2019 and earlier.
- Trends for major ions and trace elements were generally stable in 2021 and fluctuated within historical ranges. Exceptions included chloride (TL-5) and new operational maximum values for ammonia and cobalt (TL-7B).
- Total cyanide concentrations were also within range of previous data except for at TL-7B in March. WAD cyanide and free cyanide was either at limit of detection or at concentrations similar to previous data in TL-5 and TL-7B.
- Thiocyanate ranged from 12 to 51 mg/L in TL-5 and from 190 mg/L to 580 mg/L in TL-7B. These concentrations were within range of the previous data except for TL-7B in March and July, which were 580 and 560 mg/L, respectively. Cyanate ranged from 41 to 130 mg/L in TL-5 and from 540

mg/L to 1,100 mg/L in TL-7B. Cyanate concentrations fluctuated with periodic increases including February, March, and April.

Monitoring of TL-6 is summarized as follows:

- All flotation tailings samples were classified as non-PAG, which in consistent with 2017 to 2020 operational tailings monitoring (SRK 2020b) and metallurgical tailings samples (SRK 2015b). Sulphur concentrations ranged between 0.10 and 0.32% with a median value of 0.17%. TIC content ranged between 200 and 280 kg CaCO3/t.
- All parameters were below the screening criteria indicating no appreciable enrichment except arsenic was enriched for January and August samples. The higher arsenic content reported in August is roughly equivalent to tailings produced between June 2019 and March 2020, but overall, 2021 concentrations are typically lower than 2020. Processing of Madrid North ore, which has higher arsenic content than Doris (SRK 2017) commenced in 2019 and continued in 2021.

The results of the 2021 geochemical monitoring program of detoxified tailings solids (TL-7A) are summarized as follows:

- All detoxified tailings samples were classified as PAG, which is consistent with 2017 to 2020 operational tailings monitoring and metallurgical tailings samples (SRK 2015b). Sulphur concentrations ranged between 19 and 37% in 2021. TIC results for 2021 ranged between 89 and 160 kg CaCO3/t.
- All detoxified tailings samples were elevated in arsenic, bismuth, copper, selenium, and silver compared to the screening criteria. More than half of the 2021 samples were also elevated for cadmium. Selected samples were elevated in zinc (n=3) and lead (n=3) compared to the screening criteria. All other parameters, including cobalt and nickel were below the screening criteria indicating no appreciable enrichment.

8.1.3 Quarry Rock

8.1.3.1 Quarry Monitoring

Infrastructure at Doris and Madrid North were constructed using rock from Quarry 2 and Quarry D, respectively. In 2021, there were six blasts at Quarry 2 in September (7th and 12th), November (25th, 27th, and 30th), and December (4th).

The geological inspections of the quarry blast faces indicated mafic volcanics (1a) described as very fine grained to medium grained green / grey material with moderate to strong pervasive chlorite alteration and lesser amounts of epidote alteration. Occasional hematite staining was reported on fractures and joint surface. Trace amounts of quartz-carbonate veinlets at a mm to cm scale and sulphides of less than 1% were noted. Fibrous actinolite was not present.

Due to an error by the laboratory, data are pending for the quarry samples and were not available at the time of reporting. As such, the quarry and construction rock memo are not appended to this report. The final quarry memo will be provided as an addendum after data are received.

8.1.3.2 Construction Monitoring

No construction took place in 2021 and therefore, no construction rock monitoring was conducted in 2021.

8.2 BOSTON CAMP

Currently there is no monitoring under the Type A Water Licence at Boston. This section summarizes monitoring in support of the Boston Camp closure plan under Type B. Detailed discussion and interpretation of geochemical data collected at Boston in 2021 is presented in Appendix G of this report.

8.2.1 Waste Rock and Ore

The Boston ore/waste rock management plan (SRK 2017) includes a commitment to monitor the oxidation of the ore by carrying out a survey of rinse pH and conductivity every ten years. This monitoring was conducted in 2018 and was not a requirement in 2021.

9. Geochemical Seepage Surveys

This section summarizes the seepage surveys conducted at Doris and Madrid Mines as part of the geochemical operational monitoring programs.

In 2021, AEM conducted a seepage survey of the waste rock at Doris and Madrid. The seepage survey at Doris included the waste rock influenced area (WRIA) defined as the waste rock stockpile on Pad T, waste rock and ore stockpile on Pad I and access road located down-gradient of the Doris waste rock stockpiles. At Madrid North the waste rock seepage survey included the Waste Rock Storage Area (WRSA) Pad and the downstream berm of the Madrid Contact Water Pond (CWP). In addition to the seepage survey, AEM conducted routine water quality sampling of waste rock drainage managed and collected in the Madrid CWP and Sumps 1 to 3.

The scope of the 2021 construction rock seepage survey included the following areas, with rationale stated in parentheses: Madrid North Overburden Stockpile (saline seepage quality), Madrid North Portal Pad (saline seepage quality), Madrid Shop laydown (seepage not observed in 2020), Doris access road to the vent raise (seepage not observed since 2019, which was the first year of monitoring) and reference stations (background seepage quality).

9.1.1 Doris Waste Rock Influenced Area

Prior to 2020, the seepage chemistry at the toe of the access road had the signature of waste rock and was more dilute than seepage at the toe of Pad I. Since 2020, seepage chemistry has indicated a loading source other than waste rock and has been geochemically characterized according to two loading sources: i) the downstream toe of the waste rock/ore stockpile on Pad I (21-DC-01 to 21-DC-03), and ii) toe of the access road (21-DC-04 and 21-DC-05). The seepage chemistry is summarized as follows:

- pH for all seepage samples was non-acidic (7.5 to 7.9). EC values were lower at the toe of the stockpile (2,100 µS/cm) and 4,100 and 4,200 µS/cm for samples at the toe of the access road.
- The differences in major ion chemistry are summarized as follows:
  - For the stockpile samples (21DC-01 to 21DC-03), major cation chemistry was dominated by sodium (280 to 300 mg/L) with lesser calcium (99 to 100 mg/L), while major anion chemistry was dominated by sulphate (530 mg/L), chloride (250 mg/L), and
  - For the access road samples (21DC-04 and 21DC-06) the cation chemistry was dominated by calcium (350 and 360 mg/L) and sodium (340 mg/L), while major anion chemistry was dominated by chloride (1,100 mg/L), sulphate (170 and 180 mg/L) and nitrate (63 and 64 mg/L as N).
- Concentrations were higher in chloride and ammonia concentrations in the road seepage samples than the Pad I samples suggesting a loading source other than waste rock.
- A comparison of seepage trace element concentrations is summarized as follows:
  - Higher for stockpile stations: sulphate (530 mg/L), arsenic (ranging from 0.0040 to 00042 mg/L and three times higher), cobalt (0.034 to 0.035 mg/L and one order of magnitude higher), molybdenum (0.012 to 0.013 mg/L and one order of magnitude higher), and nickel (0.051 to 0.053 mg/L and one order of magnitude higher). Trends in these parameters were relatively stable except sulphate, which has been increasing with time.

- Higher for road stations: cadmium (ranging from 0.00019 and 0.00021 mg/L and one order of magnitude) and manganese concentrations (0.42 and 0.49 mg/L and 4 times greater for manganese).
- Equivalent: dissolved selenium and zinc were similar for all samples.

- For stockpile seepage, trends for all parameters were either decreasing or stable except for sulphate, which was increasing.
- For the access road seepage, concentrations for all parameters have decreased since 2020.

All drainage from the Doris camp pad, including seepage captured in the collection sumps downstream of the toe of the access road, is pumped to the sediment control pond (SCP) prior to transfer to the TIA. In 2021, water from the SCP accounted for 1.4% of total inflow volumes entering the TIA and 0.4% of the total volume stored in the TIA.

9.1.2 Madrid North Waste Rock Storage Area

SFE arsenic concentrations for Madrid North waste rock at WRSA exhibited a positive trend with solid-phase arsenic and sulphur content. SFE arsenic did not have a relationship with gold in WRSA rock suggesting arsenic leaching is not higher for the oxide stockpile containing ore (SRK 2021c).

Discharge of effluent onto tundra from the CWP is in accordance with the effluent quality limits provided in the Water License. Water that does not meet these criteria is transferred to the TIA via water truck.

The water quality sample set in 2021 included i) one seepage sample collected downstream of the WRSA pad and near Sump 1, ii) monthly water quality samples from the contact water pond (CWP), Sump 1, Sump 2, and Sump 3, and iii) seepage samples collected upstream and downstream of the CWP berm. The purpose of the seepage monitoring upstream and downstream of the CWP berm was to geochemically characterize seepage that is bypassing the CWP.

A summary of the results are as follows:

- All waste rock drainage samples were non-acidic and EC values (240 to 5,100 µS/cm) indicated the temporal and spatial variability at all stations.
- As with EC, concentrations of all major ions were variable with time (e.g. sulphate, chloride and calcium as shown in Figure 4-13 of Appendix F: Attachment D). The major cation chemistry for most Madrid WRSA samples was typically dominated by sodium (12 to 440 mg/L) and calcium (20 to 540 mg/L), with concentrations for Sumps 1, 2, and 3 lower than CWP samples. Seepage at Sump 2 was dominated by magnesium (14 to 70 mg/L) and calcium (20 to 42 mg/L) with lesser sodium (12 to 31 mg/L). Seepage near Sump 1 (21-WRP-01) was lower than Sump 1 samples. Major anions for all samples were dominated by chloride (16 to 1,500 mg/L), sulphate (3.8 to 420 mg/L), and alkalinity (39 to 230 mg/L).
- Chloride concentrations ranged from 320 to 510 mg/L for all stations in June except the seepage sample near Sump 1 (86 mg/L).
- The seepage sample near Sump 1 had chloride (86 mg/L) and sulphate (74 mg/L) concentrations that were two times smaller than the nearby sump sample from 18 days prior. The lower concentration suggests that the seepage is less representative of waste rock contact water than the Sump 1.
- There was a temporal decrease in chloride concentrations at Sump 3 (maximum 620 mg/L) and CWP samples MMS1-N and MMS1-S (maximum values of 970 and 1,500 mg/L, respectively) between July and September. Decreases are likely due to increased dilution from inflows to the

CWP and reduced loading from underground waste rock that reports to Sump 3. The temporal increase in chloride concentrations at Sump 2 (from 16 mg/L in July to 270 mg/L in September) suggests that a minor loading source from underground waste rock reports directly to this water management collection point.

- In June, concentrations of chloride and sulphate were slightly higher for samples downstream of the CWP berm (410 to 510 mg/L) compared to samples upstream of the CWP berm (320 to 410 mg/L), but overall the chemistry was roughly equivalent.

In 2022, AEM is scheduled to construct a sump downstream of the CWP berm to intercept any CWP bypassing containment.

9.1.3 Madrid Infrastructure and Roads

Infrastructure surveyed at Madrid North included the Overburden Stockpile and Madrid North Portal Pad.

Construction rock from the portal pad was sourced from NE CPR waste rock. A comprehensive summary of sources of the portal pad seepage chemistry is documented in Appendix E. Between the 2020 and 2021 seepage surveys, AEM remediated the Portal Pad by excavating areas of Portal Pad that were saline with disposal within the NE CPR. Accordingly, the results of the 2021 seepage survey are an indicator of the reclamation activities. The 2021 Portal Pad seepage chemistry in the context of reclamation activities is summarized as follows:

- All seepage observed in 2021 was non-acidic.
- EC values (780 to 2,000 µS/cm) were lower by one order of magnitude compared to 2020.
- Concentrations of calcium (71 to 190 mg/L) and chloride (110 to 510 mg/L) were lower by one order of magnitude compared to 2020. Sulphate concentrations (68 to 120 mg/L), which are an indicator of sulphide oxidation, were notably equivalent between years.
- Nitrogen nutrients, which are present in or residuals of explosives, were present at significantly lower concentrations in 2021, including ammonia (two orders of magnitude lower), nitrate (three to five orders of magnitude lower) and nitrite (up to two orders of magnitude lower).
- Trace element concentrations were lower for all elements indicated as having high rates of metal leaching by the 2020 seepage survey, including dissolved cadmium (one to two orders of magnitude), cobalt (two orders of magnitude), iron (three to four orders of magnitude), manganese (one order of magnitude), nickel (one order of magnitude), selenium (one order of magnitude) and zinc (one order of magnitude).

The results of the 2021 Portal Pad seepage survey indicates that reclamation activities has improved seepage chemistry.

In addition to overburden, the Overburden Stockpile contains some construction rock sourced from two areas: Quarry D for construction in early 2019 of access roads and NE CPR waste rock for construction in late 2019 interior access roads and placement as cladding. Overall, seepage from the Overburden Stockpile in 2021 was characterized by lower concentrations than 2020 and is summarized as follows:

- Seepage from the Overburden Stockpile in 2021 was characterized by lower concentrations of EC and most major ions, whereby EC, sulphate, calcium, and potassium were one order of magnitude lower than 2020 samples and chloride, magnesium and sodium were up to two orders of magnitude lower. The major ion composition of 2021 samples was relatively uniform and distinctive from 2020 seepage samples.

- Ammonia and phosphorus concentrations in 2021 were two orders of magnitude lower than in 2020.
- Concentrations of dissolved trace elements were lower in 2021 with levels one or two orders of magnitude lower for antimony, cadmium, cobalt, iron, lead, manganese, molybdenum, nickel, selenium, and zinc. Notably, arsenic concentrations were roughly equivalent.
- The significant decrease in concentrations of major ions and trace elements in seepage from 2020 to 2021 validates the conceptual geochemical model that the source loading to seepage chemistry in 2020 was the thawing and draining of frozen saline porewater within overburden. Seepage samples collected in 2021 were from a different location than 2020 samples and therefore may represent drainage from non- and less saline overburden that is present in the stockpile (SRK 2021d).

9.1.4 Underground Backfilled Stopes (TL-11) Seepage Survey

AEM completed underground seepage inspections of backfilled stopes in August and December 2021. Visual surveys were conducted of all backfilled stopes that could be accessed safely at the time of the survey, i.e., not all backfill could be inspected. Three seepage locations were sampled in August and three locations were sampled in December. During the August sampling survey, AEM collected three seepage samples from Levels 120, 114, and 110. In December, AEM collected three samples from Level 120, 114, and 74. SRK concluded that the sample from Level 74 did not represent contact water of backfill.

Key results for the seepage samples inferred to represent contact waters are summarized as follows:

- The pH and EC ranged between 8.0 and 8.2 and 7,200 to 22,000 µS/cm respectively. The higher EC values were reported in the Level 120 and Level 110 samples.
- The major ion composition has the equivalent chemical signature and are considered to be contact water of mine backfill. Ion chemistry was dominated by chloride (2,100 to 6,900 mg/L) and sodium (3,900 to 3,900 mg/L). Seepage collected from Level 120 and Level 110 had higher concentrations of major ions than Level 114.
- Levels of ammonia, nitrate and nitrite were lower than the 50th percentile concentrations from the historical sample set in all samples.im
- Arsenic and silver concentrations were within the same range as previous seepage surveys (0.002 to 0.005 mg/L and 0.00005 to 0.0003 mg/L respectively.
- Copper and zinc concentrations were notably lower than indicated by previous seepage surveys.
- Manganese and cadmium concentrations were also lower than the 50th percentile concentrations from the historical sample set in all samples

9.2 BOSTON CAMP

This section summarizes the geochemical monitoring results at Boston. The seepage and ephemeral streams monitoring programs are conducted annually in the context of the waste rock and ore management and Boston closure plans. The objective of the seepage monitoring is to provide an indication of water quality from the waste rock (camp pad) and ore stockpiles. The seepage samples are collected at the toe of the camp pad. The two objectives of the ephemeral streams program are to monitor drainage from the Boston ore stockpiles and camp pad before entering Aimaokatalok Lake and the natural attenuation of the tundra.

9.2.1 Seepage Monitoring

There are two opportunistic seepage monitoring programs, seepage monitoring at station BOS8 as indicated by Boston water licence 2BBBOS1727 and a freshet seepage survey along the north and east sides of the camp pad, and the southern end of the airstrip as specified in the Boston Water and Ore/Waste Rock Management Plan (SRK 2017).

During the 2021 freshet seepage survey, no flowing seeps were observed.

Three surveys of station BOS-8 were complete in June, July, and August. A total of three samples were collected from BOS-8A, BOS-8B, and BOS-8D in June and no seepage was observed in July and August.

All 2021 seepage samples were pH neutral (7.9 to 8.0). Lab EC values were equivalent to field EC values, with values lowest at BOS-8B (580 μS/cm) and highest at BOS-8D (1,200 μS/cm). The ammonia concentration at BOS-8B was the highest ammonia concentration observed since 2015 (16.0 mg/L at BOS-8C) and was within the range of historical concentrations. BOS-8D had the highest cobalt (0.45 mg/L), manganese (0.10 mg/L), nickel (0.46 mg/L), and selenium (0.0023 mg/L) and had a high concentration of arsenic (0.55 mg/L). BOS-8B had the highest concentrations of arsenic (1.5 mg/L) and had a high concentration of selenium (0.0014 mg/L). All concentrations for the aforementioned parameters are within the range of the historical concentrations.

Continued monitoring will allow for further trends in the seepage to be established.

9.2.2 Ephemeral Streams Monitoring

As outlined in the Water and Ore/Waste Rock Management Plan for the Boston Site, Hope Bay Project, Nunavut (2017), five ephemeral streams (A to E) within the catchments of the Boston camp pad are monitored during spring freshet. The objectives of the program are to monitor drainage from the Boston ore stockpiles and camp pad before entering Aimaokatalok Lake and the natural attenuation of the tundra. In 2021, flow was observed, and samples collected on June 28 from ephemeral streams A2 and C2. Field parameters at A2 and C2 were not collected in 2021.

Field pH values were 7.0 to 7.5 and were within the range of historical data. The flowrate at C2 was within historical flow rates and the flow rate at A2 was too low to quantify. Chloride concentrations for ephemeral streams exhibit a decreasing trend. Copper, arsenic, and selenium have stable trends. Nitrate concentrations at A2 have oscillated and have generally decreased at C2 since 2009. Compared to SRK (2009) model predictions, the 2021 monitoring data were below maximum predicted values for chloride, nitrate, arsenic, copper, iron, nickel, and selenium at streams A2 and C2 and sulphate at A2. At C2, sulphate concentrations observed in 2021 exceeded the maximum modeled values; however, concentrations were lower than 2020 and within the same order of magnitude as the modeled values.

Sulphate and chloride are not attenuated by the tundra and the concentrations measured in 2021 validate the Boston 2009 water and load balance. In general, ephemeral streams monitoring indicates that overall, geochemical conditions remain stable with some annual variability.

10. Fuel Storage

Bulk fuel storage at the Hope Bay Project site is accomplished in compliance with relevant regulations and authorizations. Bulk fuel is stored in steel tanks or manufactured fuel bladders which are housed in a "tank farm" that is lined with an impermeable membrane and surrounded with a berm with sufficient capacity to meet containment criteria (i.e., 110% of the largest tank in the farm). This minimizes the potential of fuel entering the environment from a spill. Chemical storage at the Hope Bay Project site is accomplished in compliance with handling and storage instructions detailed in the respective manufactures Safety Data Sheets (SDS).

Agnico maintains the Hope Bay Project Spill Contingency Plan (most recently revised in 2022), available in Appendix H of this report, which is utilized to safeguard against accidental spills of harmful substances that may negatively affect the environment. Implementation of spill prevention systems are critical to avoid such accidents, followed by a response system that is timely and efficient if spills do occur, and contains and mitigates the negative environmental consequences. The Hope Bay Project Spill Contingency Plan was developed in accordance with the Spill Contingency Planning and Reporting Regulations developed under Section 34 of the Government of Nunavut's *Environmental Protection Act* (RSNWT Nu1988), the Environmental Emergency Regulations (SOR/2019-51), the Metal and Diamond Mining Effluent Regulations (SOR/2002-222) and was developed specifically to address the requirements of the Framework Agreement; NWB Water Licences: 2AM-DOH1335, 2AM-BOS1835, 2BE-HOP1222, 2BB-MAE1727 and 2BB-BOS1727; and NIRB Project Certificates: Number 003 and Number 009; including all amendments. The Hope Bay Project Spill Contingency Plan provides a consistent spill response framework that is available to all site personnel so they can effectively and efficiently respond to a spill of petroleum products and/or hazardous materials regardless of where on the Hope Bay site they are encountered.

The Hope Bay Project Spill Contingency Plan contains detailed inventories and measurable quantities of all on-site hazardous materials and provides layouts indicating locations of all spill response equipment at site. A list of spill containment systems used are summarized below:

- Gravel/HDPE lined containment facilities (e.g., Roberts Bay and Doris Tank Farms);
- HDPE/wood containments (e.g., Jet-A storage at Heli-pad);
- Concrete berms (day-tanks at the Powerhouse);
- Double-walled steel tanks at location of use;
- Steel spill containment (e.g., beneath tanks at incinerator);
- Insta-berms; and
- Plastic spill pallets.

Spill response resources are also described in detail in the existing management plan together with their routine maintenance and inspection. The availability and organization of the human resources deemed required to respond to spill events is described in the Hope Bay Project Spill Contingency Plan, along with the responsibilities of specified personnel and response teams clearly defined. External notification and communication in the event of spill events are addressed and there is also a specified and comprehensive system of internal reporting. The Plan is subject to annual review and an update to this plan is being provided with this Annual Report in Appendix H.

11. Spill Reports

During 2021, three spills were reported to the Nunavut Spill Line, Water Licence Inspector and KIA Major Projects. No spills were reported to Environment and Climate Change Canada. These three spills met the reporting threshold as outlined in the Nunavut Spill Contingency Planning and Reporting Regulations. In addition to the required Spill Line report, a more detailed follow-up report was filed within thirty days of each reported spill that included a description of the event together with the immediate cause, corrective and preventative action. The three reportable spill events are summarized in Table 11-1 below.

The remaining spills that occurred during 2021 were minor in nature, occurring on project roads/laydowns, with quick response and clean up resulting in negligible impact to the receiving environment. Agnico tracks all unauthorized discharges and spills on site, regardless of if they are externally reportable or not, and identifies any observable trends. In 2021 Agnico conducted frequent (daily) internal reviews of incidents using visual analytics generated automatically from tracking sheets. Spills were analysed by reportability, spill location, spill product, root cause, spill reason and volume. The lessons learned, improvements and causes are discussed with site personnel at daily toolbox meetings. No apparent root cause trend for minor spills was identified with freezing temperatures contributing to majority of the spill reasons. Inspectors have the opportunity to review the information on demand or when at site conducting inspections.

Table 11-1. Summary of Reportable Spills in 2021

Date of Occurrence	Spill Number	Date of Notification to an Inspector	Spilled Material and Volume or Mass	Details of Spill Event and Follow up Activities	Date Follow-up Report Provided to an Inspector
18-Jun-21	2021252	18-Jun-21	Madrid Contact Water 2000 L	On June 18, 2021 contact water seepage was identified at the same location as it had been identified in June 2020. A second seepage location was also identified in June 2021. Contact water released from the pond was contained by a road to the east and laydown pad to the north. No contact water was released to any water body (nearest water body is Patch Lake located 800m east of the CWP). A small sump pump was immediately installed at the toe of the berm to pump water back into the pond and minimize the volume of the release. Water trucks were used to transfer contact water from the pond to the Tailings Impoundment Area. The initial estimate of quantity of water released on June 18th was unknown but believed to be more than 2000L. Based on a survey of the water level elevation on June 14th prior to the release, the estimated quantity released is 350 m3. Results of all samples were below the Maximum Concentration outlined in Part F Item 18 (a) of Water Licence 2AM-DOH1335. An incident investigation conducted soon after the incident occurred concluded with the following root causes: • The cause of the seepage to be the failure of the remedial works conducted in 2020 to fully seal the bedrock cracks/fissures in the foundation of the CWP. • The water level within the pond was above the maximum water level elevation defined for the pond based on the 2020 investigation. The following corrective/preventative actions were implemented to reduce the likelihood of a reoccurrence: • Additional remedial works to seal the bedrock fractures within the base of the pond are not anticipated to prevent future seepage events. As an alternative, a water management structure will be installed at the downstream toe prior to freshet 2022 to capture any seepage and return it to the pond. • A water level gauge and signage will be installed at the CWP to identify the full supply level to allow for quick visual assessment of water level allowing operators to quickly respond if the water level is approaching the maximum allowable water elevation. Daily inspections will be conducted leading up to and during freshet to assess water level and initiate water management as needed.	13-Jul-21
27-Jun-21	2021269	27-Jun-21	Treated Effluent ~100 L	On June 27, electricians working in the area identified that a leak was occurring from the flange of one vacuum break on the pipeline. Treated effluent from the 10" ocean discharge pipeline was leaking from this flange to the surrounding tundra. The effluent soaked immediately into the tundra and could not be recovered. The quantity of effluent released is unknown but is estimated to have exceeded 100L.	26-Jul-21

Date of Occurrence	Spill Number	Date of Notification to an Inspector	Spilled Material and Volume or Mass	Details of Spill Event and Follow up Activities	Date Follow-up Report Provided to an Inspector
				Results of the sample collected were below the allowable limits outlined in Part F Item 18 (a) of 2AM-DOH1335 licence and Schedule 4 of the MDMER. No impacts to vegetation have been identified to date, however this area will continue to be visually monitored for signs of vegetation stress/impact. An incident investigation conducted soon after the incident occurred concluded with the following root causes: • It was found that the bolts securing the flange to the 2" vertical pipe were loose, which resulted in the leak. It is believed these bolts became loose due to temperature changes over the previous days which cause contraction of the flange fitting. • The preventative maintenance schedule to retorque the bolts on these flanges during the spring/fall temperature changes had not been implemented. • No routine visual inspection of these flanges was being conducted to assess for leaks. The following corrective/preventative actions were implemented to reduce the likelihood of a reoccurrence: • A daily visual inspection of the vacuum breaks by the Water Treatment Plant operator has now been implemented. • A preventative maintenance schedule to perform retorque of bolts for all flanges along the pipeline has also been scheduled to occur twice annually (spring and fall) and will begin in fall 2021.	
04-Sep-2021	2021383	05-Sep-2021	Underground Contact Water ~100 L	On September 5, 2021 a release of underground contact water had occurred adjacent to the Tail Lake Access Road (TLR), east of the Tailings Impoundment Area (TIA). A leak was identified from a hugger clamp on the underground dewatering pipeline resulting in a release of contact water to the tundra. The dewatering pipeline is used to transfer underground contact water from the Doris mine to the TIA. The leak was identified by crews working in the area while conducting preventative maintenance on a separate pipeline. The dewatering pump was immediately shut down and locked out by the underground shifter to minimize the release, and the pipe was straightened and a new hugger clamp installed prior to restarting the dewatering system. The volume of the spill is unknown but is estimated to be more than 100L. No contact water was released to any water body (nearest water body is Doris Lake located 480m south of the release). The location was within the boundary of the TIA and no adverse impact to the surrounding environment is anticipated.	02-Oct-21

Date of Occurrence	Spill Number	Date of Notification to an Inspector	Spilled Material and Volume or Mass	Details of Spill Event and Follow up Activities	Date Follow-up Report Provided to an Inspector
				An incident investigation conducted soon after the incident occurred concluded with the following root causes: • The connection clamp coming loose and is believed to be due to repetitive heating-cooling cycles linked to temperature variations The following corrective/preventative actions were implemented to reduce the likelihood of a reoccurrence: • A daily inspection is conducted of all pipelines at the site to identify any potential leaks. • A preventative maintenance program has been implemented to conduct retorquing of the bolts on all clamps/flanges used on dewatering pipelines. This will be conducted twice annually (spring and fall) beginning in fall of 2021. • Install a heat traced/insulated pipeline for future mine dewatering. This new pipeline will be fuse welded reducing the need to use clamps which will minimize the risk of a reoccurrence. Installation of this pipeline is anticipated to be completed before January 2022.	

12. Management Plans

The Table 12-1 below provides and overview of all Management Plans for the Hope Bay Project.

Table 12-1. Hope Bay Project Management Plans

Topic	Management Plans	Revision Date
Environmental Management System	Hope Bay Project Environmental Management System	Dec-17
Management Plans		
Emergency Response	Hope Bay Project Emergency Response Plan	Feb-21
Spill Contingency	Hope Bay Project Spill Contingency Plan	Mar-22
Hazardous Waste Management Plan	Hope Bay Project Hazardous Waste Management Plan	Mar-20
Incinerator Management Plan	Hope Bay Project Incinerator Management Plan	Mar-19
De-icing Management	Hope Bay Project Aircraft De-icing Management Plan	Mar-19
QA/QC	Hope Bay Project Quality Assurance Quality Control Plan	Mar-22
Water Management	Hope Bay Project Doris-Madrid Water Management Plan	Mar-22
	Hope Bay Project Boston Water Management Plan	Dec-17
Waste Rock Management Plan	Hope Bay Project Waste Rock, Ore and Mine Backfill Management Plan	Mar-22
	Hope Bay Project Water and Ore/Waste Rock Management Plan for Boston Site	Jan-17
Landfarm Management	Hope Bay Project Hydrocarbon Contaminated Material Management Plan	Dec-17
Air Quality	Air Quality Management Plan, Hope Bay Project	Apr-19
Domestic Waste Water Management	Hope Bay Project Domestic Wastewater Treatment Management Plan	Dec-17
	Boston Sewage Treatment Operations and Maintenance Management Plan	Sep-17
WWMP	Doris North Project Wildlife Mitigation and Monitoring Plan	Dec-16
	Wildlife Mitigation and Monitoring Plan	Apr-21
AEMP	Hope Bay Project Aquatic Effects Monitoring Plan	Apr-18
Ground Water Management Plan	Hope Bay Project Ground Water Management Plan	Mar-22
Tailing Management Plan	Hope Bay Project, Phase2 Doris Tailings Impoundment Area – Operations, Maintenance, and Surveillance Manual	Feb- 22
	Hope Bay Project Boston Tailings Management Area - Operations, Maintenance, and Surveillance Manual	Dec-17
Non-Hazardous Waste	Hope Bay Project Non-hazardous Waste Management Plan	Dec-17
Quarry Management	Hope Bay Project Quarry Management and Monitoring Plan	Mar-22

Topic	Management Plans	Revision Date
Closure	Hope Bay Project Doris-Madrid Closure and Reclamation Plan	Nov-17
	Hope Bay Project Boston Conceptual Closure and Reclamation Plan	Nov-17
	Hope Bay Project Windy Camp and Patch Lake Facility Updated Closure Plan (SRK)	May-14
	Hope Bay Project: Madrid Advanced Exploration Program: Conceptual Closure and Reclamation Plan (SRK)	Oct-14
Explosives	Hope Bay Project Explosives Management Plan	Nov-17
OPPP & OPEP	Oil Pollution Prevention Plan (OPPP) and Oil Pollution Emergency Plan (OPEP)	May-20
Socio-economic Management Plans		
Health and Safety	Hope Bay Health and Safety Management Plan	Dec-17
Human Resources	Hope Bay Project Human Resources Plan	Sep-16
Community Involvement	Hope Bay Project Community Involvement Plan	Dec-16
Cultural Heritage	Cultural Heritage and Natural Resources Management Plan	Dec-17

13. Closure and Reclamation

13.1 PROGRESSIVE RECLAMATION

13.1.1 Operation Areas

The eastern portion of the Madrid North Portal Pad and Madrid North Portal Laydown, collectively referred as the Portal Pad, was reclaimed in 2021. The eastern portion was removed down to the pre-existing natural grade. Although construction rock used for the portal pad was classified as non-PAG with arsenic content below the criterion for classifying suitable waste rock, removing the eastern portion is anticipated to reduce the source of ammonia and chloride that may remain entrained in the material of the pad. Efforts were made during excavation to minimize impact to the underlying tundra (Figure 13-1). Material excavated from the eastern portion of the pad was used as backfill in the Naartok East Crown Pillar Recovery Trench.

Figure 13-1. Madrid North Portal Pad Excavation

The western side of the pad remains in place and was graded to allow positive drainage. The geochemical field surveys will continue to monitor runoff from the remaining pad area and downstream of the excavated area. Erosion control measures including coco matting and silt fencing have been put in place to minimize sediments in runoff from the excavated area and the remaining pad area. Routine inspections of the area will be conducted throughout the snow-free period to monitor stability of the excavated area and ensure positive drainage is maintained.

The Doris North Reagent Pad constructed at the north end of the TIA was decommissioned as a reagent storage area. The pad underwent minor grading and maintenance to enhance positive drainage

13.1.2 Exploration Areas

Following surface diamond drilling operations, a reclamation process is conducted. Once drill equipment is demobilized from site, all drill casings are removed, if the casing is stuck due to permafrost it will be cut off at ground level. Cuttings are either used to fill the depression left by other drill operations in the vicinity or collected and removed. The land will then be leveled with bentonite if required and covered using overburden. Following drilling operations on ice, equipment and soiled and/or oily snow and ice are removed from the surface of the ice and deposited in active sumps. Once drilling operations are complete at a drill site, a site closure inspection report is completed by Agnico Eagle, reviewed by the site Drilling Supervisor and approved by the Agnico Eagle Environment Superintendent. Generalized items inspected in closure review include water management, drill collar sites, sump locations and adjacent vegetation inspections and housekeeping. All site closures are photographed with records filed and maintained by Agnico Eagle. Due to reduced operations and personnel on site, no historical drill site reclamation was completed in 2021.

13.2 COST ESTIMATE

The reclamation work for the Hope Bay Project will be done in accordance to approved Closure and Reclamation Plans for the Project. Reclamation progress is monitored through site inspections and annual reporting to the KIA, Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) and NWB, and is documented in updates of the Project Closure and Reclamation Plan and financial security costs estimates. As part of the Type A Water Licence approval process for Boston-Madrid (Phase 2) Project in 2018, financial security costs estimates were updated and approved by the NWB, KIA and CIRNAC and consider all existing infrastructure, proposed Phase 2 infrastructure, and any new information available since the last revision. The resulting financial security estimates and their associated Closure and Reclamation Plans, which are applicable to each site, are outlined in the subsections below.

13.2.1 Doris and Madrid

Agnico maintains the *Hope Bay Project Doris-Madrid Closure and Reclamation Plan* (November 2017) which describes the activities, requirements, and monitoring necessary for the closure and reclamation of the Doris site.

As part of the Type A Water Licence approval process for Boston-Madrid (Phase 2) Project in 2018, TMAC provided to the NWB an updated and final Closure and Reclamation cost estimate, which constituted an agreement between Agnico, KIA and CIRNAC on the financial security parties agreed was required for Doris and Madrid sites. Details of this process can be found on the NWB public registry and resulted in a requirement in Type A Water Licence 2AM-DOH1335 for $62,058,577 to be posted for the Doris-Madrid portion of the Project; $51,659,822 to KIA, $10,398,755 to the Crown. This security is to be posted across nine (9) installments or tranches based on distinct project components.

In addition to the financial security required to be posted for Doris and Madrid under Type A Water Licence 2AM-DOH1335 described above, Agnico also has rights to conduct the Madrid Advanced Exploration Program in accordance with Water Licence No. 2BB-MAE1727 Amendment No.2. In the event Agnico proceeds the Madrid Advanced Exploration Program, and does not commence activities under Type A Water Licence 2AM-DOH1335, Agnico's Conceptual *Madrid Closure and Reclamation Plan* (2017) will dictate the activities, requirements, and monitoring necessary for the closure and reclamation of the Madrid site(s). In this scenario, Agnico is required to maintain reclamation security in the amount of $7,131,000 for the work at Madrid. As per the amended licence, this amount is split between activities at Madrid North ($4,042,000), Madrid South ($3,072,000) and Madrid North to South All Weather Road (AWR) ($17,000).

13.2.2 Windy

Agnico has an approved *Hope Bay Project, Windy Camp and Patch Lake Facility Updated Closure Plan* (SRK 2014). This document presents the closure obligations and the plan for closing both facilities, and demonstrates how the closure obligations can be met. A copy of this plan can be found on the NWB public registry.

13.2.3 Boston

For current Boston infrastructure, Agnico has an approved *Boston Camp Interim Closure Plan* (2020), which was submitted to the NWB September 14, 2020. The plan includes a current closure cost estimate of $3,722,000. This amount includes cost escalation, management of mineralized rock, reclaiming drill sites and other areas of permafrost degradation, remediation of hydrocarbon contaminated soils, indirect costs, and a contingency. A copy of this plan can be found on the NWB public registry.

For planned Boston infrastructure under the Boston-Madrid (Phase 2) Project, Agnico provided to the NWB an updated and final Closure and Reclamation cost estimate as part of the Type A Water Licence approval process. The updated and final Closure and Reclamation cost estimate provided constituted an agreement between Agnico, KIA and CIRNAC on the financial security parties agreed was required for the Boston site. Details of this process can be found on the NWB public registry and resulted in a requirement in Type A Water Licence 2AM-BOS1835 for $37,458,491 total to be posted; $9,963,564 to KIA and $27,494,927 to the Crown. This security is to be posted across nine (6) installments or tranches based on distinct project components.

14. Community Consultation

Agnico is committed to engaging positively and effectively with local communities in a manner that emphasizes respect, integrity and demonstrates a willingness to learn from experience and embrace necessary change. Agnico recognizes that maintaining engagement and community involvement is necessary throughout the mining cycle, and critical to continuous improvement. Agnico bases its approach to community involvement on the following principles:

1. Identify all Stakeholders in our operations;
2. Effectively engage Stakeholders and establish a dialogue;
3. Provide Stakeholders with means to respond to us as well as generate responses; and
4. Report to Stakeholders and regulators on our Engagements.

Agnico operates within Nunavut, and on Inuit Owned Lands. The Kitikmeot Inuit Association (KIA), representing the Inuit of the Kitikmeot region, advised Agnico during the Inuit Impact and Benefits Agreement (IIBA) negotiation process that all Kitikmeot communities are considered affected by Hope Bay. As a result, Agnico considers every Kitikmeot Inuk, and their representative organizations including the KIA to be Stakeholders in the Belt. For the purposes of local community engagement, communities involved in the Belt include Kugaaruk, Taloyoak, Gjoa Haven, Cambridge Bay, Umingmaktok, Kingaok, and Kugluktuk, comprising the Kitikmeot region of Nunavut.

In order to effectively engage, establish and maintain a dialogue with Agnico's various local communities, Agnico has implemented a number of steps and activities designed to support two-way communication. These efforts and activities are described in the subsections below.

In 2021, Agnico Community Consultation activities continued to be severely constrained by public health measures enacted by the Government of Nunavut Department of Health pursuant to the Nunavut public health emergency declared in response to the COVID-19 global pandemic.

14.1 CAMBRIDGE BAY OFFICE

Agnico maintains an office in Cambridge Bay, which is the closest, occupied, affected community to the Hope Bay Greenstone Belt. The office is centrally located in the community, furnished with bilingual signage, and accessible by the public during regular business hours, including wheelchair access. The primary purpose of this office is to facilitate community engagement. The Cambridge Bay office supports Agnico's engagement of government, regulators, intervenors, interested members of the public, employees, those seeking employment at Hope Bay and other interested parties.

Staff of the Cambridge Bay office are available to communicate directly with local Stakeholders and participate in a number of regional and territorial events that regularly occur in Cambridge Bay, thereby informing communities of Agnico operations, and actively soliciting feedback. The Cambridge Bay office is staffed with a Vice President of Corporate Social Responsibility, a Agnico Liaison and a Human Resources/Social Responsibility (HR/SR) Coordinator. They engage regularly with the public using two-way communications for a variety of activities including:

- Employee and public relations;

- Annual community awareness meetings;
- Regular meetings with individual Inuit job seekers;
- Recruiting and onboarding Inuit personnel;
- Regular communications with Community Liaison Officers in the Kitikmeot;
- Annual meetings between KIA and Agnico Presidents;
- Annual updating of KIA Board by Agnico Executive;
- Attendance at the KIA Annual General Meeting;
- Quarterly participation in the IIBA Implementation Committee;
- Presentation of the IIBA Annual Evaluation Report to the KIA Board;
- At a minimum, semi-annual meetings of the Inuit Environmental Advisory Committee (IEAC) in order to review environmental management and monitoring plans, discuss project related environmental issues, and obtain advice from knowledgeable Inuit on these matters;
- Meetings between Agnico staff and Kitikmeot Qualified Businesses;
- Regular meetings with relevant KIA Lands, Employment and Training and Executive staff; and
- Annual visits of the KIA Board, IIBA Implementation Committee, IEAC, and individual harvesters at Hope Bay.

During 2021, public health measures impeded or precluded implementation of the Community Involvement Plan. These measures included public closures of offices of Agnico and Stakeholders, Event cancellations, group size restrictions, travel restrictions. These measures prevented Agnico from communicating directly with the Cambridge Bay public, and to engage in face-to-face meetings with stakeholders. The uncertainty created by the pandemic in Nunavut also prevented Agnico from implementing the Community Involvement Plan; although it may have been possible to engage with stakeholders at any given time in 2021, there was no assurance this would hold true long enough for engagements to be scheduled and concluded.

14.2 ENGAGEMENT WITH INUIT THROUGH THE IIBA

In accordance with the Hope Bay Inuit Impact and Benefit Agreement ("IIBA"), signed in 2015, Agnico regularly engages Inuit on a range of matters directly as well as through the KIA. The IIBA includes the following schedules which contain specific provisions of adaptive socio-economic effect mitigation measures aimed at Kitikmeot Inuit:

- Schedule D – Training and Education Opportunities: whereby Inuit are provided support and training for opportunities at the Hope Bay Project;
- Schedule E – Employment: whereby measures and supports are provided to maximize Inuit participation in the Hope Bay Project;
- Schedule F – Business and Contracting Opportunities: whereby Inuit are provided business and contracting opportunities; and
- Schedule I – Inuit Environmental Advisory Committee: whereby Inuit have the opportunity to receive and consider information, provide advice and attempt to resolve community concerns relative to the environment and wildlife for the Hope Bay Project.

During 2021, engagement between Agnico and the KIA for the purposes of implementing the Hope Bay IIBA were curtailed due to office closures and travel restrictions made as a result of the COVID-19 public health emergency.

14.3 COMMUNITY AWARENESS: KITIKMEOT COMMUNITY MEETINGS

Agnico is committed to undertaking annual regional consultation tours of the Kitikmeot region. The tours consist of visits to each Kitikmeot community by Agnico community relations staff and relevant subject matter experts. During community consultation tours, public meetings are scheduled in each community, and in-person meetings are arranged with local stakeholders.

The 2021 annual Kitikmeot Community meeting tour was cancelled due to the COVID-19 public health emergency.

14.4 COMMUNITY AWARENESS: KITIKMEOT CAREER AWARENESS SESSIONS

Agnico hosts community and information and career awareness sessions in all Kitikmeot communities annually in order to maximize Inuit employment opportunities at Hope Bay. The purpose of these sessions is to provide information on:

- expected labour needs of Hope Bay;
- the skills, behaviours and qualifications required for employment and advancement at Hope Bay;
- the training opportunities and educational support programs available to prepare for employment at Hope Bay; and
- career opportunities in related fields such as science, technology, mathematics or professional services.

In 2021, the Hope Bay site continued to be physically separated from Kitikmeot communities in order to eliminate the potential for COVID-19 transmission from mine workers to Kitikmeot residents. A Return to Work proposal and plan to allow Kitikmeot (Nunavut) based staff to be rehired to work at Hope Bay was prepared and submitted to the Nunavut Public Health Officer in Q2 2021. Agnico (AEM) choose not to implement this plan in 2021 due to continued outbreaks of COVID-19 at Hope Bay, and the emergence of new COVID-19 variants. Due to these factors, Career and Employment opportunities for Kitikmeot (Nunavut) residents at Hope Bay were not available in 2021. The Kitikmeot Career Awareness tour was cancelled due to the COVID-19 public health emergency.

14.5 SOCIAL MEDIA

Agnico maintains a company Facebook™ page to both share operational information with communities and increase awareness of mining. In 2021, in response to the acquisition of Agnico Resources by Agnico Eagle Mining Ltd, the Hope Bay social media presence was adjusted to reflect the change in ownership. Agnico (AEM) uses its Facebook™ page to augment information distributed through AEM’s website. Agnico (AEM) also makes use of Kitikmeot community Facebook™ pages to advertise job postings, meeting notices, and any other news that may be of interest to Nunavut Stakeholders (https://www.facebook.com/AEMHopeBay).

Comments, questions or concerns received via social media are addressed promptly in a manner consistent with public meetings.

14.6 ELECTRONIC MAIL

Agnico maintains and periodically updates a listing of electronic mail addresses of Stakeholders, including select community members. This listing includes, but is not restricted to the following:

- Public elected officials;
- Inuit elected officials;
- Relevant federal and territorial regulator employees;
- Relevant Inuit Organization employees;
- Relevant Municipal officials; and
- Relevant training and employment agency employees.

When necessary, Agnico distributes electronic mail messages to this listing to inform them of Agnico related events, news and happenings. This engagement activity is conducted to ensure that Stakeholders and communities are well informed, encouraged to provide feedback, and if willing, able to plan participation in any future Agnico engagement.

14.7 NUNAVUT EVENT PARTICIPATION

Agnico ensures it is well informed of key events that occur on an annual basis in Nunavut that represent opportunities for community involvement and dialogue. Agnico makes staff available to attend these events in order to foster communication. Agnico also provides financial support as appropriate to event planning groups in order to assist in paying for event costs. Sponsored events include the following:

- Kitikmeot Mayor's Meeting;
- Kitikmeot Trade Show; and
- Nunavut Mining Symposium.

In 2021, all Nunavut events normally attended and sponsored were cancelled due to the COVID-19 public health emergency. The Nunavut Mining Symposium Society organized several virtual events in 2021 in lieu of an in-person conference. Agnico attended these virtual events.

14.8 STAKEHOLDER REPRESENTATIVE ORGANIZATIONS

Agnico recognizes that one of the most effective means of engagement and dialogue with Stakeholders and communities is joining with them in an organization of mutual benefit. Towards this aim, Agnico is a member of established organizations involving numerous community members. Agnico's participation in these groups provides members with information on Agnico's activities and, allows them to discuss matters of mutual concern, and undertake initiatives of mutual benefit. These organizations include the following:

- NWT/Nunavut Chamber of Mines;
- Nunavut Mine Training Roundtable; and
- Kitikmeot Indigenous Skills and Employment Training (ISET) Stakeholder Working Group.

In 2021, Agnico continued to participate in Stakeholder representative organizations. However, in-person meetings that normally take place within the listed groups above were cancelled due to the COVID-19 public health emergency. A reduced number of virtual meetings with the stakeholder representatives occurred in 2021.

14.9 COMMUNITY RELATIONS SUMMARY FOR 2021

Agnico's Corporate Social Responsibility (CSR) group is responsible for leading community relations on behalf of Agnico. Agnico conducts its activities in accordance with the *Community Involvement Plan*, and in compliance with the *Hope Bay Inuit Impact and Benefit Agreement*.

Agnico Corporate Social Responsibility supports the implementation of a number of Agnico Policies and Procedures including:

- Code of Ethical Business Conduct;
- Respectful Workplace;
- Whistleblower Policy;
- Corrective Action Policy;
- Community Complaints Procedure;
- Sustainable Development Policy; and
- Employee and Family Assistance Program.

During 2021, Alex Buchan, Director of Western Nunavut Affairs for Agnico headed the community involvement team based on corporate reorganization stemming from the Agnico Eagle Mining Ltd. Acquisition of Agnico. Alex Buchan is primarily responsible for delivering community involvement activities. The Community Relations team in Cambridge Bay includes Ikey Evalik, Inuit Impact and Benefit Agreement Coordinator, and Sandra Eyegetok, the HR/SR Coordinator.

Communications in 2021 focused on the acquisition of Hope Bay and Agnico Resources Inc. by Agnico Eagle Mining Ltd, and the effects of the COVID-19 global pandemic on Hope Bay operations and Inuit employment.

14.9.1 Cambridge Bay Logistics Hub

Response to the COVID-19 global pandemic required significant changes to resupply and transport to and from Hope Bay. All air transport links between the Kitikmeot region and Hope Bay continued to be severed during 2021 in order to prevent disease transmission from mine workers to Kitikmeot Communities. In Q2 2021, Agnico proposed a Return to Work protocol to the Government of Nunavut Chief Public Health Officer that would allow the resumption of crew change flights to and from Kitikmeot communities and Hope Bay. After the proposal was submitted, Hope Bay continued to experience outbreaks of COVID-19, and variants of concern were first identified, and spread across Canada. Given these developments, the Return to Work protocol was not implemented given the continued and heightened risk of disease transmission at Site.

14.9.2 Other Communications in 2021

Agnico continues the use of a project/company Facebook page to provide information on Hope Bay primarily to northern stakeholders. Content of this page includes permitting information, meeting notices, job advertisements, and pictures of site activities linked to Kitikmeot community news pages. Feedback from Agnico information from this social media source is growing and it may be surmised that many younger

Kitikmeot residents make better use of this information source than Elders or others more typically reliant on information received during public meetings. The page can be viewed at the following link: https://www.facebook.com/AEMHopeBay.

14.9.3 Corporate Social Responsibility Activities in 2021 by Month

January

- CSR Staff participated and where appropriate, lead, engagements with stakeholders this month to provide information and answer questions on the acquisition of Agnico.
- CSR Staff provided initial orientations and presentations this month to Agnico management to familiarize them with Hope Bay community relations topics such as the content of Inuit Agreements, terms and conditions of Hope Bay project certificates, and the work of the Cambridge Bay office.
- CSR Staff supported and participated in an initial virtual meeting between KIA and Agnico to introduce the new company owners to this Inuit organization.

February

- CSR Staff continued work this month to orient and provide information on Hope Bay Corporate Social Responsibility matters to Agnico staff that would now be involved in this work.
- CSR Staff supported the submission of the Roberts Bay Discharge Location change documentation to regulators this month.
- The Kitikmeot Workforce Readiness strategy process began this month with initial interviews of CSR staff by consultants. The Strategy has been initiated by Kitikmeot Corporation to find ways to better support Inuit employment at major developments in the region.
- CSR staff provided input and advice to the Agnico team responsible for responding to information requests from the KIA on the corporate acquisition this month.

March

- CSR staff engaged with others in the company to prepare for the scheduled review of the Hope Bay IIBA with the KIA.
- CSR staff assisted in the preparation of materials for the next Inuit Environmental Advisory Committee meeting to discuss Hope Bay Fisheries Offsetting. This IEAC meeting took place later on in the month to provide feedback on fisheries research plans for Freshwater Creek adjacent to Cambridge Bay.
- CSR staff engaged engineers working for the Government of the NWT inquiring about the availability of quarry rock at Hope Bay to be used to support erosion control in Tuktoyaktuk harbour this month.
- CSR staff supported Agnico in further development of a draft Hope Bay worker reintegration plan that would allow the rehiring of Nunavummuit at Hope Bay while maintaining strict pandemic measures.
- CSR staff engaged with others in the company to prepare for the scheduled review of the Hope Bay IIBA with the KIA.
- CSR staff provided input this month to the Conference Board of Canada in their research effort to study the effects of Fly-In Fly-Out employment in Northern Canada. The research findings may be useful for considering how best to maximize benefits from this type of employment at Hope Bay.

April

- CSR staff worked within the Nunavut Mining Symposium Steering Committee to consider alternatives to an in person conference this month including planning and preparation of virtual events during the summer and fall of 2021.
- CSR Staff attended, along with Agnico Senior Management, the KIA Board meeting in Kugluktuk this month. Agnico presented to the Board providing information on the new ownership of the company, and described AEM plans to rehire Inuit workers when safe, maintain and assess existing Gold production, and focus on gold exploration at Hope Bay. Follow up meetings were arranged in Cambridge Bay to introduce Agnico to Kitikmeot businesses and community stakeholders. However, due to the Covid outbreak experienced in the Kivalliq at that time, AEM Senior Management were required to vacate the region. Follow up virtual meetings were held later in the month in stead.
- CSR staff worked with Agnico communications staff to retire Agnico internet communications efforts and design and create replacement Agnico Hope Bay online content.

May

- Early in the month, CSR staff attended and presented at an internal workshop to ensure that the planned 2021 Hope Bay exploration program complied with Inuit agreements and permits to ensure all requirements would be met.
- CSR Staff continued to assist site staff this month in administering Hope Bay Covid protocols including questioning off rotation staff on their infection and isolation status to ensure their availability for upcoming shifts.
- Agnico staff responded to a media inquiry this month regarding the status of operations at Hope Bay, and when Nunavut workers could be rehired from Kitikmeot communities. Details of the draft Return To Work protocols were provided.
- An IIBA Implementation Committee meeting was held this month with KIA representatives.
- Agnico High School Achievement Awards, normally awarded this month were cancelled due to the pandemic measures in effect in Kitikmeot schools, and the continuing isolation of the Hope Bay site from communities.
- CSR Staff assisted AEM Communications personnel in scheduling and arranging for a professional photographer to attend Hope Bay site to create an updated inventory of imagery of Hope Bay infrastructure, operations and activities that could be used for public presentations and other materials. The photographer was scheduled to conduct this work during the later part of summer.

June

- A follow up Hope Bay IIBA Implementation Committee meeting was conducted this month with representatives of the KIA.
- CSR staff worked with KIA Lands staff this month to recalculate and confirm certain Water Compensation Payments made under the Hope Bay Water and Wildlife Compensation Agreement this month.
- CSR staff supported initial efforts to communicate the results of planning to install and operate wind turbines at Hope Bay with a newly formed Kitikmeot Based Business.
- This month, CSR staff participated in the first of several Nunavut Mining Symposium virtual events held in 2021 in lieu of an in-person conference cancelled due to the pandemic.

July

- Agnico staff participated in a KIA Kitikmeot Stakeholders Working Group this month in order to share information on employment and training matters with regional agencies and groups. The focus of the Hope Bay discussion was in relation to drafting, submitting and gaining approval for a return to work protocol for Hope Bay workers resident in Nunavut (Kitikmeot).
- CSR staff provided feedback to the Canadian Executive Services Organization (CESO) this month on an initiative that they are considering to support aboriginal business in entering the mine services sector.
- Agnico participated in formulating a company response to the proposed Nunavut Bill-55 regarding Property Tax collection for Nunavut mine sites upon invitation from the Nunavut Legislature Standing Committee.
- CSR staff were approached this month by independent researchers working with the Ekaluktutiak Hunters and Trappers Organization seeking international research funding to study marine water quality, including potentially at the Roberts Bay mine effluent discharge location. The researchers were provided information on Hope Bay aquatic effects monitoring programs, introduced to logistical considerations (fuel availability at Hope Bay), and invited to the next Inuit Environmental Advisory Committee meeting to present their research study proposal.

August

- CSR staff supported contracted hydrology and fisheries researcher field work this month investigating water flow and fish passage on the east channel of Freshwater Creek adjacent to Cambridge Bay in order to support future Fisheries Offsetting proposals to the Department of Fisheries and Oceans.

September

- Agnico staff participated in internal discussions and preparations for a comprehensive company submission to the Nunavut Planning Commission to comment on the 2021 Nunavut Draft Land Use Plan this month.
- CSR and HR staff provided input this month into the latest draft of the Kitikmeot Inuit Workforce Readiness Strategy commissioned by Kitikmeot Corporation. Included in the draft are steps and activities designed to support Inuit employment and training. Over a multi-year period by Kitikmeot agencies and major employers.
- During this month, a COVID 19 outbreak occurred at Doris Mine. CSR staff worked with communications staff to inform the public and Kitikmeot communities about the status of the outbreak, and the steps being taken to control the disease. The outbreak continued into October at which time a “circuit-breaker” mine site worker demobilization effort took place, followed by a major sanitation effort, before work crews could return to work.

October

- CSR staff continued public communications and media efforts to provide information on the Hope Bay COVID-19 outbreak early in the month, including the ramp down of operations to break site infection.
- CSR staff prepared for Agnico participation in Nunavut Planning Commission Public Hearings on the 2021 Draft Land Use Plan this month. These public hearings were subsequently cancelled due to the pandemic.

- Community Career Awareness Sessions, usually planned for this month, were cancelled due to the pandemic.
- CSR staff received initial training on new community relations tracking software used by AEM this month. Agnico will employ this software in 2022 in relation to Hope Bay.

<u>November</u>

- CSR staff worked extensively this month with KIA staff to begin the review of the implementation of the Hope Inuit Impact and Benefit Agreement.

<u>December</u>

- CSR staff facilitated an Inuit Environmental Advisory Committee meeting this month. Topics of discussion included informing the committee about legislated changes in lethality testing of mine effluent to include a new crustacean species, a report on Fisheries Offsetting research to date, discussions on wildlife Height of Land and Track monitoring survey design and local involvement in field work, and finally, an introduction to proposed independent marine water quality research that could take place in Roberts Bay.

15. Annual Inspection Activities

In 2021 Agnico hosted regulatory inspections for CIRNAC, NIRB, KIA, and WSCC. Details of when those visits occurred and a summary of the reports and follow up from those visits are detailed in Table 15-1.

Table 15-1. Summary of Annual Inspection Activities

Date	Agency	Summary	Follow up	Response
August 19-20, 2021	Kitikmeot Inuit Association	On August 19-20 the KIA inspected the Doris Commercial Lease area and infrastructure including Roberts Bay, the Airstrip and Access Road, Doris North, Waste Management Area, Quarry #2, Secondary Road, the TIA area, Windy Road and Windy Lake Camp, and Madrid North were inspected.	The remediation of the Windy Lake Camp needs to continue. It has been recommended to AEM – Agnico to test paint on buildings to determine if it is lead free. If the paint is lead free, buildings can be torn down, cut up, and burned in a burn pan. Ashes can then be backhauled to the land farm. Once AEM's workforce reintegration plan with Kitikmeot communities is approved, deploying Inuit workers to remediation work at Windy Lake Camp would provide immediate work for returning Inuit employees.	Lead analysis in paint is being conducted. All areas identified will continue to be monitored by Agnico.
August 25, 2021	Nunavut Impact Review Board	On August 25, 2021 the NIRB Monitoring Officer visited the Doris North and Phase 2 Hope Bay Project sites. The site visit consisted of the Roberts Bay area, Quarry 2 and the incinerator, the Madrid area and the tailings impoundment area.	Hope Bay has generally moved the Project towards overall compliance with requirements of the Project Certificates and is in general compliance with the terms and conditions contained therein. On November 9, 2021, NIRB issued the 2020-2021 Annual Monitoring Report for Doris North Gold Mine and Phase 2 Hope Bay Belt Project. The Board had no recommendations for the 2020-2021 Monitoring season	
September 6, 2021	Crown-Indigenous Relations and Northern Affairs Canada	Inspection to verify compliance with water licenses 2AM DOH1335, 2BB-BOS1727 and 2BE-HOP1222. The inspection focus was on fuel storage, waste and water management, site infrastructure as well as drilling and mining activities. Inspection of Crown Leases 77A/3-1-7 and 77A/3-3-2 were also conducted.	No follow up items identified.	
September 27, 2021	Worker's Safety and Compensation Commission	Inspection to verify compliance with Mines Health & Safety Regulations. The inspection focused on exploration activities, underground mining as well as surface infrastructure including the camp facility and warehouse. The inspector issued two orders for action.		Compliance report was submitted from Agnico within 30 days for order 2021-VM-01782-002. An extension was granted for order 2021-VM-01782-001 and report submitted on February 28, 2022.

References

SRK Consulting (Canada) Inc. 2009. *Water and Ore/Waste Rock Management Plan for the Boston Site Hope Bay Project, Nunavut*. Report 1CH008.022 for Hope Bay Mining Ltd. July 2009.

SRK Consulting (Canada) Inc. 2017. *Water and Ore/Waste Rock Management Plan for the Boston Site Hope Bay Project, Nunavut*. Report 1CT022.009 for TMAC Resources Inc. January 2017.

SRK Consulting (Canada) Inc., 2019. Classification of Waste Rock in Support of Segregating Construction Rock from Naartok East Crown Pillar Recovery Trench, Madrid North, Hope Bay Project - DRAFT. Prepared for TMAC Resources Inc. SRK Project No. 1CT022.037. June 2020.ERM. 2016. *Doris North Project: 2015 Aquatic Effects Monitoring Program Report.* Prepared for TMAC Resources Inc. by ERM Consultants Canada Ltd.: Yellowknife, NT.

TMAC. 2017. *Madrid-Boston Project Final Environmental Impact Statement.* TMAC Resources Inc.: Toronto, ON.

TMAC. 2018. *Hope Bay Project: Aquatic Effects Monitoring Plan.* Prepared by TMAC Resources Inc.: Toronto, ON.

Agnico Eagle Mines. 2021. *Waste Rock, Ore and Mine Backfill Management Plan, Hope Bay Project, Nunavut*. Prepared by Agnico Eagle Mines Limited for the Nunavut Water Board: Toronto, ON.

Appendix A
Concordance Table

Appendix A. Concordance Table

Condition	Section
Type A Water Licence 2AM-DOH1335	
Summary of monitoring reporting performed in accordance with Part I, Item 6. The Summary shall include conversion of daily amounts to monthly and annual amounts.	Section 5, Appendix D
A Geochemical Monitoring and Waste Rock Storage Assessment that includes the following: a. For the tailings solids: i. All geochemical data appended; ii. All tonnage data appended and locations of disposal; iii. Discussion of geochemical data (static and kinetic, if applicable) with relevant figures and calculation of NNP and NPR; and iv. Geochemical interpretation of data. b. For waste rock: i. Tonnage of mineralized and un-mineralized Waste Rock placed on Temporary Waste Rock Pad and in other locations as approved by the Boain writing; ii. Tonnage of Waste rock placed underground; and iii. Geochemical and inspection data. Note: Detox Tailings are characterized by TL-7 (dry detoxified tailings sent underground as backfill (solids)) and proposed TL-8 (filtrate from TL-7 (solution)).	Section 8, Appendix F
Include the report referenced in Part D, Item 18, that presents the data collected from the Quarry Rock Seepage Monitoring and Management Program. The report shall include a discussion of the interpretation of geochemical data and shall be presented to the Board for review.	Section 9, Appendix F
A summary of the results of the monthly TIA Water balance and Water quality model assessments referred to in Part E, Item 24 and any recalibrations that have been carried out. The report shall include: a. Relevant supporting data; b. a comparison of measured Water balance and Water quality values to predicted values; c. Monitoring and internal modelling results; d. a discussion of any discrepancies in model inputs; and e. Identification of any necessary adaptive management strategies.	Appendix E
An update on the current capacity of the Tailings Management Area.	Section 5.1.2
A record of measurements of the following: a. The flows (m3/day) at monitoring station TL-2; and b. A record of measurements of Doris Lake Water Level.	Appendix D.1
Annual review of and submission of any revisions to the Management Plans or Emergency Response or Contingency Plan in the form of either addenda or revised Plan.	Section 12
A list and description of all reportable unauthorized discharges including volumes, spill report line identification number and summaries of follow-up action taken.	Section 11
The results of the Aquatic Effects Monitoring Program and in accordance with Part I, Item 3.	Section 7 Also see 2021 AEMP Report Submission
A summary of any closure and reclamation work undertaken and an outline of any work anticipated for next year, including changes to implementation and scheduling.	Section 13
Incineration stack testing results when stack testing is required.	Section 6.1.1

Condition	Section
Type A Water Licence 2AM-DOH1335 *(cont'd)*	
Annual Landfill Management Report.	Section 6.4
A summary of modifications and/or major maintenance work carried out on the Water Supply and Waste Disposal Facilities, including all associated structures and an outline of any work anticipated for the next year.	Section 3 and Section 4
A summary report describing consultation and participation with local organizations and residents of nearby communities, including a schedule of upcoming events/information sessions.	Section 14
GPS locations of monitoring stations as confirmed with the Inspector under Part I, Item 3.	Appendix B
A summary of the data requested under Part I Item 5 and 6.	Section 5, 8 and 9 Appendix D and G
A summary of actions taken to address concerns or deficiencies listed in the inspection reports and/or compliance reports filed by an Inspector any other details on water use and waste disposal requested by the board.	Section 15
Any other details on Water use or Waste Disposal requested by the Board by November 1 of the year being reported.	N/A
Type A Water Licence 2AM-BOS1835	
Summary of monitoring reporting performed in accordance with Part I, Item 11. The Summary shall include conversion of daily amounts to monthly and annual amounts.	Section 5, Appendix D
Information with respect to Geochemical Monitoring and Waste Rock Storage Assessment a. For the tailings solids. b. geochemical data appended: i. All tonnage data appended and locations of disposal; ii. Discussion of geochemical data (static and kinetic, if applicable) with relevant figures and calculation of NNP and NPR; and iii. Geochemical interpretation of data. c. For waste rock: i. Tonnage of mineralized and un-mineralized Waste Rock placed on the Temporary Waste Rock Pad and in other locations as approved by the Board in writing; and ii. Tonnage of Waste rock placed underground.	Section 8, Appendix F
Include the report referenced in Part D, Item 17, that presents the data collected from the Quarry Rock Seepage Monitoring and Management Program. The report shall include a discussion of the interpretation of geochemical data and shall be presented to the Board for review.	Section 9, Appendix F
An update on the current capacity of the Tailings Management Area.	Section 5.1.2
Annual review of and submission of any revisions to the Management Plans or Emergency Response or Contingency Plan in the form of either addenda or revised Plan.	Section 12
A list and description of all reportable unauthorized discharges including volumes, spill report line identification number and summaries of follow-up action taken.	Section 11
The results of the Aquatic Effects Monitoring Program approved by the Board under Part B, Item 13.	Section 7 Also see 2020 AEMP Report Submission
Annual Adjustments to reclamation security estimates including any additional security that may be required or reductions in security requirements for progressive reclamation actions.	Section 13
A summary of any closure and reclamation work undertaken and an outline of any work anticipated for next year, including changes to implementation and scheduling.	Section 13
Incineration stack testing results when stack testing is required.	Section 6.1 and Appendix I

Condition	Section
Type A Water Licence 2AM-BOS1835 *(cont'd)*	
Annual Landfill Management Report.	Section 6.4
A summary of modifications and/or major maintenance work carried out on the Water Supply and Waste Disposal Facilities, including all associated structures and an outline of any work anticipated for the next year.	Section 3 and Section 4
A summary report describing consultation and participation with local organizations and residents of nearby communities, including a schedule of upcoming events/information sessions.	Section 14
GPS locations of monitoring stations as confirmed with the Inspector under Part I, Item 3.	Appendix B
A summary of the data requested under Part I Item 5 and 6.	Section 5, 8 and 9 Appendix D and G
A summary of actions taken to address concerns or deficiencies listed in the inspection reports and/or compliance reports filed by an Inspector any other details on water use and waste disposal requested by the board.	Section 15
Any other details on Water use or Waste Disposal requested by the Board by November 1st of the year being reported.	N/A
Type A Water Licence 2BE-HOP1222	
A summary report of water use and waste disposal activities.	Section 5.2, Section 6, Appendix D.2
A summary of all information requested and results of the Monitoring Program.	Section 5.2, Appendix D.2
A list of unauthorized discharges and a summary of follow-up actions taken.	Section 11
A brief description of follow-up actions taken to address concerns detailed in inspection and compliance reports prepared by the Inspector.	Section 15
An update to the Spill Contingency Plan, if required, including contact information in the form of an addendum.	Section 10, Section 12
A description of all progressive and/or final reclamation work undertaken, including photographic records of site conditions before, during and after completion of operations.	Section 13
A summary of modification and/or major maintenance work carried out on the water supply and waste disposal facilities, including all associated structures, and an outline of any work anticipated for the next year.	Section 3, Section 4
A summary of any specific studies or reports requested by the board, and a brief description of future studies planned or proposed.	Section 4
Any other details on water use or waste disposal requested by the board.	Section 5.2
Type A Water Licence 2BB-MAE1727	
The monthly and annual quantities in cubic metres of all freshwater obtained at Monitoring Stations No. MAE-01, No. MAE-02 and MAE-03, including all sources of water identified for domestic and industrial use under Part D, Item 1.	Section 5.3, Appendix D.3
The daily, monthly and annual quantities, in cubic metres, of mine water pumped from the underground mine.	Section 5.3, Appendix D.3
The monthly and annual quantities in cubic metres of Effluent discharged from the Pollution Control Ponds onto the tundra and/or transported to Doris to be discharged into the TIA, including the analysis result.	Section 5.3, Appendix D.3
The monthly and annual quantities in cubic metres of Sewage Effluent transported to the Doris North site.	Section 5.3, Appendix D.3
Report all artesian flow occurrences as identified under Part F, Item 9.	Section 5.3

Condition	Section
Type A Water Licence 2BB-MAE1727 ***(con't)***	
An estimate of the volume of waste rock and ore currently stockpiled at site, to date.	No waste rock and ore to date.
Tabular summaries of all data generated under the Monitoring Program, Part J.	Section 5.3, Appendix D.3
A summary of modifications and/or major maintenance work carried out on the Water Supply Facilities, Bulk Fuel Storage Facility, Pollution Control Ponds and any wastewater related facility including all associated structures, and an outline of any work anticipated for the next year.	Section 3, Section 4
A list of unauthorized discharges and follow-up action taken.	Section 11
Updates or revisions to the Water Management Plan, Abandonment and Restoration Plan, QA/QC, Waste Rock and Ore Storage Plan, and Spill Contingency Plan and/or any other management plan.	Section 12
An updated estimate of the current Madrid Advanced Exploration Project restoration and liability, as required under Part C, Item 5, based upon the results of the restoration research, project development monitoring, and any modifications to the site plan.	Section 13
A brief description of follow-up action taken to address concerns detailed in inspection and compliance reports prepared by the Inspector.	Section 15
A summary of drilling activities and reclamation of drilling sites.	Section 3.2, Section 13
A public consultation/participation report describing consultation with local organizations and residents of the nearby communities, conducted during the Report period.	Section 14
A summary of any abandonment and restoration work completed during the year and an outline of any work anticipated for the next year.	Section 13
A summary of any specific studies or reports requested by the Board, and a brief description of any future studies planned or proposed; and any other details on the use of Water or the deposit of Waste requested by the board Board by November 1 of year being reported.	Section 5.3
Type A Water Licence 2BB-BOS1727	
The monthly and annual quantities in cubic metres of all freshwater obtained from Aimaokatalok (Spyder) Lake, Monitoring Stations No. BOS1a and from Stickleback Lake, Monitoring Station No. BOS-1b and additional sources of water identified for domestic and other uses under Part C, Item 1.	Section 5.4, Appendix D.4
The monthly and annual quantities in cubic metres of Mine water pumped from the underground.	Section 5.4, Appendix D.4
The monthly and annual quantities in cubic metres of Effluent discharged at Monitoring Station Number BOS-2, BOS-2, BOS-4 and BOS5, BOS-6 and BOS-7.	Section 5.4, Appendix D.4
The monthly and annual quantities in cubic metres of non-compliant effluent transported to Doris North's Tailings Impoundment Area.	Section 5.4, Appendix D.4
The monthly and annual quantities in cubic metres of Sludge removed from the Sewage Treatment Facility.	Appendix D.4
The annual quantities in cubic metres of all soil and types of contaminants from all locations that are placed within the Landfarm facility and/or transported to Doris North Project.	Section 6.2
Report all artesian flow occurrences as identified under Part F, Item 3.	Section 5.4
Boston Ephemeral Stream Monitoring Report.	Section 9.2, Appendix G
Tabular summaries of all data generated under the Monitoring Program.	Appendix D.4

Condition	**Section**
Type A Water Licence 2BB-BOS1727 *(cont'd)*	
A summary of modification and/or major maintenance work carried out on the Water Supply and the Waste Disposal Facilities, including all associated structures, and an outline of any work anticipated for the next year.	Section 3, Section 4
A list of unauthorized discharges and follow-up action taken.	Section 11
Updates or revisions to the Closure Plan, QA/QC, Water and Ore/Waste Rock Management Plan, Spill Contingency Plan, and Landfarm Plan and/or any other plans.	Section 12
A brief description of follow-up action taken to address concerns detailed in inspection and compliance reports prepared by the Inspector.	Section 15
A summary of drilling activities and progressive reclamation of drill sites.	Section 13.1
An estimate of the current volume of waste rock and ore stockpiled on site.	Section 8.2
A public consultation/participation report describing consultation with local organizations and residents of the nearby communities, if any were conducted.	Section 14
A summary of any abandonment and restoration work completed during the year and an outline of any work anticipated for the next year.	Section 13
A summary of any specific studies or reports requested by the Board, and a brief description of any future studies planned or proposed.	Section 5.4
Any other details on Water use or Waste disposal requested by the Board by November 1st of the year being reported.	Section 5.4

Appendix B
NWB Forms

AGNICO EAGLE

NWB Annual Report **Year being reported:** 2021

License No: 2AM-DOH1335 **Issued Date:** August 16, 2013
Expiry Date: March 30, 2035

Project Name: Doris-Madrid Project

Licensee: TMAC Resources Inc.

Mailing Address: 145 King St E
Toronto, ON M5C 2Y7

Name of Company filing Annual Report (if different from Name of Licensee please clarify relationship between the two entities, if applicable):

Licence 2AM-DOH0713 was assigned from Hope Bay Mining Ltd. to TMAC Resources Inc. on June 18, 2013. This licence was renewed on Aug. 16, 2013 and renamed 2AM-DOH1323. This license was subsequently amended in November, 2016. The licence was amended a second time in December, 2018 and renamed 2AM-DOH1335.

General Background Information on the Project (*optional):

Licence 2AM-DOH1335 allows TMAC to carry out out activities in support of mining and milling operations at Doris and Madrid.

Licence Requirements: the licensee must provide the following information in accordance with

Part B	Item 2.

A summary report of water use and waste disposal activities, including, but not limited to: methods of obtaining water; sewage and greywater management; drill waste management; solid and hazardous waste management.

Water Source(s): Doris Lake/Windy Lake/lakes proximal to drilling targets/ice road

Water Quantity:

43000 cu.m/yr*	Quantity Allowable Domestic (cu.m)
12479 cu. m/yr	Actual Quantity Used Domestic (cu.m)
2033800 cu.m/yr	Quantity Allowable Domestic, Mining, Milling, Drilling, etc. (cu.m)
16807 cu. m/yr	Total Quantity Used Domestic, Mining, Milling, Drilling, etc. (cu.m)

**Part E, Item 1 total volume from "all sources and for all purposes"*

Waste Management and/or Disposal

- ☑ Solid Waste Disposal
- ☑ Sewage
- ☑ Drill Waste
- ☑ Greywater
- ☑ Hazardous

☑ Other: Containment Berm and Control Pond Effluent

Additional Details:

Water for domestic use at Doris Camp was obtained from Windy Lake. Water is drawn from the lake at the freshwater intake and trucked to Doris Camp. The Doris Lake pump house is not supplying domestic water to Doris Camp at this time.

Waste produced on site is treated according to Part F of the licence, and in accordance with the relevant Management Plans *(Incinerator Management Plan, Non-Hazardous Waste Management Plan, Hazardous Waste Management Plan, Waste Rock, Ore and Mine Backfill Management Plan, Hydrocarbon Contaminated Material Management Plan, Domestic Waste Water Treatment Management Plan, and Doris-Madrid Water Management Plan*).

Some specifics are as follows:

-Food waste is incinerated as per Part F Item 6.
-Paper products, paperboard packing, and untreated wood waste is open burned as per Part F Item 7.
-Agnico is authorized to dispose of all non-hazardous solid waste in a landfill on site as per Part F Item 9. To date, a landfill has not been built. All waste that cannot be incinerated on site is backhauled to an approved facility off site or will be held for deposit in a landfill once constructed.
-Sewage and greywater produced onsite is processed in the sewage treatment plant as per Part F Item 5. Sludge produced by the treatment plant is disposed in the TIA as outlined in the Domestic Waste Water Treatment Management Plan.
-Hazardous materials such as waste oil, glycol, and contaminated soil are shipped offsite for disposal at an approved site as per Part F Item 10.
-All containment berm water is sampled for water quality against the discharge criteria of the licence. Water that meets the standards for discharge is released in accordance with the licence following a notification to the Inspector; water that does not meet the licence criteria is treated onsite until it is remediated to acceptable levels for discharge to the tundra, and/or it is discharged to the TIA.
-Runoff and contact seepage at site is managed in accordance with the Quarry Management and Monitoring Plan and Doris-Madrid Water Management Plan.

A list of unauthorized discharges and a summary of follow-up actions taken.

Spill No.: (as reported to the Spill Hot-line)
Date of Spill:
Date of Notification to an Inspector:
Additional Details: (impacts to water, mitigation measures, short/long term monitoring, etc.)

Please see Section 11. of the attached Annual Report Supplement for a summary of all unauthorized discharges that occurred in 2021under license 2AM-DOH1335.

Revisions to the Spill Contingency Plan

Additional Details:

Please see Section 12. of the attached Annual Report Supplement for details.

Revisions to the Abandonment and Restoration Plan

Additional Details:

Please see Section 12. of the attached Annual Report Supplement for details.

Progressive Reclamation Work Undertaken

Additional Details (i.e., work completed and future works proposed)

Please see Section 13. of the attached Annual Report Supplement for details.

Results of the Monitoring Program including:

The GPS Co-ordinates (in degrees, minutes and seconds of latitude and longitude) of each location where sources of water are utilized;

Additional Details:

N/A

The GPS Co-ordinates (in degrees, minutes and seconds of latitude and longitude) of each location where wastes associated with the licence are deposited;

Additional Details:

N/A

Results of any additional sampling and/or analysis that was requested by an Inspector

Additional Details: (date of request, analysis of results, data attached, etc.)

N/A

Any other details on water use or waste disposal requested by the Board by November 1 of the year being reported.

Additional Details: (Attached or provided below)

N/A

Any responses or follow-up actions on inspection/compliance reports

Additional Details: (Dates of Report, Follow-up by the Licensee)

See Section 15. of attached Annual Report Supplement for details on inspection action items and how these were addressed.

Any additional comments or information for the Board to consider

Please see attached Annual Report Supplement for additional information requirements set out in Licence No. 2AM-DOH1335.

Date Submitted:	March 31 2022	
Submitted/Prepared by:	Nancy Duquet Harvey	
Contact Information:	**Tel:**	819.856.4385
	Fax:	
	email:	nancy.harvey@agnicoeagle.com

GPS Coordinates for water sources utilized

Source Description	UTM Easting	UTM Northing
ST-7 Doris Freshwater Intake	433525	7558727
ST-7a/MMS-4b Windy Freshwater Intake	432626	7550477

GPS Locations of areas of waste disposal

Location Description	UTM Easting	UTM Northing
TL-5	435539	7556285
TL-6	435539	7556285
TL-7a	435539	7556285
TL-7b	435539	7556285
TL-9	435539	7556285
ST-4	432450	7559600
ST-5	432960	7559270
ST-6A	432954	7563407
ST-6B	432878	7563130
ST-8 STP Discharge	432413	7559596
ST-9 STP Tundra Discharge	430898	7559328

GPS Locations of Active Monitoring Stations not included above*

Monitoring Station	UTM Easting	UTM Northing
TL-1	434712	7558948
TL-2	434059	7559504
TL-11	various locations as required	
TL-12	435539	7556285
ST-1	433093	7558914
ST-2	433217	7558935
ST-10	various locations as required	
ST-11	434573	7559182
ST-12	various locations as required	
MMS-1	433175	7549837
MMS-9	various locations as required	

** Thermal monitoring locations are documented in the Annual Geotechnical Report*

NWB Annual Report **Year being reported:** 2021

License No:	2BE-HOP1222	**Issued Date:**	June 30, 2012
		Expiry Date:	June 30, 2022

Project Name: Hope Bay Regional Exploration Project

Licensee: TMAC Resources Inc.

Mailing Address:
145 King St E
Toronto, ON M5C 2Y7

Name of Company filing Annual Report (if different from Name of Licensee please clarify relationship between the two entities, if applicable):

Licence 2BE-HOP1222 was issued June 30, 2012 to Hope Bay Mining Ltd. Effective June 18, 2013, the NWB authorized the assignment of Licence 2BE-HOP1222 from Hope Bay Mining Ltd. to TMAC Resources Inc.

General Background Information on the Project (*optional):

Licence 2BE-HOP1222 allows TMAC to carry out activities in support of exploration drilling at the Hope Bay Regional Exploration Project and the Windy Camp, which supports exploration activities.

Licence Requirements: the licensee must provide the following information in accordance with

Part B Item 2

A summary report of water use and waste disposal activities, including, but not limited to: methods of obtaining water; sewage and greywater management; drill waste management; solid and hazardous waste management.

Water Source(s): Domestic and dust suppression water sourced from Windy Lake. Water to supply drilling activities taken from source proximal to drilling target.

Water Quantity:

22995 cu.m	Quantity Allowable Domestic (cu.m)
12479 cu.m	Actual Quantity Used Domestic (cu.m)
29200 cu.m	Quantity Allowable Drilling (cu.m)
3727.3 cu. m.	Total Quantity Used Drilling (cu.m)
30600 cu.m	Quantity Allowable Dust Suppression (cu.m)
0.5 cu.m	Total Quantity Used Dust Suppression (cu.m)

Waste Management and/or Disposal

- [x] Solid Waste Disposal
- [ ] Sewage
- [x] Drill Waste
- [ ] Greywater
- [ ] Hazardous
- [ ] Other:

Additional Details:

Windy Camp was not operational in 2021 and all water used for Domestic purposes were to satisfy requirements for the Doris Camp permitted under the Type A Water Licence 2AMDOH1335

Occupancy of the Old Windy Camp ended October 23, 2008 and dismantling and reclamation of the area is on-going. Surface exploration drilling conducted in the licence area is supported from Doris Camp.

Water was used from Windy Lake to supply domestic water to Doris Camp in accordance with 2BE-HOP1222 Part C, Item 1. Water used for drilling is taken from the closest lake to each drill using a similar system to the domestic system, or for drill locations accessible by road or winter ice road, water is hauled by truck from Windy Lake, or compliant berm effluent from the Doris Project is recycled through the drills to lessen freshwater lake use. In the case of regional drilling, water is taken from the closest lake to the drill site in accordance with Part C Item 1. Drill cuttings produced under this licence are deposited in a sump constructed for this purpose, an appropriate natural depression located at least 31m from the high water mark of any adjacent water body, or disposed of in the Tailings Imoundmnet Area at the Doris Project. A regional exploration drill program occurred in the license area in 2020.

The Landfarm at Windy Camp and Bulk Fuel Storage Facilities at Windy Camp and Patch Lake have been dismantled and are in the process of reclamation. No effluent is produced at these locations.

Water accumulated in Quarries A, B and D is managed in accordance with the approved *Quarry A, B, D Management and Monitoring Plan* and the relevant sections of Part D of the licence. No discharges of water occurred form these sites in 2021

A list of unauthorized discharges and a summary of follow-up actions taken.

Spill No.: (as reported to the Spill Hot-line)

Date of Spill:

Date of Notification to an Inspector:

Additional Details: (impacts to water, mitigation measures, short/long term monitoring, etc)

No unauthorized discharges occurred in 2020 under licence 2BE-HOP1222.

Revisions to the Spill Contingency Plan

Additional Details:

Please see Section 12. of the attached Annual Report Supplement for details.

Revisions to the Abandonment and Restoration Plan

Additional Details:

Please see Section 12. of the attached Annual Report Supplement for details.

Progressive Reclamation Work Undertaken

Additional Details (i.e., work completed and future works proposed)

Please see Section 13. of the attached Annual Report Supplement for details.

Results of the Monitoring Program including:

The GPS Co-ordinates (in degrees, minutes and seconds of latitude and longitude) of each location where sources of water are utilized;

Additional Details:

Details attached.

The GPS Co-ordinates (in degrees, minutes and seconds of latitude and longitude) of each location where wastes associated with the licence are deposited;

Additional Details:

N/A

Results of any additional sampling and/or analysis that was requested by an Inspector

Additional Details: (date of request, analysis of results, data attached, etc)

No additional sampling requested.

Any other details on water use or waste disposal requested by the Board by November 1 of the year being reported.

Additional Details: (Attached or provided below)

No additional sampling requested.

Any responses or follow-up actions on inspection/compliance reports

Additional Details: (Dates of Report, Follow-up by the Licensee)

See Section 15. of attached Annual Report Supplement for details on inspection action items and how these were addressed.

Any additional comments or information for the Board to consider

Please see attached Annual Report Supplement for additional information requirements set out in Licence No. 2BE-HOP1222.

Date Submitted:	March 31 2022	
Submitted/Prepared by:	Nancy Duquet Harvey	
Contact Information:	**Tel:**	819.856.4385
	Fax:	
	email:	nancy.harvey@agnicoeagle.com

GPS Coordinates for water sources utilized

Source Description	Latitude	Longitude
HOP-1 - Raw water supply intake at Windy Lake	432626	7550477

GPS Locations of areas of waste disposal

Source Description	Latitude	Longitude

NWB Annual Report **Year being reported:** 2020

License No:	2BB-MAE1727	**Issued Date:**	May 23, 2017
		Expiry Date:	May 22, 2027

Project Name: Madrid Advanced Exploration Program

Licensee: TMAC Resources Inc.

Mailing Address:
145 King St E
Toronto, ON M5C 2Y7

Name of Company filing Annual Report (if different from Name of Licensee please clarify relationship between the two entities, if applicable):

Licence 2BB-MAE1727 was assigned to TMAC Resources Inc. on May 23, 2017.

General Background Information on the Project (*optional):

No activities occurred under license 2BB-MAE1727 in 2021.

Licence Requirements: the licensee must provide the following information in accordance with

A summary report of water use and waste disposal activities, including, but not limited to: methods of obtaining water; sewage and greywater management; drill waste management; solid and hazardous waste management.

Water Source(s): Patch Lake/Windy Lake

Water Quantity:		
	108000 cu.m/yr*	Quantity Allowable Domestic (cu.m)
	0 cu. m/yr	Actual Quantity Used Domestic (cu.m)
	not specified	Quantity Allowable Drilling (cu.m)
	0 cu. m/yr	Total Quantity Used Drilling (cu.m)

**Part E, Item 1 total volume from "all sources and for all purposes"*

Waste Management and/or Disposal

- ☐ Solid Waste Disposal
- ☐ Sewage
- ☐ Drill Waste
- ☐ Greywater
- ☐ Hazardous
- ☐ Other:

Additional Details:

No water was used or waste disposal under this licence in 2021.

A list of unauthorized discharges and a summary of follow-up actions taken.

Spill No.: N/A (as reported to the Spill Hot-line)
Date of Spill: N/A
Date of Notification to an Inspector: N/A
Additional Details: (impacts to water, mitigation measures, short/long term monitoring, etc.)

No spills occurred in this license area during 2021.

Revisions to the Spill Contingency Plan

Additional Details:

See Section 12. of attached Annual Report Supplement for details.

Revisions to the Abandonment and Restoration Plan

Additional Details:

Please see Section 12. of the attached Annual Report Supplement for details.

Progressive Reclamation Work Undertaken

Additional Details (i.e., work completed and future works proposed)

Please see Section 13. of the attached Annual Report Supplement for details.

Results of the Monitoring Program including:

The GPS Co-ordinates (in degrees, minutes and seconds of latitude and longitude) of each location where sources of water are utilized;

Additional Details:

N/A

The GPS Co-ordinates (in degrees, minutes and seconds of latitude and longitude) of each location where wastes associated with the licence are deposited;

Additional Details:

N/A

Results of any additional sampling and/or analysis that was requested by an Inspector

Additional Details: (date of request, analysis of results, data attached, etc.)

N/A

Any other details on water use or waste disposal requested by the Board by November 1 of the year being reported.

Additional Details: (Attached or provided below)

N/A

Any responses or follow-up actions on inspection/compliance reports

Additional Details: (Dates of Report, Follow-up by the Licensee)

See Section 15. of attached Annual Report Supplement for details on inspection action items and how these were addressed.

Any additional comments or information for the Board to consider

Please see attached Annual Report Supplement for additional information requirements set out in Licence No. 2BB-MAE1727.

Date Submitted:	March 31 2022	
Submitted/Prepared by:	Nancy Duquet Harvey	
Contact Information:	**Tel:**	819.856.4385
	Fax:	
	email:	nancy.harvey@agnicoeagle.com

GPS Coordinates for water sources utilized

Source Description	UTM Easting	UTM Northing
MAE-01 Windy Freshwater Intake	432626	7550477

GPS Locations of areas of waste disposal

Location Description	UTM Easting	UTM Northing

GPS Locations of Active Monitoring Stations not included above*

Monitoring Station	UTM Easting	UTM Northing
MAE-14	7550317	432644
MAE-15	7550458	433578
MAE-16	7547060	434748

NWB Annual Report **Year being reported:** 2021

License No: 2BB-BOS1727 **Issued Date:** August 1, 2017
Expiry Date: July 31, 2027

Project Name: Boston Advanced Exploration Project

Licensee: TMAC Resources Inc.

Mailing Address:
145 King St E
Toronto, ON M5C 2Y7

Name of Company filing Annual Report (if different from Name of Licensee please clarify relationship between the two entities, if applicable):

Licence 2BB-BOS1217 was issued Aug 2, 2012 to Hope Bay Mining Ltd. Effective June 18, 2013, the NWB authorized the assignment of Licence 2BB-BOS1217 from Hope Bay Mining Ltd. to TMAC Resources Inc. The license was renewed on August 1, 2017 and renamed 2BB-BOS1727.

General Background Information on the Project (*optional):

The Boston site supports advanced mineral exploration in the south end of the Hope Bay Project. Boston Camp was was closed in December 2019 and remained closed throughout 2020. Routine sampling, inspections and dewatering of water management facilities occurred during the open water season in 2021.

Licence Requirements: the licensee must provide the following information in accordance with

Part B	Item 9

A summary report of water use and waste disposal activities, including, but not limited to: methods of obtaining water; sewage and greywater management; drill waste management; solid and hazardous waste management.

Water Source(s): Aimaokatalok (Spyder) Lake for domestic use and drilling purposes. The total quantity of water allowable by the licence is 36,500 m^3/yr or 100 m^3/day. There is no differentiation between quantities to be used domestically or for drilling.

Water Quantity:

not specified	Quantity Allowable Domestic (cu.m)
0 cu.m	Actual Quantity Used Domestic (cu.m)
not specified	Quantity Allowable Drilling (cu.m)
0 cu.m	Total Quantity Used Drilling (cu.m)

Waste Management and/or Disposal

- [x] Solid Waste Disposal
- [x] Sewage
- [ ] Drill Waste
- [x] Greywater
- [ ] Hazardous
- [x] Other: Fuel Farm Berm, Containment Pond and Mine Portal discharges

Additional Details:

Boston Camp was was closed in December 2019 and remained closed throughout 2021.

Water for domestic use at Boston Camp is obtained from Aimaokatalok Lake via a 2 inch diameter submerged pipe with a DFO compliant fish screen. This intake pipe is linked to a pump house located approximately 30 metres from shore. In winter, the pump house is moved onto the ice to decrease the length of heat-traced line required to reach the location where the water is open under the ice. No water was used in 2021.
Sewage and greywater produced on site is processed in the sewage treatment plant as per Part D Item 11. Effluent from the Sewage Treatment Plant is sampled for effluent quality against the dischrage criteria of the licence. Effluent that meets the standards for discharge is released in accordance with the licence following a notification to the Inspector. Sludge is transported to Doris camp via winter track for disposal. No effluent was discharged from the Sewage Treatment Plant and no sludge was generated at Boston Camp in 2020.
Waste produced on site is treated according to Part D of the licence, and in accordance with the relevant Management Plans *(Incineration Management Plan, Non-Hazardous Waste Management Plan, and Hazardous Waste Management Plan*). Some specifics are as follows:
-Food waste, paper waste and untreated wood waste is burned in the incinerator as per Part D Item 3.
-Solid waste that cannot be burned is transferred to the Roberts Bay waste management facility for packaging and is taken offsite for disposal.
-Drill cuttings produced under this licence are disposed of in depressions as per Part F Item 2.
-Waste hazardous materials such as waste oil, glycol, and contaminated soil are shipped to Doris either to be reclaimed or shipped offsite for disposal in an approved facility as per Part D Item 6.
-Fuel berm effluent and Containment Berm effluent is sampled for water quality against the discharge criteria of the licence. Effluent that meets the standards for discharge is released in accordance with the licence following a notification to the Inspector. Effluent that does not meet the licence criteria is treated onsite with an oil-water separator system containing activated carbon and Metsorb media until it is remediated to acceptable levels for discharge.
-The landfarm facility was decommissioned in 2019. Hydrocarbon contaminated material generated by activities under this licence will be transported to Doris for treatment/disposal.
- Effluent from the mine portal/decline is sampled in accordance with the criteria specified for Monitoring Station BOS-9.

A list of unauthorized discharges and a summary of follow-up actions taken.

Spill No.: (as reported to the Spill Hot-line)
Date of Spill:
Date of Notification to an Inspector:
Additional Details: (impacts to water, mitigation measures, short/long term monitoring, etc)

No spills occurred in this license area during 2021.

Revisions to the Spill Contingency Plan

Additional Details:

See section 12. of attached Annual Report Supplement for details.

Revisions to the Abandonment and Restoration Plan

Additional Details:

Please see section 12. of the attached Annual Report Supplement for details.

Progressive Reclamation Work Undertaken

Additional Details (i.e., work completed and future works proposed)

Please see section 13. of the attached Annual Report Supplement for details.

Results of the Monitoring Program including:

The GPS Co-ordinates (in degrees, minutes and seconds of latitude and longitude) of each location where sources of water are utilized;

Additional Details:

Details attached.

The GPS Co-ordinates (in degrees, minutes and seconds of latitude and longitude) of each location where wastes associated with the licence are deposited;

Additional Details:

Details attached.

Results of any additional sampling and/or analysis that was requested by an Inspector

Additional Details: (date of request, analysis of results, data attached, etc)

No additional sampling or analysis was requested.

Any other details on water use or waste disposal requested by the Board by November 1 of the year being reported.

Additional Details: (Attached or provided below)

No additional sampling or analysis was requested.

Any responses or follow-up actions on inspection/compliance reports

Additional Details: (Dates of Report, Follow-up by the Licensee)

See Section 15. of attached Annual Report Supplement for details on inspection action items and how these were addressed.

Any additional comments or information for the Board to consider

Please see attached Annual Report Supplement for additional information requirements set out in Licence No. 2BB-BOS1727.

Date Submitted:	March 31 2022	
Submitted/Prepared by:	Nancy Duquet Harvey	
Contact Information:	**Tel:**	819.856.4385
	Fax:	
	email:	nancy.harvey@agnicoeagle.com

GPS Coordinates for water sources utilized

Source Description	UTM Easting	UTM Northing
BOS-1a - Raw water supply intake at Spyder Lake	440855	7505584

GPS Locations of areas of waste disposal

Location Description (type)	UTM Easting	UTM Northing
BOS-2 - Containment Pond Discharge	441332	7505378
BOS-3 - Sewage Disposal Facility Final Discharge	441191	7505560
BOS-4 - Treated sewage effluent point prior to entry into Aimaokatuk (Spyder) Lake	441211	7505776
BOS-5 - Effluent from the bulk fuel storage facility prior to release	441321	7505322
BOS-6 - Effluent from the landfarm treatment facility prior to release	441274	7505317
BOS-8 - Seepage/runoff from the ore stockpiles and camp pad, monitored on the tundra east of the ore stockpiles	441272	7505473
BOS-9 - Effluent from the portal decline	441219	7505378

NWB Annual Report **Year being reported:** 2021

License No:	2AM-BOS1835	**Issued Date:**	December 7, 2018
		Expiry Date:	March 30, 2035

Project Name: Boston Project

Licensee: TMAC Resources Inc.

Mailing Address:
145 King St E
Toronto, ON M5C 2Y7

Name of Company filing Annual Report (if different from Name of Licensee please clarify relationship between the two entities, if applicable):

Licence 2AM-BOS1835 was issued Dec 7, 2018 to TMAC Resources Inc.

General Background Information on the Project (*optional):

No construction, operations or other activities occurred under licence 2AM-BOS1835 in 2021.

Licence Requirements: the licensee must provide the following information in accordance with

Part B	Item 2

A summary report of water use and waste disposal activities, including, but not limited to: methods of obtaining water; sewage and greywater management; drill waste management; solid and hazardous waste management.

Water Source(s): Aimoakatalok Lake/lakes proximal to drilling targets/ice road

Water Quantity:

33000 cu.m/yr*	Quantity Allowable Domestic (cu.m)
0 cu. m/yr	Actual Quantity Used Domestic (cu.m)
503000 cu.m/yr	Quantity Allowable Domestic, Mining, Milling, Drilling, etc. (cu.m)
0 cu. m/yr	Total Quantity Used Domestic, Mining, Milling, Drilling, etc. (cu.m)

**Part E, Item 1 total volume from "all sources and for all purposes"*

Waste Management and/or Disposal

- ☐ Solid Waste Disposal
- ☐ Sewage
- ☐ Drill Waste
- ☐ Greywater
- ☐ Hazardous

- ☐ Other:

Additional Details:

No water was used or waste disposal under this licence in 2021. Facilities listed under this licence have not yet been constructed.

A list of unauthorized discharges and a summary of follow-up actions taken.

Spill No.: (as reported to the Spill Hot-line)

Date of Spill:

Date of Notification to an Inspector:

Additional Details: (impacts to water, mitigation measures, short/long term monitoring, etc.)

No spills occurred in this license area during 2021.

Revisions to the Spill Contingency Plan

Additional Details:

Please see Section 12. of the attached Annual Report Supplement for details.

Revisions to the Abandonment and Restoration Plan

Additional Details:

Please see Section 12. of the attached Annual Report Supplement for details.

Progressive Reclamation Work Undertaken

Additional Details (i.e., work completed and future works proposed)

Please see Section 13. of the attached Annual Report Supplement for details.

Results of the Monitoring Program including:

The GPS Co-ordinates (in degrees, minutes and seconds of latitude and longitude) of each location where sources of water are utilized;

Additional Details:

Facilities under this licence have not yet been constructed. No water used in 2021.

The GPS Co-ordinates (in degrees, minutes and seconds of latitude and longitude) of each location where wastes associated with the licence are deposited;

Additional Details:

Facilities under this licence have not yet been constructed. No waste disposal in 2021.

Results of any additional sampling and/or analysis that was requested by an Inspector

Additional Details: (date of request, analysis of results, data attached, etc.)

N/A

Any other details on water use or waste disposal requested by the Board by November 1 of the year being reported.

Additional Details: (Attached or provided below)

N/A

Any responses or follow-up actions on inspection/compliance reports

Additional Details: (Dates of Report, Follow-up by the Licensee)

See Section 15. of attached Annual Report Supplement for details on inspection action items and how these were addressed.

Any additional comments or information for the Board to consider

Please see attached Annual Report Supplement for additional information requirements set out in Licence No. 2AM-BOS1835.

Date Submitted:	March 31 2022	
Submitted/Prepared by:	Nancy Duquet Harvey	
Contact Information:	**Tel:**	819.856.4385
	Fax:	
	email:	nancy.harvey@agnicoeagle.com

GPS Coordinates for water sources utilized

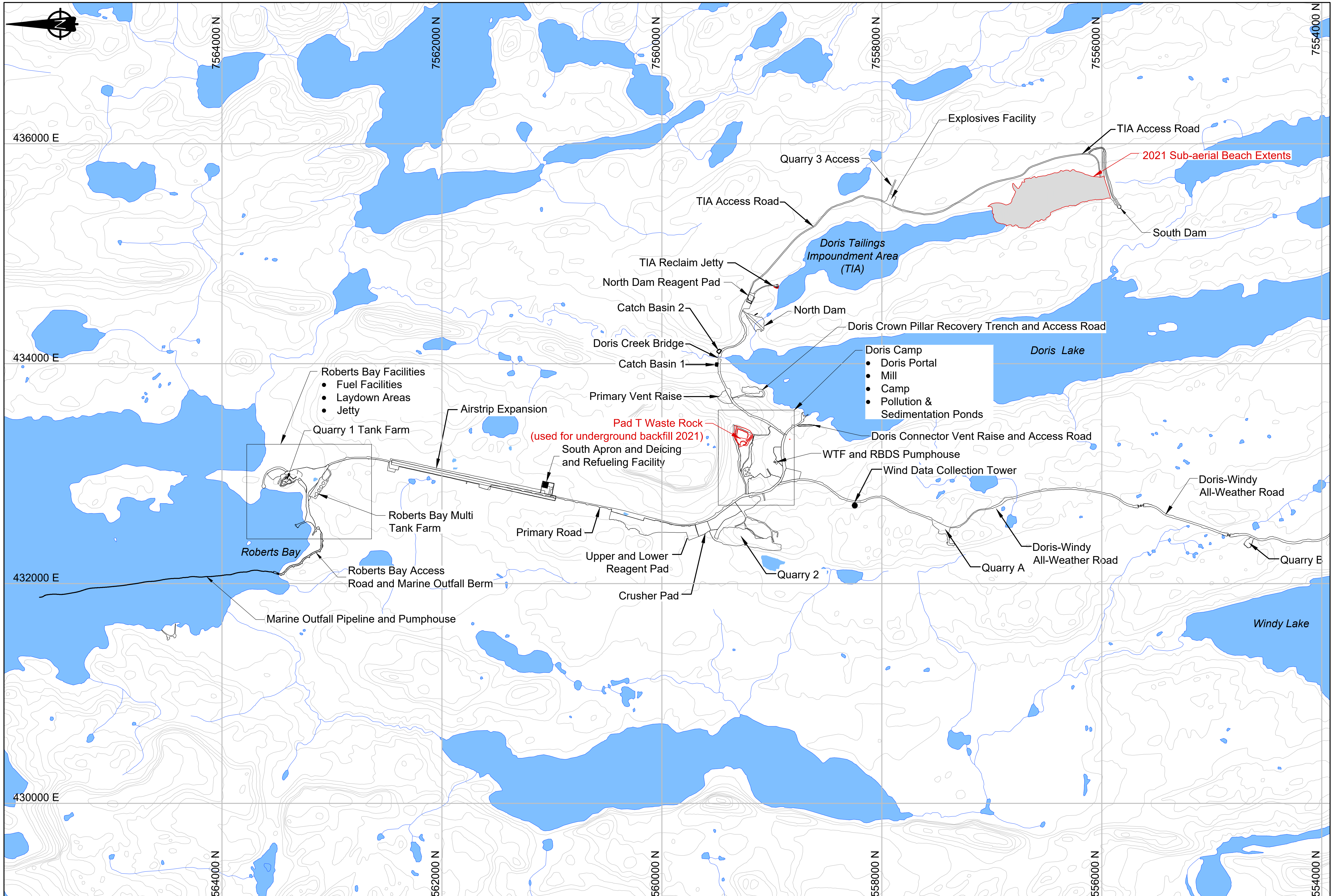
Source Description	UTM Easting	UTM Northing

GPS Locations of areas of waste disposal

Location Description (type)	UTM Easting	UTM Northing

Appendix C
Site Layouts

AGNICO EAGLE



LEGEND

Existing As-Built Infrastructure

2021 As-Built Infrastructure

NOTES

1. Coordinate system is UTM Zone 13, NAD83.
2. 2021 As-built linework delineated from drone LiDAR collected in August 2021, data provided by client.

0m 350 700 1050 1400

srk consulting

SRK JOB NO.: 1CT022.071

FILE NAME: 1CT022.071 - 2021 As-Built Update.dwg

AGNICO EAGLE

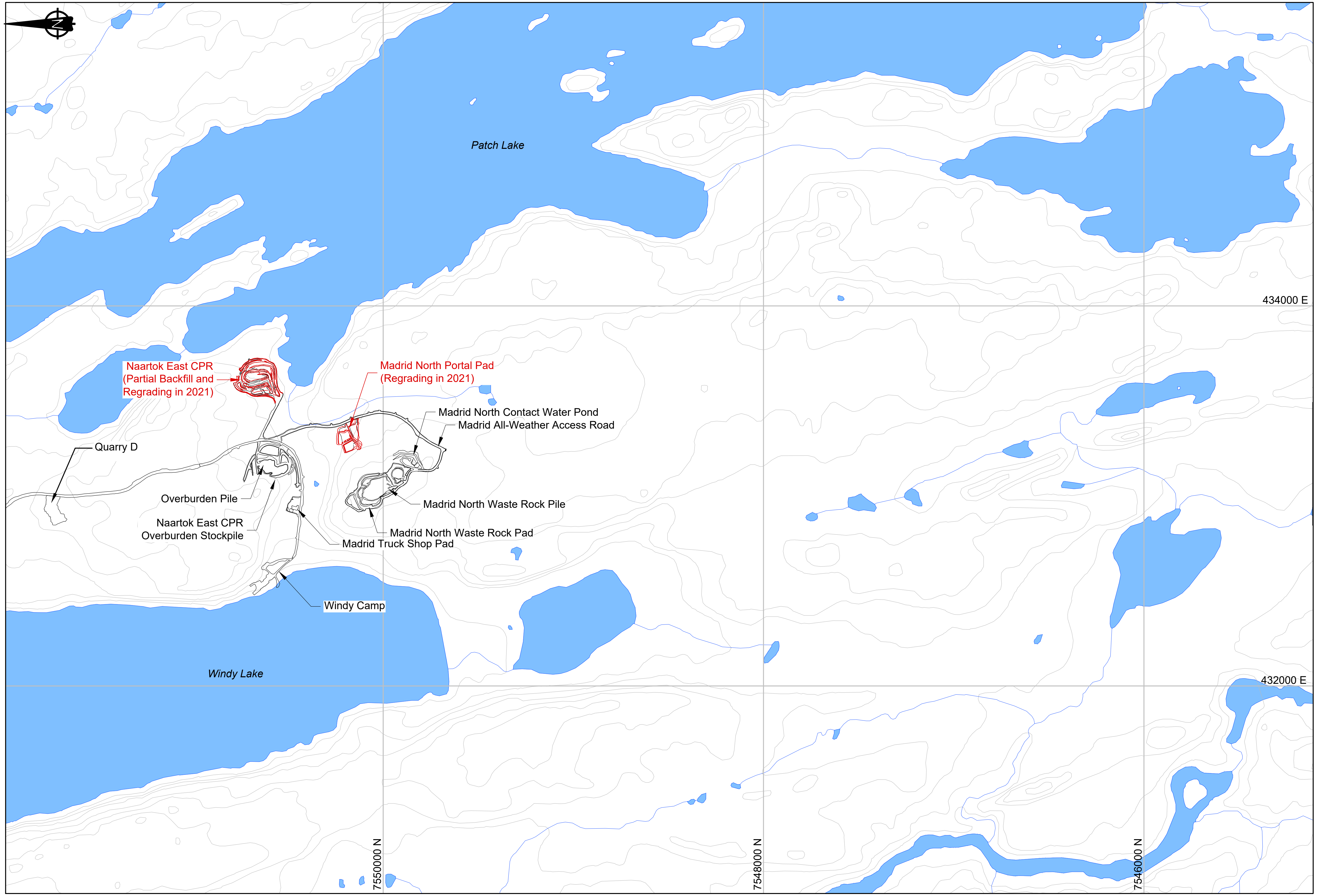
HOPE BAY

2021 KIA Annual Report

Doris Area 2021 As-Built Summary

DATE:	APPROVED:	FIGURE:
March 2022	PDL	1

C:\Users\thaye\SRK Consulting\FS208 Hope Bay (Doris North, Boston, Madrid) - \ACAD\2022 Drawings\2021 KIA Annual Report\1CT022.071 - 2021 As-Built Update.dwg



LEGEND

Existing As-Built Infrastructure

2021 As-Built Infrastructure

NOTES

1. Coordinate system is UTM Zone 13, NAD83.
2. 2021 As-built linework delineated from drone LiDAR collected in August 2021, data provided by client.

srk consulting

SRK JOB NO.: 1CT022.071

FILE NAME: 1CT022.071 - 2021 As-Built Update.dwg

AGNICO EAGLE

HOPE BAY

2021 KIA Annual Report

Madrid North Area 2021 As-Built Summary

DATE:	APPROVED:	FIGURE:
March 2022	PDL	2

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Appendix D
Water Licence(s) Monitoring Data

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Appendix D.1. 2AM-DOH1335

Appendix D.1. 2AM-DOH1335

The Type A Water Licence No. 2AM-DOH1335 details the sampling and analysis requirements for the Surveillance Network Program (SNP) program. Table D1-1 summarizes the sampling stations, sampling frequency and monitoring parameters required as part of the SNP for water licence 2AM-DOH1335. The location of each sampling point is illustrated in Figure D1-1 through Figure D1-3 below.

Table D1-1. 2AM-DOH1335 Sample Stations, Sample Frequency and Analytical Parameters

SNP Station	Description	Phase	Monitoring Parameters	Frequency during Operations and Anytime after Initial Deposit of Tailings to the TIA
ST-1	Doris Sedimentation Pond	Construction, Operation, Care and Maintenance, Closure	G, N1, MT and Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, and Total Metals by ICP-MS	Annually
ST-2	Doris Contact Water Pond	Construction, Operation, Care and Maintenance, Closure	G, N1, MT and Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, and Total Metals by ICP-MS	Annually
ST-3	Discharge from Non-hazardous Landfill Contact Water control sump	Construction, Care and Maintenance, Operation, Closure	G, MT and Total Ammonia-N, Total Sulphate, Total and Free CN, Total Oil and Grease	Annually. Once prior to every discharge onto the tundra
			D	Daily during periods of discharge
ST-4	Discharge from Landfarm sump	Construction, Operation, Care and Maintenance, Closure	G, HC, total Ammonium, total Lead	Annually. Once prior to every discharge onto the tundra
			D	Daily during periods of discharge
ST-5	Discharge from Doris Plant Site Fuel Storage and Containment Area Sump	Construction, Operation, Care and Maintenance, Closure	G, HC, Total Pb	Annually. Once prior to every discharge onto the tundra
			D	Daily during periods of discharge
ST-6a and ST-6b	Discharge from the Roberts Bay Fuel Storage and Containment Area Sumps	Construction, Operation, Care and Maintenance, Closure	G, HC, Total Pb	Annually. Once prior to every discharge onto the tundra
			D	Daily during periods of discharge

SNP Station	Description	Phase	Monitoring Parameters	Frequency during Operations and Anytime after Initial Deposit of Tailings to the TIA
ST-7	Freshwater pumped from Doris Lake	Construction, Operation, Care and Maintenance, and Closure	G, N1, N2, MT and Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, T-Tl, and Total Oil and Grease, Cl	Monthly during periods of pumping
			D	Monthly during periods of pumping
			Cl-a	Annually
ST-7a	Freshwater pumped from the Windy Lake freshwater intake	Construction, Operation, Care and Maintenance, Closure	G, N1, N2, MT, Cl and, T-Ag, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, T-Tl, T-Ca, and Total Oil and Grease, Free CN, Total CN	Monthly during periods of pumping
			B	
			D	
ST-8	Discharge from Doris Sewage Treatment Plant bio-membrane	Construction, Operation, Care and Maintenance, Closure	G, B, and Total Oil and Grease	Monthly when discharge to the Tundra, Annually when discharge to the TIA
			Location of discharge	Monthly during periods of discharge
			D	Daily during periods of discharge
ST-9	Runoff from Doris Sewage Treatment Plant discharge - downstream of wastewater treatment plant discharge point and just prior to flow entering Doris Lake	Construction, Operation, Care and Maintenance, Closure	G, B, and Total Oil and Grease	Monthly when ST-8 is discharged to the tundra
ST-10	Doris Site Runoff from Sediment Controls	Construction, Operations, Closure	TSS or Turbidity (following development and approval of a site-specific TSS-Turbidity)	Daily during periods of discharge
ST-11	Reagent and Cyanide Doris Storage Facility Sumps	Construction, Operation, Care and Maintenance, Closure	G, HC , MT, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, T-Tl Total Ammonia, Total and Free Cyanide, and D	Annually
ST-12	Doris Lake	Operation, Closure	Water Level	Monthly
			Ice Thickness	Annually in April
ST-13	Doris Contact Water Pond associated to Pad U	Construction, Operation, Care and Maintenance, Closure	G, N1, MT and Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, and Total Metals by ICP-MS	Annually
			D	Daily during periods of discharge

SNP Station	Description	Phase	Monitoring Parameters	Frequency during Operations and Anytime after Initial Deposit of Tailings to the TIA
TL-1	TIA at the Reclaim Pipeline	Operation, Care and Maintenance, Closure, Post-Closure	G, N1, N2, MT and TDS, Cl, Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-K, T-Mo, T-Mg, T-Na, T-Se, T-Tl, HC, Fecal Coliforms	Monthly during Operations, Closure and Post-Closure Annually during Care and Maintenance
			Dissolved Oxygen, Redox Potential, BOD	Annually
			Acute Lethality	Annually during Post-Closure
			D	Daily during periods of discharge
TL-2	Doris Outflow Creek - upstream (at the flow monitoring station adjacent to the bridge)	Closure, Post-Closure	G, N1, N2, MT and TDS, Cl, Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-K, T-Mo, T-Mg, T-Na, T-Se, T-Tl, Oil and Grease	Annually during Care and Maintenance Annually for 2 years prior to Post-Closure, and during Post-Closure, Increase to three times per year (under ice, freshet, and pre-freeze up), two years prior to breach of the North Dam.
		Operation	D	Daily upon commencement of mining in or beneath the Doris Lake Talik.
TL-3	Doris Outflow Creek (~80m downstream of the base of the waterfall)	Care and Maintenance, prior to any deposit of tailings to the TIA	G, N1, N2, MT and TDS, Cl, Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-K, T-Mo, T-Mg, T-Na, T-Se, T-Tl, Total Oil and Grease D	Inactive
TL-4	TIA Discharge End-of-Pipe	Care and Maintenance, prior to any deposit of tailings to the TIA	G, N1, N2, MT, and TDS, Cl, Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-K, T-Mo, T-Mg, T-Na, T-Se, T-Tl, T-Radium 226 Acute Lethality B D	Inactive
TL-5	Effluent from Doris Process Plant (tailings slurry/water)	Operations	G, N1, MT, and Free CN, Total CN, WAD CN, Sulphate, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, and Total Metals by ICP-MS	Monthly
			Cyanate and Thiocyanate	Quarterly

SNP Station	Description	Phase	Monitoring Parameters	Frequency during Operations and Anytime after Initial Deposit of Tailings to the TIA
TL-6	Tailings Discharged into TIA (Solid Component) taken from a valve in the mill at the discharge end of the mill tailings pumps	Operations	Tonnage of dry tailings solids	Monthly during periods of discharge
			MT and T-Cd, T-Cr, T-Hg, T-Mo, T-Se, Total Inorganic Carbon and Total Metals by ICP-MS (must include Sulphur)	Sampled on a weekly basis with analyses carried out monthly on a composite sample of the TL-6 weekly samples
TL-7a	Detoxified tailings solids sent underground as backfill	Operations	Dry tonnage of detoxified tailings sent underground; Moisture content of backfill trucked underground	Monthly
TL-7b	Filtrate from TL-7a (Detoxified tailings sent underground as backfill)	Operations	Cyanate and Thiocyanate, WAD CN, Total Inorganic Carbon, Total Metals by ICP-MS (including Sulphur)	Monthly
TL-8	Reclaim water pumped from TIA to Mill Process water tank taken from a valve at the discharge end of the reclaim water pump	Operations	G, N1, N2, MT and Free CN, Total CN, T-Ag, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, T-Tl	Inactive
			D	Daily during periods of pumping
TL-9	Detox tailings reactor tank (650-TK-565)	Monitoring and reporting is captured within the Water Management Plan		Monitoring and reporting is captured within the Water Management Plan
TL-10	Water Column in deepest portion of Tail Lake and at a location away from the TIA Reclaim water floating pump house, sampled at surface, mid- depth and near bottom	Inactive		Inactive
TL-11	Seepage from Doris underground backfilled stopes	Operations	Visual inspection for seepage. If seepage present parameters to be monitored include N1 and pH, EC, Trace metals by ICP-MS, Alkalinity, Acidity, Sulphate, Total, Free and WAD CN	Survey Twice annually

SNP Station	Description	Phase	Monitoring Parameters	Frequency during Operations and Anytime after Initial Deposit of Tailings to the TIA
TL-12	Doris Mine Water Discharge Point	Operations during continuous pumping	Chloride, TDS and nitrate	Weekly
			Total Ammonia, Nitrate, Nitrite, pH, EC, Total Metals by ICPMS, alkalinity, bromide, fluoride, sulphate, TSS, and Total and WAD Cyanide	Monthly
			D	Daily during periods of discharge
MMS-1	Madrid North Contact Water Pond	Construction, Operations, Care and Maintenance	G, N1, MT and Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, and Total Metals by ICP-MS	Sampled twice annually, Weekly water levels
MMS-2	Madrid South Primary Contact Water Pond	Construction, Operations, Care and Maintenance, Closure	G, N1, MT and Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, and Total Metals by ICP-MS	Sampled twice annually, Weekly water levels
MMS-3	Madrid South Secondary Contact Water Pond	Construction, Operations, Care and Maintenance, Closure	G, N1, MT and Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, and Total Metals by ICP-MS	Sampled twice annually, Weekly water levels
MMS-4a	Freshwater Intake at Windy Lake North	Construction, Operations, Care and Maintenance, Closure	G, N1, N2, MT and Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, T-Tl, and Total Oil and Grease, Cl, D	Sampled monthly during active pumping periods
MMS-4b	Freshwater Intake at Windy Lake South (Windy Camp)	Construction, Operations, Care and Maintenance, Closure	G, N1, N2, MT and Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, T-Tl, and Total Oil and Grease, Cl, D	Sampled monthly during active pumping periods
MMS-5	Discharge from Madrid South Fuel Storage facility	Construction, Operations, Care and Maintenance, Closure	G, HC, Total Pb	Annually. Once prior to every discharge to tundra
MMS-6	Brine Mixing Facility	Operations during continuous pumping	G, N1, Chloride, Fluoride, Bromide, Sulphate, TDS, EC, Total Metals ICP-MS, alkalinity, Total and WAD Cyanide	Sampled monthly during active pumping periods
MMS-7	Effluent from Madrid North Concentrator to TIA	Operations	G, N1, MT, and Free CN, Total CN, WAD CN, Sulphate, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, and Total Metals by ICP-MS	Sampled quarterly during active pumping periods
MMS-8	Discharge from Madrid North Fuel Storage Facility	Construction, Operations, Care and Maintenance, Closure	G, HC, Total Pb	Annually. Once prior to every discharge to tundra

SNP Station	Description	Phase	Monitoring Parameters	Frequency during Operations and Anytime after Initial Deposit of Tailings to the TIA
MMS-9	Site runoff from sediment controls during construction	Construction	TSS or Turbidity	Sampled daily during periods of discharge
MMS-10	Mine Water Discharge Point	Operations during continuous pumping	Chloride, TDS and nitrate Total Ammonia, Nitrate, Nitrite, pH, EC, Total Metals ICP-MS, alkalinity, Fluoride, Bromide, Sulphate, TSS, and Total and WAD Cyanide	Weekly Monthly

Figure D1-1. 2AM-DOH1335 Sample Stations Location

Figure D1-2. 2AM-DOH1335 Sample Stations Location

Figure D1-3. 2AM-DOH1335 Sample Stations Location

SUMMARY OF MONTHLY MONITORING REPORTING [SEE PART I ITEM 12]

Commercial operations continued in 2021 at Doris with continued efforts to stabilize mill throughput and optimize gold recovery. In 2021 the mill processed 262,466 tonnes (t) of ore and poured 64,583 ounces of gold, and successfully treated 19,249 t of cyanide solutions. Following the reduction in workforce due to the COVID-19 pandemic, Agnico continued processing ore at a reduced rate and achieved steady state processing and improved gold recovery.

Discharge to Robert’s Bay was commenced in May 2021 in accordance with MDMER and suspended as of November 2021 to remain compliant with MDMER. The initial steps to retrieve and relocate the Roberts Bay Discharge System diffuser were completed. The 800m submerged dewatering pipeline was retrieved from Roberts Bay. Final reattachment of the diffuser was delayed to 2022 due to equipment issues and safety concerns related to conducting the work during sealift fuel/materials offload.

Civil construction activities included the installation of a heated parking structure for emergency vehicles,the construction of laydown space for designated core storage north of Quarry 2, the beginning of installation of the metallurgy lab expansion at the Mill, the construction of the millwright shop located at the Mill, the installation and commissioning of air quality monitor in the Doris Air Quality Monitoring building.

Production at the Madrid North site was halted in early 2021 and the supporting earthworks for the Naartok East Crown Pillar and Madrid North underground decline were stopped in February 2021. The removal of ammonia/rine impacted area of the Madrid North portal laydown was completed prior to freshet 2021.

Underground mining operations continued at Doris Mine, while Madrid underground and surface operations were suspended in February 2021. At Doris, Agnico focused on producing from ore headings and production stopes. Ore was hauled to surface and stockpiled. A ventilation raise from the 201 – 81 level was also constructed. A grouting program coupled with an inflow measurement program at Doris was carried out over the course of 2021.

During 2021, Agnico collected data from the following active or seasonally active monitoring stations: TL-1, TL-5, TL-6, TL-7a, TL-7b, TL-9, TL-11, TL-12, ST-1, ST-2, ST-4, ST-5, ST-6a, ST-6b, ST-7, ST-7a/MMS-4b, ST-8, ST-9, - ST-11, ST-12, and MMS-1.

Monitoring at stations ST-3 (Landfill Sump), ST-13 (Doris Contact Water Pond Pad U), MMS-4a (Freshwater intake at Windy Lake North), and MMS-8 (Madrid North Fuel Storage Facility) did not occur, as these facilities were not constructed as of 2021. Monitoring at station MMS-6 (Brine mixing facility) did not occur as the unit was demobilized and stored.

Monitoring at ST-10 (Doris Site runoff from sediment controls) was not conducted as no new infrastructure was constructed at Doris. Monitoring at MMS-9 (Madrid Site runoff from sediment controls during construction) was not conducted as no construction was conducted at Madrid in 2021.

The Madrid North Concentrator was not constructed in 2021, therefore no effluent was discharged to the TIA from this facility and no monitoring occurred at station MMS-7. No monitoring at station MMS-10 (Madrid Mine Water Discharge) occurred as no mine water was pumped from Madrid underground workings in 2021.

No activities occurred at Madrid South in 2021. Therefore, monitoring at stations MMS-2 (Madrid South Primary Contact Water Pond), MMS-3 (Madrid South Secondary Contact Water Pond) and MMS-5 (Madrid South Fuel Storage Facility) did not occur as these facilities were not constructed as of 2021.

Monitoring of the TIA was undertaken at monitoring station TL-1. Monitoring of the tailings deposited into the TIA continued at monitoring stations TL-5 and TL-6 in 2021. Monitoring of detoxified tailings backfilled underground was completed at monitoring stations TL-7a, TL-7b and TL-11. As described in the Hope Bay Water Management Plan, the Doris Sedimentation Pond (ST-1) was used as a collection pond for the water that accumulated in the Doris Contact Water Pond (ST-2) and the three underflow sumps (ST2-S1, ST2-S2 and ST2-S3). The water collected in ST-1 was then transferred to the TIA by pipeline. The sedimentation pond was also used to transfer water from the landfarm (ST-4) and fuel storage facility berms (ST-5 and ST-6b) to the TIA. Water from the Naartok East Crown Pillar Trench (NECPT) and Madrid North Contact Water Pond (MMS-1) was also transferred to the TIA through the sedimentation pond while awaiting test results, then discharged directly to the tundra as per the Water Management Plan (2021). Dewatering of the TIA to Roberts Bay through the Roberts Bay Discharge System began in May and continued until November 2021.

All monitoring was conducted in accordance with the Hope Bay Project Quality Assurance and Quality Control Plan (2020).

Agnico uses an external certified laboratory to carry out all analyses reported in the monthly and annual reports. The QA/QC data produced by ALS Canada Ltd. and Bureau Veritas Laboratories Inc. are used to determine the accuracy and precision of results in these reports.

Thermal monitoring was undertaken in 2021 at active ground temperature monitoring stations. Results of this monitoring are included in the annual Geotechnical Inspection report.

Conditions of the Doris North Diversion Berm’s effectiveness during spring freshet, major rain events, and periods of sustained (non-frozen) precipitation were monitored and documented.

Details of all monitoring follows.

ST-1 Doris Sedimentation Pond

This facility was constructed and first used in 2011. In 2021, during open water season, all discharges from the facility were made directly to the TIA via pipeline as per Part F Item 17. All discharges from the facility were metered. Water quality samples were collected from an outlet on the discharge pump with the intake on the pump submerged approximately 0.25m below the water surface. If the pump was not running, samples were collected from the pond itself.

Water was transferred from ST-1 to the TIA beginning in June and continued into October. The final day of discharge from the Sedimentation Pond was October 11, 2021.

Volumes transferred to the TIA from ST-1 are summarized in Table D1-2. This includes water transferred from ST-2, ST2-S1, ST2-S2 and ST2-S3 to ST-1, as described above, and water transferred from the landfarm (ST-4) and fuel storage facility berms ST-5 and ST-6b. Volumes presented also include water transferred from the Madrid North Contact Water Pond (MMS-1) and Naartok East Crown Pillar Recovery Trench (NECPRT) to the Doris Sedimentation Pond for transfer to the TIA. Results of water quality samples, collected from ST-1, are summarized in Table D1-3. The October sample was attempted to be taken on October 11, however due to safety concerns related to accessing the sampling point on foot, and the pump sampling point having been demobbed for winter, the sample was unable to be taken.

Table D1-2. Summary of Monthly Water Management Volumes for Monitoring Station ST-1, June to October 2021

Month	Monthly Volume (m^3)	Cumulative Volume (m^3)*
June	2480	2480.1
July	3699	6179.4
August	2188	8367.2
September	5651	14018.5
October	1857	15875.8
Total Volume		**15875.8**

** Values rounded to nearest whole cubic metre.*
Volumes presented includes water from transferred from ST-2, ST2-S1, ST2-S2, ST2-S3, ST-4, ST-5, ST-6b, MMS-1, and NECPRT.

ST-2 Doris Contact Water Pond

This facility was constructed in 2011. In 2021, it was active between June and October. Samples from ST-2 were collected from a depth of 0.25 m below the water surface. All water from the Doris Contact Water Pond was directed to the Sedimentation Pond.

Water quality monitoring sampling at ST-2 occurred as per Schedule I of the water licence. Results of the sampling are presented in Table D1-4.

ST-4 Landfarm

Water quality samples were collected on June 14 from the Landfarm (ST-4) prior to discharge of water from this facility. Notification of discharge from this facility was provided to the Inspector on May 10, 2021. This sample met the discharge criteria identified in Part F Item 18(b). No discharge to tundra occurred from this facility in 2021. A total of 14 m3 was transferred from the Landfarm to the sedimentation pond, and 28 m^3 was transferred to the TIA. Results of Landfarm water sampling are presented in Table D1-5.

Table D1-3. Water Quality Monitoring Program Results for ST-1, June, July, August, and September 2021

	Sample ID	ST1	ST1	ST1	ST1
	ALS ID	YL2100615-001	YL2100780-001	YL2101041-001	YL2101277-001
	Date Sampled	2021-06-21 11:20	2021-07-12 15:10	2021-08-15 16:25	2021-09-12 10:10
Parameter	**Units**	**Results**			
pH	pH	7.88	7.8	7.71	7.86
Total Suspended Solids	mg/L	14.9	32.2	19.2	10.3
Chloride (Cl)	mg/L	1110	1270	1400	912
Cyanide, Total	mg/L	0.0631	0.492	0.358	3.12
Ammonia, Total (as N)	mg/L	8.7	17.9	19.5	11.2
Nitrate (as N)	mg/L	25.9	54.6	47.2	41.3
Nitrite (as N)	mg/L	0.396	2.07	4.46	0.701
Sulfate (SO4)	mg/L	243	336	329	298
Aluminum (Al)-Total	mg/L	0.222	0.64	0.0255	0.0651
Antimony (Sb)-Total	mg/L	0.00077	0.00072	0.00059	0.00057
Arsenic (As)-Total	mg/L	0.0423	0.00491	0.00267	0.00212
Barium (Ba)-Total	mg/L	0.0258	0.0616	0.0578	0.0468
Beryllium (Be)-Total	mg/L	<0.000040	<0.000040	<0.000040	<0.000040
Boron (B)-Total	mg/L	0.299	0.332	0.341	0.254
Cadmium (Cd)-Total	mg/L	0.0000932	0.000157	0.000118	0.000083
Calcium (Ca)-Total	mg/L	219	374	412	278
Chromium (Cr)-Total	mg/L	<0.00100	0.00176	<0.00100	<0.00100
Cobalt (Co)-Total	mg/L	0.0116	0.0158	0.0201	0.0149
Copper (Cu)-Total	mg/L	0.0909	0.186	0.0434	0.725
Iron (Fe)-Total	mg/L	0.754	2.56	0.927	1.61
Lead (Pb)-Total	mg/L	0.000635	0.000914	0.000131	0.000171
Lithium (Li)-Total	mg/L	0.0157	0.015	0.0146	0.0114
Magnesium (Mg)-Total	mg/L	70.4	84.9	85.4	58.1

Sample ID		ST1	ST1	ST1	ST1
ALS ID		YL2100615-001	YL2100780-001	YL2101041-001	YL2101277-001
Date Sampled		2021-06-21 11:20	2021-07-12 15:10	2021-08-15 16:25	2021-09-12 10:10
Parameter	**Units**	**Results**			
Manganese (Mn)-Total	mg/L	0.267	0.578	0.636	0.533
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	0.0000066
Molybdenum (Mo)-Total	mg/L	0.0057	0.0085	0.00811	0.00648
Nickel (Ni)-Total	mg/L	0.0175	0.0181	0.0202	0.0341
Potassium (K)-Total	mg/L	23.8	36.3	34.7	24.4
Selenium (Se)-Total	mg/L	0.00157	0.00313	0.00414	0.00373
Silver (Ag)-Total	mg/L	0.000628	0.000736	0.000269	0.00383
Sodium (Na)-Total	mg/L	442	488	541	349
Thallium (Tl)-Total	mg/L	<0.000020	0.000023	0.000027	<0.000020
Tin (Sn)-Total	mg/L	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)-Total	mg/L	0.00736	0.0142	<0.00060	0.00281
Uranium (U)-Total	mg/L	0.000857	0.00108	0.00125	0.0013
Vanadium (V)-Total	mg/L	0.0012	0.00328	<0.00100	<0.00100
Zinc (Zn)-Total	mg/L	0.0134	0.113	0.044	0.0281
Alkalinity, Total (as CaCO3)	mg/L	91	114	138	100
Oil and Grease	mg/L	<5.0	<5.0	<5.0	<5.0
Oil And Grease (Visible Sheen)		Absent	Absent	Absent	Absent

Table D1-4. Water Quality Monitoring Program Results for ST-2, June, July, August, September, and October 2021

	Sample ID	ST2	ST2	ST2	ST2	ST2
	ALS ID	YL2100464-001	YL2100780-002	YL2101041-002	YL2101277-002	YL2101523-001
	Date Sampled	2021-06-01 14:15	2021-07-12 14:45	2021-08-15 16:40	2021-09-12 8:25	2021-10-11 14:15
Parameter	**Units**	**Results**				
pH	pH	7.92	7.76	7.69	7.9	7.54
Total Suspended Solids	mg/L	13.8	15.4	4.4	3.1	<3.0
Chloride (Cl)	mg/L	382	720	914	768	2200
Cyanide, Total	mg/L	0.244	3.51	2.63	6.05	5.75
Ammonia, Total (as N)	mg/L	3.11	7.78	10.8	9.84	42.1
Nitrate (as N)	mg/L	11.7	21.9	16.2	32.5	101
Nitrite (as N)	mg/L	0.208	3.14	4.06	0.618	0.281
Sulfate (SO4)	mg/L	107	386	335	387	528
Aluminum (Al)-Total	mg/L	0.786	0.155	0.0157	0.0904	<0.0150
Antimony (Sb)-Total	mg/L	0.00029	0.00092	0.00073	0.00078	0.00088
Arsenic (As)-Total	mg/L	0.00221	0.00501	0.00341	0.00274	0.00148
Barium (Ba)-Total	mg/L	0.0168	0.0278	0.0306	0.0416	0.0859
Beryllium (Be)-Total	mg/L	<0.000020	<0.000040	<0.000040	<0.000020	<0.000100
Boron (B)-Total	mg/L	0.092	0.368	0.351	0.314	0.362
Cadmium (Cd)-Total	mg/L	0.0000237	<0.0000450	0.0000321	0.000059	0.0000504
Calcium (Ca)-Total	mg/L	104	212	237	219	606
Chromium (Cr)-Total	mg/L	0.00228	0.0011	<0.00100	0.00072	<0.00250
Cobalt (Co)-Total	mg/L	0.00668	0.0266	0.0257	0.0246	0.043
Copper (Cu)-Total	mg/L	0.0765	0.327	0.0482	1.26	0.359
Iron (Fe)-Total	mg/L	1.23	1.99	1.32	2.56	1.97
Lead (Pb)-Total	mg/L	0.000503	0.000139	<0.000100	0.00015	<0.000250
Lithium (Li)-Total	mg/L	0.0076	0.0122	0.013	0.0124	0.0225
Magnesium (Mg)-Total	mg/L	23	54.1	66.3	52.3	146

Sample ID		ST2	ST2	ST2	ST2	ST2
ALS ID		YL2100464-001	YL2100780-002	YL2101041-002	YL2101277-002	YL2101523-001
Date Sampled		2021-06-01 14:15	2021-07-12 14:45	2021-08-15 16:40	2021-09-12 8:25	2021-10-11 14:15
Parameter	**Units**	**Results**				
Manganese (Mn)-Total	mg/L	0.172	0.226	0.252	0.344	0.387
Mercury (Hg)-Total	mg/L	<0.000050	0.0000065	<0.0000050	0.000006	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.0032	0.0114	0.0109	0.00845	0.00999
Nickel (Ni)-Total	mg/L	0.00434	0.0309	0.0277	0.0583	0.0587
Potassium (K)-Total	mg/L	8.77	28.2	29.2	25.2	56.4
Selenium (Se)-Total	mg/L	0.000778	0.0038	0.00401	0.00474	0.00737
Silver (Ag)-Total	mg/L	0.000479	0.00148	0.000377	0.00693	0.00143
Sodium (Na)-Total	mg/L	141	369	462	348	820
Thallium (Tl)-Total	mg/L	<0.000010	<0.000020	<0.000020	0.000012	<0.000050
Tin (Sn)-Total	mg/L	<0.00010	<0.00020	<0.00020	<0.00010	<0.00050
Titanium (Ti)-Total	mg/L	0.0343	0.00576	<0.00060	0.00376	<0.00150
Uranium (U)-Total	mg/L	0.000707	0.0015	0.00151	0.00168	0.00238
Vanadium (V)-Total	mg/L	0.00302	0.00194	<0.00100	0.0014	<0.00250
Zinc (Zn)-Total	mg/L	0.0063	<0.0060	<0.0060	<0.0030	<0.0150
Alkalinity, Total (as CaCO3)	mg/L	67.3	165	180	122	148
Oil and Grease	mg/L	<5.0	5.6	<5.0	<5.0	<5.0
Oil And Grease (Visible Sheen)		Absent	Absent	Absent	Absent	Absent

Note:
Effluent quality limits listed under Part F Item 18(a) are not applicable as water accumulating in this facility is transferred to the Tailings Impoundment Area.

Table D1-5. Water Quality Monitoring Program Results for ST-4, June 2021

	Sample ID	ST4	Part F Item 18(b)	
	ALS ID	YL2100562-001		
	Date Sampled	2021-06-14 14:40	Maximum Authorized Monthly Mean Concentration (mg/L)	Maximum Authorized Concentration in a Grab Sample (mg/L)
Parameter	**Units**	**Results**		
pH	pH	7.91	6.0-9.5	6.0-9.5
Total Suspended Solids	mg/L	<3.0	50.0	100.0
Benzene	mg/L	<0.00050	0.37	0.37
Toluene	mg/L	<0.00050	0.002	0.002
Ethylbenzene	mg/L	<0.00050	0.09	0.09
Oil and Grease	mg/L	<5.0	5	10
Oil And Grease (Visible Sheen)		Absent	No Visible	No Visible
Lead (Pb)-Total	mg/L	0.000082	0.2	0.4
Ammonia, Total (as N)	mg/L	<0.0050		

ST-5 Doris Plant Site Fuel Storage and Containment

Water from the Doris tank farm (ST-5) was sampled on June 7, 2021, prior to dewatering events and results met the discharge criteria outlined in Part F Item 18(b). Notification of discharge from this facility was provided to the Inspector on May 10, 2021. Results of this sampling are presented in Table D1-6.

No discharge to tundra occurred from this facility in 2021. A total of 1066 m^3 of water was transferred to the Sedimentation Control Pond and 41 m3 was directed to the TIA.

ST-6a Roberts Bay Bulk Fuel Storage Facility

Water from the Roberts Bay 5ML tank farm (ST-6a) was sampled on June 7, 2021, prior to discharge and met the discharge criteria outlined in Part F Item 18(b). Results of this sampling are presented in Table D1-7.

Notification of discharge from this facility was provided to the Inspector on May 10, 2021. Upon receipt of compliant results, a total of 14 m^3 of water was discharge to tundra (location 13W 432973 7563440), 192 m^3 of water was discharged to the Sedimentation Control Pond and 16m^3 of water was transferred directly to the TIA.

ST-6b Roberts Bay Bulk Fuel Storage Facility

Water from the Roberts Bay 4x5 ML tank farm (ST-6b) was sampled on May 10, 2021, prior to discharge and results met the discharge criteria outlined in Part F Item 18(b) of the licence. Notification of discharge from this facility was provided to the Inspector on May 10, 2021. Results of this monitoring are presented in Table D1-8. A total of 2135 m3 was discharge to tundra (location 13W 432730 7563200) from this facility in 2021.

Table D1-6. Water Quality Monitoring Program Results for ST-5, June 2021

Sample ID		ST5	Part F Item 18(b)	
ALS ID		YL2100489-001		
Date Sampled		2021-06-07 7:08		
Parameter	Units	Results	Maximum Authorized Monthly Mean Concentration (mg/L)	Maximum Authorized Concentration in a Grab Sample (mg/L)
pH	pH	7.98	6.0-9.5	6.0-9.5
Total Suspended Solids	mg/L	<3.0	50.0	100.0
Benzene	mg/L	<0.00050	0.37	0.37
Toluene	mg/L	<0.00050	0.002	0.002
Ethylbenzene	mg/L	<0.00050	0.09	0.09
Oil and Grease	mg/L	<5.0	5	10
Oil And Grease (Visible Sheen)		Absent	No Visible Sheen	No Visible Sheen
Lead (Pb)-Total	mg/L	0.000173	0.2	0.4

Table D1-7. Water Quality Monitoring Program Results for ST-6a, June 2021

Sample ID		ST6A	Part F Item 18(b)	
ALS ID		YL2100489-002		
Date Sampled		2021-06-07 7:38		
Parameter	Units	Results	Maximum Authorized Monthly Mean Concentration (mg/L)	Maximum Authorized Concentration in a Grab Sample (mg/L)
pH	pH	8.13	6.0-9.5	6.0-9.5
Total Suspended Solids	mg/L	3.9	50.0	100.0
Benzene	mg/L	<0.00050	0.37	0.37
Toluene	mg/L	<0.00050	0.002	0.002
Ethylbenzene	mg/L	<0.00050	0.09	0.09
Oil and Grease	mg/L	<5.0	5	10
Oil And Grease (Visible Sheen)		Absent	No Visible Sheen	No Visible Sheen
Lead (Pb)-Total	mg/L	0.000195	0.2	0.4

Table D1-8. Water Quality Monitoring Program Results for ST-6b, May 2021

	Sample ID	ST6B	Part F Item 18 (b)	
	ALS ID	YL2100362-001		
	Date Sampled	2021-05-10 8:30		
Parameter	**Units**	**Results**	**Maximum Authorized Monthly Mean Concentration (mg/L)**	**Maximum Authorized Concentration in a Grab Sample (mg/L)**
pH	pH	8.04	6.0-9.5	6.0-9.5
Total Suspended Solids	mg/L	7.5	50.0	100.0
Benzene	mg/L	<0.00050	0.37	0.37
Toluene	mg/L	<0.00050	0.002	0.002
Ethylbenzene	mg/L	<0.00050	0.09	0.09
Oil and Grease	mg/L	<5.0	5	10
Oil And Grease (Visible Sheen)		Absent	No Visible Sheen	No Visible Sheen
Lead (Pb)-Total	mg/L	0.000498	0.2	0.4

ST-7 and ST-7a/MMS-4b Freshwater Usage from Doris and Windy Lakes

Table D1-9 provides the volumes of water usage at the Doris and Madrid project areas as required under Part E Item 1 of water licence 2AM-DOH1335. The water extraction pump for Doris operations is located off the northwest shoreline of Doris Lake and the sampling station ST-7 is located within the Doris Lake pump house. In 2021, water from Doris Lake was not used for domestic consumption; all water for domestic consumption was obtained from Windy Lake at ST-7a (also referred to as MMS-4b in this licence and equivalent to location HOP-1 of the Regional Exploration Licence 2BE-HOP1222). Water for dust suppression in 2021 was obtained from Windy Lake and Doris Lake. All water obtained from Windy lake for dust suppression was used exclusively for the Windy Road and is reported under the 2BE-HOP1222 licence. Underground development and construction occurred in support of the Doris mine and Madrid North mine; water was sourced from Doris Lake and Windy lake respectively, for these purposes. Additionally, water was used from Doris Lake and Windy Lake for seasonal winter ice track construction in January, February, March, April and May. Water from Doris Lake and Windy Lake was used in the mill for reagent mixing in 2021. Table D1-9 provides only water volumes used from lake sources and does not include water recycled from berms that would otherwise have been discharged to tundra as effluent.

Results of sampling at ST-7 at Doris Lake are provided in Table D1-10 and Table D1-11. Table D1-12 and Table D1-13 provide the results of water quality sampling for monitoring station ST-7a/MMS-4b (HOP-1) at Windy Lake in compliance with the requirements set out in Schedule I of water licence 2AM-DOH1335. Due to a mechanical failure related to cold weather in the Doris Lake pump house, it was out of commission between February 3 and March 1. As a result, no sample was collected for the month of February.

ST-8 Discharge from Sewage Treatment Plant Bio-membrane

The Sewage Treatment Plant (STP) at Doris Camp is made up of two sewage treatment plant modules. Each plant has the capacity to treat wastewater for up to 180 personnel. Both units were utilized throughout 2021 to treat all domestic wastewater generated by the site.

Treated effluent samples were collected from the combined effluent holding tank of these two modules (ST-8) in 2021 to test the quality of the effluent to be discharged to the tundra, in accordance with Part F, Item 5(b) of the Licence. In-plant sampling facilitates year-round compliance evaluation of plant performance.

All effluent quality samples collected in 2021 were in compliance with the discharge criteria. All effluent quality monitoring results for ST-8 are provided in Table D1-14 and Table D1-15.

Treated effluent volumes released from ST-8 are metered daily and summary volumes reported in the monthly monitoring reports. In 2021 all treated effluent from ST-8 was discharged to the tundra west of the facility laydown areas (13W 432933 7559057) as approved by the Inspector. The monthly volumes of effluent discharged are presented in Table D1-16.

The sludge produced at the sewage treatment plant is sent to the TIA for disposal. The volume of sludge produced in 2021 is presented in Table D1-17.

ST-9 Runoff from Sewage Treatment Plant Discharge

In consultation with the Inspector during the 2009 inspection tour, the ST-9 sampling location was established (13W 430807 7559282). This point is east of Glenn Lake and down slope from the ST-8 tundra discharge location. Monthly monitoring was conducted at ST-9 in June, July, August and September in 2021 in accordance with Schedule I of 2AM-DOH1335; due to COVID-19 restrictions and limited helicopter support, samples could not be collected in October 2021. The station is frozen during the remainder of the year. There is no water quality criteria specified in the licence for this monitoring station. Table D1-18 provides results of the 2021 seasonal monitoring.

Table D1-9. Doris North Water Usage in 2021

Month	Windy Lake (ST-7A)			Doris Lake (ST-7)				Total Usage
	Domestic Water*	Industrial Usage**	Dust suppression	Domestic Water*	Industrial Usage**	Dust Suppression	Winter Track	
January	964	224	14	0	0	0	1	1203
February	878	236	142	0	0	0	15	1271
March	1100	135	28	0	73	0	1738	3074
April	1099	156	0	0	80	0	345	1679
May	1069	42	0	0	127	109	96	1443
June	1084	50	0	0	44	328	0	1506
July	1058	84	0	0	111	402	0	1655
August	1298	224	0	0	28	322	0	1871
September	1167	104	0	0	48	112	0	1432
October	577	53	0	0	0	0	0	630
November	978	14	0	0	0	0	0	992
December	1206	30	0	0	0	0	0	1236
Annual Total	12,479	1351	184	0	510	1272	2195	17,991
Annual Allowance	**43,800**				**1,930,000**		**60,000**	**2,033,800**

Note:

All values rounded to nearest whole cubic metre.

** As permitted by water licences 2BE-HOP1222 and 2AM-DOH1335 Part E Item 1 and Part I Item 5(a)(b).*

*** Includes industrial uses such as underground drilling, core processing, milling, concrete batching, etc.*

Table D1-10. Water Sampling Monitoring Program Results for January to May 2021 Taken from ST-7

Sample ID		ST7	ST7	ST7^	ST7	ST7	ST7
ALS ID		YL2100013-001	YL2100154-001	YL2100154-002	YL2100181-001	YL2100268-001	YL2100376-001
Date Sampled		2021-01-05 14:30	2021-03-09 15:00	2021-03-09 15:00	2021-03-17 10:30	2021-04-14 11:05	2021-05-11 11:40
Parameter	**Units**	**Results**					
pH	pH	7.55	7.28	7.35	7.65	7.47	7.45
Total Suspended Solids	mg/L	<3.0	4.4	3.4	5.3	5.5	6.4
Chloride (Cl)	mg/L	55.3	59.6	59.6	60.8	62.2	63
Cyanide, Free	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Cyanide, Total	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Ammonia, Total (as N)	mg/L	0.0386	0.0161	0.0122	0.0109	0.0072	<0.0050
Nitrate (as N)	mg/L	0.0131	0.015	<0.0050	0.0079	<0.0050	<0.0050
Nitrite (as N)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Orthophosphate-Dissolved (as P)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)-Total	mg/L	<0.050	0.0308	0.0278	0.0291	0.0309	<0.050
Aluminum (Al)-Total	mg/L	0.0461	0.0104	0.0096	0.0085	0.0097	0.0107
Arsenic (As)-Total	mg/L	0.00028	0.00023	0.00025	0.00028	0.00026	0.00029
Cadmium (Cd)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)-Total	mg/L	7.97	8.54	8.52	8.78	8.16	9.3
Chromium (Cr)-Total	mg/L	0.00019	<0.00010	0.00013	0.0001	0.00013	<0.00050
Copper (Cu)-Total	mg/L	0.00211	0.00199	0.00245	0.00186	0.00208	0.00245
Iron (Fe)-Total	mg/L	0.18	2.11	0.159	0.114	0.152	0.104
Lead (Pb)-Total	mg/L	0.000148	0.000186	0.000558	0.000692	<0.000050	0.000302
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.000196	0.000322	0.000243	0.000194	0.00017	0.0002
Nickel (Ni)-Total	mg/L	0.00061	0.00065	<0.00050	<0.00050	<0.00050	0.00069
Selenium (Se)-Total	mg/L	0.000056	<0.000050	<0.000050	<0.000050	0.000061	<0.000050
Silver (Ag)-Total	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)-Total	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010

Sample ID		ST7	ST7	ST7^	ST7	ST7	ST7
ALS ID		YL2100013-001	YL2100154-001	YL2100154-002	YL2100181-001	YL2100268-001	YL2100376-001
Date Sampled		2021-01-05 14:30	2021-03-09 15:00	2021-03-09 15:00	2021-03-17 10:30	2021-04-14 11:05	2021-05-11 11:40
Parameter	**Units**	**Results**					
Zinc (Zn)-Total	mg/L	<0.0030	0.003	<0.0030	<0.0030	0.0095	<0.0030
Oil and Grease	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Oil And Grease (Visible Sheen)		Absent	Absent	Absent	Absent	Absent	Absent
Chlorophyll-a	µg						

^ *Indicates duplicate sample.*

Table D1-11. Water Sampling Monitoring Program Results for June to December 2021 Taken from ST-7

Sample ID		ST7	ST7	ST7	ST7	ST7	ST7	ST7
ALS ID		YL2100463-001	YL2100740-001	YL2100998-001	YL2101278-001	YL2101513-001	YL2101686-001	YL2101796-001
Date Sampled		2021-06-01 14:45	2021-07-07 16:45	2021-08-11 8:10	2021-09-13 15:15	2021-10-11 10:35	2021-11-14 14:40	2021-12-19 11:10
Parameter	**Units**	**Results**						
pH	pH	7.62	7.3	7.68	7.73	7.5	7.4	7.48
Total Suspended Solids	mg/L	5.1	7.8	5.3	5.8	<3.0	5.1	4.8
Chloride (Cl)	mg/L	63.2	40.9	48.5	48.8	48.1	50.5	55.3
Cyanide, Free	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Cyanide, Total	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Ammonia, Total (as N)	mg/L	0.0074	<0.0050	0.0062	0.005	0.0078	<0.0050	0.0058
Nitrate (as N)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	0.137	<0.0050	<0.0050
Nitrite (as N)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	0.0012	<0.0010	<0.0010
Orthophosphate-Dissolved (as P)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)-Total	mg/L	0.063	<0.050	0.0308	0.0312	0.0146	0.0297	0.0454
Aluminum (Al)-Total	mg/L	0.0137	0.0975	0.0513	0.0928	0.0417	0.0598	0.0212

Sample ID		ST7	ST7	ST7	ST7	ST7	ST7	ST7
ALS ID		YL2100463-001	YL2100740-001	YL2100998-001	YL2101278-001	YL2101513-001	YL2101686-001	YL2101796-001
Date Sampled		2021-06-01 14:45	2021-07-07 16:45	2021-08-11 8:10	2021-09-13 15:15	2021-10-11 10:35	2021-11-14 14:40	2021-12-19 11:10
Parameter	**Units**	**Results**						
Arsenic (As)-Total	mg/L	0.00029	0.00021	0.00024	0.00029	0.00021	0.00024	0.00028
Cadmium (Cd)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)-Total	mg/L	9.44	6.04	6.76	7.15	6.87	7.29	8.05
Chromium (Cr)-Total	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Copper (Cu)-Total	mg/L	0.00207	0.00216	0.00199	0.00205	0.00273	0.00165	0.0019
Iron (Fe)-Total	mg/L	0.203	0.294	1.72	0.196	0.283	0.271	0.093
Lead (Pb)-Total	mg/L	0.000327	0.00222	0.000094	0.000121	0.00008	0.000124	<0.000050
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.0002	0.000137	0.000124	0.000177	0.000139	0.000173	0.000205
Nickel (Ni)-Total	mg/L	0.00055	0.00068	0.00068	<0.00050	0.00065	0.00066	0.00059
Selenium (Se)-Total	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Silver (Ag)-Total	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)-Total	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Zinc (Zn)-Total	mg/L	0.0069	0.0077	0.0045	0.0048	0.0094	<0.0030	0.0063
Oil and Grease	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Oil And Grease (Visible Sheen)		Absent	Absent	Absent	Absent	Absent	Absent	Absent
Chlorophyll-a*	µg							4.39

Table D1-12. Water Sampling Monitoring Program Results for January to July 2021 Taken from ST-7a/MMS-4b (HOP-1)

	Sample ID	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B
	ALS ID	YL2100032-001	YL2100077-001	YL2100138-001	YL2100269-001	YL2100269-001	YL2100512-001	YL2100770-001
	Date Sampled	2021-01-13 11:35	2021-02-03 16:00	2021-03-03 16:05	2021-04-14 15:35	2021-05-11 9:00	2021-06-08 7:37	2021-07-13 15:20
Parameter	**Units**	**Results**						
pH	pH	7.69	7.93	7.74	7.86	7.26	7.81	7.54
Total Suspended Solids	mg/L	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chloride (Cl)	mg/L	110	111	115	120	122	121	60.8
Cyanide, Free	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0100	<0.0050	<0.0050
Cyanide, Total	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0100	0.0074	<0.0050
Ammonia, Total (as N)	mg/L	0.0162	0.0121	0.0064	<0.0050	<0.0050	0.0482	0.0071
Nitrate (as N)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0497	<0.0050
Nitrite (as N)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0035	<0.0010
Orthophosphate-Dissolved (as P)	mg/L	0.0012	0.0011	<0.0010	<0.0010	<0.0010	0.0013	<0.0010
Phosphorus (P)-Total	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Aluminum (Al)-Total	mg/L	0.0112	0.0118	0.0118	0.0061	0.0096	0.0179	0.051
Arsenic (As)-Total	mg/L	0.00023	0.00026	0.0003	0.00028	0.00023	0.00039	0.0002
Cadmium (Cd)-Total	mg/L	<0.0000050	<0.0000050	0.000022	<0.0000050	0.0000071	0.000009	<0.0000050
Calcium (Ca)-Total	mg/L	13.4	15.2	15.9	14.6	16.4	19.2	8.46
Chromium (Cr)-Total	mg/L	0.00017	0.00014	0.00017	0.00017	<0.00050	<0.00050	<0.00050
Copper (Cu)-Total	mg/L	0.00092	0.00128	0.00133	0.0011	0.00142	0.00208	0.00069
Iron (Fe)-Total	mg/L	<0.010	0.012	0.014	0.015	0.014	0.038	0.051
Lead (Pb)-Total	mg/L	<0.000050	0.00056	<0.000050	0.00013	0.000556	0.000122	<0.000050
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.000724	0.000777	0.000777	0.000741	0.000774	0.000872	0.000398

	Sample ID	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B
	ALS ID	YL2100032-001	YL2100077-001	YL2100138-001	YL2100269-001	YL2100269-001	YL2100512-001	YL2100770-001
	Date Sampled	2021-01-13 11:35	2021-02-03 16:00	2021-03-03 16:05	2021-04-14 15:35	2021-05-11 9:00	2021-06-08 7:37	2021-07-13 15:20
Parameter	**Units**	**Results**						
Nickel (Ni)-Total	mg/L	<0.00050	0.00091	<0.00050	<0.00050	0.00055	0.00095	<0.00050
Selenium (Se)-Total	mg/L	<0.000050	<0.000050	<0.000050	0.000055	0.000052	0.000054	<0.000050
Silver (Ag)-Total	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)-Total	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Zinc (Zn)-Total	mg/L	0.0035	0.0202	0.0043	0.0062	0.0153	0.017	<0.0030
Biochemical Oxygen Demand (BOD_5)	mg/L	3	2	3	<2	<2	<2	<2
Fecal Coliforms	MPN/100mL	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Oil and Grease	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Oil And Grease (Visible Sheen)		Absent	Absent	Absent	Absent	Absent	Absent	Absent

Table D1-13. Water Sampling Monitoring Program Results for August to December 2021 Taken from ST-7a/MMS-4b (HOP-1)

	Sample ID	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B
	ALS ID	YL2100999-001	YL2101316-001	YL2101316-003	YL2101566-001	YL2101687-001	YL2101765-001
	Date Sampled	2021-08-10 17:40	2021-09-15 10:00	2021-09-15 10:00	2021-10-20 14:12	2021-11-14 13:30	2021-12-12 15:00
Parameter	**Units**	**Results**					
pH	pH	7.94	7.84	7.84	7.8	7.76	7.84
Total Suspended Solids	mg/L	<3.0	<3.0	<3.0	4	<3.0	<3.0
Chloride (Cl)	mg/L	95.8	95.5	94.9	97.4	102	109
Cyanide, Free	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Cyanide, Total	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Ammonia, Total (as N)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0083
Nitrate (as N)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite (as N)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Orthophosphate-Dissolved (as P)	mg/L	<0.0010	0.0012	0.001	<0.0010	<0.0010	<0.0010
Phosphorus (P)-Total	mg/L	0.0061	0.0078	0.0071	0.0069	0.0026	0.0055
Aluminum (Al)-Total	mg/L	0.118	0.0933	0.0541	0.105	0.0254	0.0134
Arsenic (As)-Total	mg/L	0.00027	0.00026	0.00024	0.00025	0.00023	0.00024
Cadmium (Cd)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)-Total	mg/L	12	13.4	13.6	12.9	12.6	14.2
Chromium (Cr)-Total	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Copper (Cu)-Total	mg/L	0.001	0.00114	0.00101	0.00115	0.0012	0.00109
Iron (Fe)-Total	mg/L	0.109	0.104	0.061	0.124	0.026	0.014
Lead (Pb)-Total	mg/L	<0.000050	<0.000050	<0.000050	0.000051	0.000096	<0.000050
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.00062	0.000647	0.000656	0.000619	0.000624	0.000712
Nickel (Ni)-Total	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Selenium (Se)-Total	mg/L	<0.000100	<0.000050	<0.000050	<0.000050	<0.000050	0.000059
Silver (Ag)-Total	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010

	Sample ID	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B	ST-7A/MMS-4B
	ALS ID	YL2100999-001	YL2101316-001	YL2101316-003	YL2101566-001	YL2101687-001	YL2101765-001
	Date Sampled	2021-08-10 17:40	2021-09-15 10:00	2021-09-15 10:00	2021-10-20 14:12	2021-11-14 13:30	2021-12-12 15:00
Parameter	**Units**	**Results**					
Thallium (Tl)-Total	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Zinc (Zn)-Total	mg/L	<0.0030	<0.0030	<0.0030	<0.0030	0.0068	<0.0030
Biochemical Oxygen Demand (BOD_5)	mg/L	<2	<2	<2	<2	<2	3
Fecal Coliforms	MPN/100mL	<1.0	<1.0	4	<1.0	<1.0	<1.0
Oil and Grease	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Oil And Grease (Visible Sheen)		Absent	Absent	Absent	Absent	Absent	Absent

Table D1-14. Water Quality Monitoring Program Results for ST-8 (Sewage Treatment Plant), January to May 2021

	Sample ID	ST8	ST8	ST8^	ST8	ST8	ST8	Part F Item 5(b)	
	ALS ID	L2405187-1	YL2100090-001	YL2100090-002	YL2100141-001	YL2100270-001	YL2100270-001	Maximum Average Concentration (mg/L)	Maximum Concentration of Any Grab Sample (mg/L)
	Date Sampled	2020-01-14 6:15	2021-02-11 7:10	2021-02-11 7:10	2021-03-04 6:45	2021-04-15 4:40	2021-05-13 7:30		
Parameter	**Units**	**Results**							
pH	pH units	7	7.41	7.44	7.35	8.02	7.82	6.0-9.5	6.0-9.5
Total Suspended Solids	mg/L	<3.0	<3.0	<3.0	<3.0	<3.0	8.2	100	100
Biochemical Oxygen Demand (BOD5)	mg/L	<2	2	<2	2	2	3	80	160
Fecal Coliforms	CFU/100mL	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	10,000	10,000
Oil and Grease	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5	10
Oil And Grease (Visible Sheen)		Absent	Absent	Absent	Absent	Absent	Absent	No Visible Sheen	No Visible Sheen

^ Indicates duplicate sample

Table D1-15. Water Quality Monitoring Program Results for ST-8, June to December 2021

	Sample ID	ST8	ST8	ST8	ST8	ST8	ST8	ST8	Part F Item 5(b)	
	ALS ID	YL2100510-001	YL2100769-001	YL2101012-001	YL2101344-001	YL2101567-001	YL2101674-001	YL2101743-001	Maximum Average Concentration (mg/L)	Maximum Concentration of Any Grab Sample (mg/L)
	Date Sampled	2021-06-09 6:55	2021-07-13 4:20	2021-08-11 6:50	2021-09-20 6:45	2021-10-21 7:10	2021-11-11 7:15	2021-12-06 5:50		
Parameter	**Units**	**Results**								
pH	pH units	7.54	7.92	8.23	7.82	7.9	7.69	7.51	6.0-9.5	6.0-9.5
Total Suspended Solids	mg/L	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	100	100
Biochemical Oxygen Demand (BOD5)	mg/L	<2	4	3	<2	<2	<2.0	4	80	160
Fecal Coliforms	CFU/100mL	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	10,000	10,000
Oil and Grease	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5	10
Oil And Grease (Visible Sheen)		Absent	Absent	Absent	Absent	Absent	Absent	Absent	No Visible Sheen	No Visible Sheen

Table D1-16. Treated Effluent Released from the Doris Sewage Treatment Plant (ST-8), 2021

Month	Monthly Volume (m^3)*	Cumulative Volume (m^3)*
January	863	863
February	782	1,645
March	883	2,528
April	982	3,510
May	970	4,480
June	1,032	5,512
July	1,035	6,547
August	1,128	7,675
September	1,186	8,861
October	587	9,448
November	856	10,304
December	1,061	11,365
Total Volume of Treated Effluent Released 2021 (m^3)		**11,365**

** Values rounded to nearest whole cubic metre.*

Table D1-17. Volume of Sludge Removed from the Doris Sewage Treatment Plant, 2021

Month	Monthly Volume (m^3)	Cumulative Volume (m^3)
January	23.9	23.9
February	25.9	49.8
March	27.3	77.0
April	25.7	102.7
May	30.0	132.7
June	30.5	163.2
July	28.2	191.4
August	24.8	216.1
September	23.7	239.8
October	14.0	253.8
November	18.2	272.0
December	26.4	298.4
Total Volume of Sludge Produced in 2020 (m^3)		**298.4**

** All sewage sludge reported to the TIA for disposal.*

Table D1-18. Water Quality Monitoring Program Results for ST-9, June and August 2021

	Sample ID	ST9	ST9	ST9	ST9
	ALS ID	YL2100675-001	YL2100817-001	YL2101062-001	YL2101420-001
	Date Sampled	2021-06-30 15:35	2021-07-20 15:25	2021-08-18 13:40	2021-09-26 16:05
Parameter	**Units**	Results			
pH	pH	7.81	7.94	8.17	7.79
Total Suspended Solids	mg/L	<3.0	4.5	3	<3.0
Biochemical Oxygen Demand (BOD_5)	mg/L	**	<2	<2	<2
Fecal Coliforms	MPN/100mL	<1.0	<1.0	<1.0	<1.0
Oil and Grease	mg/L	<5.0	<5.0	<5.0	<5.0
Oil And Grease (Visible Sheen)		Absent	Absent	Absent	Absent

*** Inadvertently omitted from the sample*

ST-10 Site Runoff from Sediment Controls

Monitoring at Doris Site runoff from sediment controls (ST-10) was not conducted in 2021 as no new infrastructure was constructed at Doris.

No earthworks were conducted in the Doris area in 2021 and no samples were collected.

ST-11 Reagent and Cyanide Storage Containment Area Sump

This facility was constructed and first used in 2017. The storage area is a lined berm area divided into two cells to allow separation of different chemical products. Each cell has a water collection sump to facilitate water management (ST-11a and ST-11b). Water accumulating in this facility will be discharged directly into the Tailings Impoundment Area (TIA). No water was transferred to the TIA from this facility in 2021 as not enough water accumulated to require dewatering. No sample was taken at the ST-11b location due error from technical team.

Water quality samples were collected from each sump as per Schedule I of the water licence. Results of the sampling are presented in Table D1-19.

Table D1-19. Water Quality Monitoring Program Results for ST-11, July 2021

	Sample ID	ST11A
	ALS ID	YL2100816-001
	Date Sampled	2021-07-19 15:25
Parameter	**Units**	
pH	pH	8.06
Total Suspended Solids	mg/L	<3.0
Cyanide, Free	mg/L	<0.0100
Cyanide, Total	mg/L	<0.0100
Ammonia, Total (as N)	mg/L	0.036
Aluminum (Al)-Total	mg/L	0.0289
Arsenic (As)-Total	mg/L	0.001
Cadmium (Cd)-Total	mg/L	0.0000148
Calcium (Ca)-Total	mg/L	76.5
Chromium (Cr)-Total	mg/L	<0.00050
Copper (Cu)-Total	mg/L	0.00192
Iron (Fe)-Total	mg/L	0.042
Lead (Pb)-Total	mg/L	<0.000050
Mercury (Hg)-Total	mg/L	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.00628
Nickel (Ni)-Total	mg/L	0.00081
Selenium (Se)-Total	mg/L	0.00045
Silver (Ag)-Total	mg/L	<0.000010
Thallium (Tl)-Total	mg/L	<0.000010
Zinc (Zn)-Total	mg/L	<0.0030

	Sample ID	ST11A
	ALS ID	YL2100816-001
	Date Sampled	2021-07-19 15:25
Parameter	**Units**	
Oil and Grease	mg/L	<5.0
Oil And Grease (Visible Sheen)		Absent
Benzene	mg/L	<0.00050
Toluene	mg/L	<0.00050
Ethylbenzene	mg/L	<0.00050

Hydrology Monitoring – Doris Lake Water Level and Ice Thickness (ST-12) and Doris Creek Flow (TL-2)

Lake level monitoring in Doris Lake (ST-12) and stream flow monitoring in Doris Creek (TL-2) was conducted in 2021 as outlined in Schedule I of the licence. Stations were visited throughout the open water season to perform water level surveys and manual discharge measurements. Water level surveys are performed using an engineer's level and stadia rod using a minimum of three local bench marks at each station. All bench marks are tied to geodetic elevation. Manual discharge measurements were performed using the velocity area method with an OTT MF Pro electromagnetic current meter. Details regarding the standard methods used for installation of hydrometric stations, development of stage-discharge rating equations, and daily flow hydrographs can be found in the Doris North Project 2013 Hydrology Compliance Monitoring Report (ERM 2014).

Doris Lake Station (ST-12)

Doris Lake-2 monitoring station collected data from January 1st through to December 31st, 2021, as summarized in Table D1-20, and continues to collect data. In September of 2017, the Doris Lake monitoring location was moved to the north to facilitate the installation of two, year-round pressure transducers and to avoid potential interactions with mine construction. The new location was named Doris Lake-2 (13W 433547 7558601) and consists of two Solinst Leveloggers installed at depths of approximately 7 metres to monitor lake level year round. The Leveloggers are coupled with a Solinst Barologger, located at Doris Camp, to compensate for changes in atmospheric pressure. The Leveloggers and Barologger record a pressure reading every 15 minutes. Agnico personnel performed under ice water level surveys on May 17. Four water level surveys were performed between June 28 and September 26, 2021 to confirm the proper functioning of the pressure transducer.

Ice thickness measurements were collected in April 2021 at monitoring station ST-12 as per Schedule I, Table 2. Ice thickness of Doris Lake was 180 cm.

Doris Creek Flow (TL-2)

The Doris Creek stream flow monitoring station TL-2 (13W 434059 7559504) was reactivated on June 26 after being deactivated during the winter. The station uses an INW PT2X vented pressure transducer, recording water level readings every 15 minutes. The station operated during the open water season until October 19, when the station was deactivated for winter. During the 2021 open water season, Agnico personnel made a combined 2 visits to the station. Water level (stage) measured by the pressure transducer every 15 minutes was converted to discharge using a stage-discharge curve, also known as a rating curve. The rating curve at TL-2 is well established, with small changes from year to year due to aggradation and scour of the channel. No adjustment to the rating curve was necessary in 2021. Flow during periods that were not observed during the 2021 open water season was estimated using a linear regression between Doris Lake water level and monitored flow at TL-2, and exponential growth/decay curves from June 10 to 25 and October 13 to November 12. It is estimated that there is no flow in Doris Creek prior to June 10 or after November 12. Discharge at the TL-2 hydrometric monitoring station is reported as mean daily discharge in cubic meters per second (m^3/s). Table D1-21 provides the results of this monitoring.

Table D1-20. Summary of Doris Lake Mean Daily Water Levels, in Metres above Sea Level (masl), 2021

Date	January	February	March	April	May	June	July	August	September	October	November	December
1	21.801	21.800	21.784	21.775	21.778	21.770	22.261	21.911	21.762	21.894	21.831	21.802
2	21.804	21.801	21.783	21.777	21.777	21.774	22.248	21.910	21.758	21.898	21.823	21.809
3	21.805	21.807	21.784	21.771	21.774	21.772	22.234	21.902	21.756	21.901	21.819	21.804
4	21.803	21.803	21.780	21.771	21.774	21.775	22.217	21.887	21.753	21.914	21.816	21.800
5	21.808	21.803	21.769	21.773	21.777	21.785	22.202	21.877	21.753	21.919	21.812	21.804
6	21.808	21.803	21.788	21.788	21.776	21.788	22.194	21.870	21.759	21.920	21.809	21.801
7	21.785	21.803	21.797	21.773	21.773	21.785	22.177	21.869	21.775	21.915	21.807	21.803
8	21.798	21.795	21.797	21.771	21.770	21.785	22.165	21.860	21.824	21.922	21.804	21.808
9	21.801	21.794	21.791	21.792	21.769	21.785	22.162	21.858	21.849	21.922	21.804	21.809
10	21.803	21.794	21.790	21.786	21.776	21.800	22.154	21.852	21.864	21.921	21.804	21.805
11	21.803	21.793	21.786	21.783	21.771	21.837	22.139	21.847	21.872	21.918	21.793	21.796
12	21.797	21.792	21.788	21.778	21.770	21.878	22.132	21.835	21.877	21.913	21.782	21.801
13	21.786	21.789	21.786	21.779	21.772	21.947	22.110	21.827	21.884	21.907	21.785	21.795
14	21.792	21.792	21.782	21.779	21.765	22.068	22.105	21.826	21.896	21.904	21.781	21.801
15	21.796	21.797	21.781	21.778	21.765	22.197	22.095	21.820	21.903	21.897	21.783	21.801
16	21.794	21.794	21.788	21.781	21.765	22.268	22.080	21.814	21.906	21.892	21.782	21.804
17	21.797	21.797	21.789	21.782	21.769	22.313	22.061	21.810	21.908	21.895	21.784	21.807
18	21.803	21.794	21.783	21.781	21.764	22.345	22.049	21.808	21.909	21.907	21.779	21.811
19	21.810	21.785	21.782	21.783	21.763	22.358	22.041	21.807	21.907	21.905	21.784	21.807
20	21.790	21.790	21.780	21.779	21.766	22.354	22.027	21.798	21.904	21.902	21.787	21.799
21	21.794	21.787	21.783	21.788	21.764	22.345	22.014	21.795	21.902	21.895	21.784	21.800
22	21.797	21.790	21.783	21.783	21.756	22.341	22.006	21.787	21.902	21.885	21.787	21.802
23	21.789	21.792	21.778	21.779	21.767	22.360	21.998	21.783	21.900	21.879	21.782	21.803
24	21.791	21.789	21.775	21.775	21.762	22.346	21.982	21.780	21.891	21.872	21.784	21.802
25	21.806	21.794	21.778	21.779	21.759	22.331	21.968	21.776	21.886	21.864	21.785	21.799
26	21.805	21.787	21.778	21.777	21.757	22.324	21.958	21.784	21.885	21.858	21.788	21.805

Date	January	February	March	April	May	June	July	August	September	October	November	December
27	21.799	21.793	21.780	21.781	21.754	22.303	21.951	21.773	21.887	21.856	21.783	21.799
28	21.801	21.794	21.780	21.777	21.769	22.292	21.939	21.767	21.882	21.851	21.793	21.803
29	21.797		21.780	21.778	21.762	22.281	21.929	21.762	21.890	21.844	21.791	21.800
30	21.796		21.774	21.777	21.767	22.277	21.925	21.766	21.894	21.842	21.801	21.793
31	21.795		21.779		21.763		21.918	21.763		21.836		21.797
Minimum	21.785	21.785	21.769	21.771	21.754	21.770	21.918	21.762	21.753	21.836	21.779	21.793
Maximum	21.810	21.807	21.797	21.792	21.778	22.360	22.261	21.911	21.909	21.922	21.831	21.811
Mean	21.798	21.795	21.783	21.779	21.768	22.086	22.079	21.823	21.858	21.892	21.795	21.802

Table D1-21. Summary of Doris Creek (TL-2) Daily Flow Rate, in Cubic Metres per Second (m^3/s), 2021

Date	January	February	March	April	May	June	July	August	September	October	November	December
1	*0*	*0*	*0*	*0*	*0*	-	2.809	0.813	0.267	0.716	*0.292*	*0*
2	*0*	*0*	*0*	*0*	*0*	-	2.716	0.789	0.261	0.727	*0.215*	*0*
3	*0*	*0*	*0*	*0*	*0*	-	2.613	0.723	0.255	0.746	*0.158*	*0*
4	*0*	*0*	*0*	*0*	*0*	-	2.504	0.717	0.263	0.778	*0.116*	*0*
5	*0*	*0*	*0*	*0*	*0*	-	2.395	0.682	0.237	0.790	*0.086*	*0*
6	*0*	*0*	*0*	*0*	*0*	-	2.318	0.656	0.240	0.809	*0.063*	*0*
7	*0*	*0*	*0*	*0*	*0*	-	2.225	0.623	0.300	0.816	*0.046*	*0*
8	*0*	*0*	*0*	*0*	*0*	-	2.123	0.597	0.467	0.821	*0.034*	*0*
9	*0*	*0*	*0*	*0*	*0*	-	2.089	0.594	0.540	0.822	*0.025*	*0*
10	*0*	*0*	*0*	*0*	*0*	*0.010**	2.025	0.574	0.585	0.809	*0.018*	*0*
11	*0*	*0*	*0*	*0*	*0*	*0.056*	1.962	0.546	0.629	0.804	*0.014*	*0*
12	*0*	*0*	*0*	*0*	*0*	*0.309*	1.866	0.522	0.663	0.793	*0.010^*	*0*
13	*0*	*0*	*0*	*0*	*0*	*0.750*	1.791	0.505	0.673	0.784	-	*0*
14	*0*	*0*	*0*	*0*	*0*	*1.538*	1.711	0.484	0.709	0.757	-	*0*
15	*0*	*0*	*0*	*0*	*0*	*2.368*	1.631	0.465	0.729	0.740	-	*0*
16	*0*	*0*	*0*	*0*	*0*	*2.827*	1.549	0.451	0.739	0.712	-	*0*

Date	January	February	March	April	May	June	July	August	September	October	November	December
17	*0*	*0*	*0*	*0*	*0*	*3.121*	1.484	0.433	0.753	0.738	-	*0*
18	*0*	*0*	*0*	*0*	*0*	*3.324*	1.431	0.433	0.761	0.724	-	*0*
19	*0*	*0*	*0*	*0*	*0*	*3.412*	1.376	0.404	0.762	0.750	-	*0*
20	*0*	*0*	*0*	*0*	*0*	*3.382*	1.325	0.395	0.753	*0.744*	-	*0*
21	*0*	*0*	*0*	*0*	*0*	*3.327*	1.293	0.374	0.743	*0.720*	-	*0*
22	*0*	*0*	*0*	*0*	*0*	*3.302*	1.233	0.361	0.748	*0.684*	-	*0*
23	*0*	*0*	*0*	*0*	*0*	*3.423*	1.159	0.346	0.738	*0.664*	-	*0*
24	*0*	*0*	*0*	*0*	*0*	*3.332*	1.100	0.331	0.713	*0.640*	-	*0*
25	*0*	*0*	*0*	*0*	*0*	*3.237*	1.062	0.321	0.683	*0.612*	-	*0*
26	*0*	*0*	*0*	*0*	*0*	3.172	1.013	0.313	0.670	*0.594*	-	*0*
27	*0*	*0*	*0*	*0*	*0*	3.104	0.962	0.299	0.668	*0.585*	-	*0*
28	*0*	*0*	*0*	*0*	*0*	3.035	0.924	0.285	0.664	*0.568*	-	*0*
29	*0*		*0*	*0*	*0*	2.963	0.886	0.276	0.704	*0.546*	-	*0*
30	*0*		*0*	*0*	*0*	2.907	0.858	0.278	0.707	*0.539*	-	*0*
31	*0*		*0*		*0*		0.849	0.274		*0.397*		*0*
Minimum	0	0	0	0	0	0.010	0.849	0.274	0.237	0.397	0.010	0
Maximum	0	0	0	0	0	3.423	2.809	0.813	0.762	0.822	0.292	0
Mean	0	0	0	0	0	2.519	1.654	0.479	0.587	0.707	0.090	0

Notes:
Estimated and modelled values are italicized. Estimated data were determined using linear regression with Doris Lake elevations.
Monitored data were observed using stage data collected by the TL-2 pressure transducer, converted to discharge using a rating curve that was developed using stage and discharge measurements from 2017-2021.
**Assumed start of flow.*
^Assumed end of flow

TL-1 TIA Monitoring

This section presents the results of monitoring of the Tailings Impoundment Area (TIA) as per the applicable sections of Part F (Conditions Applying to Waste Deposit and Waste Management), Part I (Conditions Applying to General and Aquatic Effects Monitoring) and Schedule I of the water licence.

Dewatering of the TIA to Roberts Bay through the Roberts Bay Discharge System (RBDS) occurred between May 18 and November 29, 2021. Table D1-22 provides the volume of water discharged from the TIA to Roberts Bay in 2021. Water quality sampling and Acute Lethality testing was conducted as outlined in the Metal and Diamond Mining Effluent Regulations; no exceedance of the discharge criteria occurred.

Tailings deposition into the TIA continued throughout the year. Reclaim water was utilized to support the milling process. Table D1-23 provides the volume of reclaim water obtained from the TIA for process water in 2021.

Water quality samples were collected at the TIA Reclaim Pipeline monitoring station TL-1 from January to December from a sample port on the reclaim pump. Sampling results are provided in Table D1-24 and Table D1-25.

Table D1-22. Volume of Water Pumped from TIA to Roberts Bay, 2021

Month	Number of Days of Discharge	Discharge Volume (m^3)	Exceedances of Discharge Criteria*
January	0	0	0
February	0	0	0
March	0	0	0
April	0	0	0
May	3	826	0
June	29	185,609	0
July	26	152,583	0
August	31	166,253	0
September	21	137,679	0
October	12	84,749	0
November	29	205,497	0
December	0	0	0
Annual Cumulative	**151**	**933,196**	**0**

** Discharge criteria as outlined in Metal and Diamond Mining Effluent Regulations.*
Acute Lethality testing conducted as per Part F Item 22 and Part I Item 14.

Table D1-23. Volume of Reclaim Water Used to Support Mill Processing, 2021

Month	Monthly Volume (m^3)*	Cumulative Volume (m^3)*
January	85,079	85,079
February	77,385	162,464
March	76,663	239,127
April	78,336	317,463
May	74,222	391,685
June	57,629	449,314
July	56,777	506,091
August	66,438	572,529
September	69,343	641,872
October	66,438	708,310
November	55,723	764,033
December	58,925	822,958
Volume of Reclaim Water Used in Mill Processing, 2021 (m^3)		**822,958**

** Values rounded to nearest whole cubic metre.*

TL-5, TL6 and TL7a/b Tailings Monitoring

This section presents the results of monitoring of the Tailings as per the applicable sections of Part I (Conditions Applying to General and Aquatic Effects Monitoring) and Schedule I of the water licence.

Samples of effluent from the Process Plant (TL-5) were collected from January to September 2021. Samples were not taken for the months of October, November and December as mill operations were shut down on October 5. These samples were collected monthly from the tailings thickener tank inside the Process Plant prior to discharge to the Tailings Impoundment Area. A clean container was used to collect a representative sample of tailings material from the tailings thickener tank and the solid material allowed to settle. The remaining supernatant (the liquid effluent of the discharged tailings) was collected and submitted for laboratory analysis. Results of monitoring conducted at TL-5 are presented in Table D1-26 and Table D1-27.

Samples of the tailings solids (TL-6) were collected weekly from the tailings thickener tank inside the Process Plant from January to September 2021. Samples were not taken for the months of October, November and December as mill operations were shut down on October 5. A clean container was used to collect a representative sample of tailings material from the tailings thickener tank and the solid material allowed to settle in the container. The supernatant was then discarded, and the solid materials transferred into a clean Ziploc bag and refrigerated until four weekly samples had been collected. These weekly samples were then combined to create a composite sample which was submitted for laboratory analysis. Table D1-28 and Table D1-29 provide results for monitoring conducted at TL-6. Due to the operating schedule of the mill, only one TL6 subsample was collected in February, and was included in the March 2021 composite. For the same reason, only one TL-6 subsample was obtained in July and was submitted as part of the August composite sample. Finally, the June composite sample exceeded its hold time and was inadvertently thrown out before analysis.

Detoxified tailings solids (TL-7a) were collected monthly from January to September 2021 from the discharge compartment of the detox filter press inside the Process Plant (Table D1-29 and Table D1-30). Filtrate from the detoxified solids (TL-7b) was collected monthly from January to September 2021 from the receiving filtrate tank for the detox filter press inside the Process Plant (Table D1-31 and Table D1-32). Samples were not taken for the months of October, November and December for both TL-7a and TL-7b as mill operations were shut down on October 5.

TL-11 Underground Seepage Monitoring

Visual inspections were conducted of all safely accessible backfilled underground stopes in August and December 2021 to identify seepage (TL-11) from the stopes. In August, seepage was observed and sampled at three locations during the inspection. In December, three flowing seeps were identified, and samples were collected at each location. Results of this sampling is provided in Table D1-33 and Table D1-36.

Table D1-24. Water Quality in the Tailings Impoundment Area (TL-1), January to June 2021

	Sample ID	TL1	TL1	TL1	TL1	TL1	TL1
	ALS ID	YL2100011-001	YL2100074-001	YL2100139-001	YL2100249-001	YL2100249-001	YL2100511-001
	Date Sampled	2021-01-05 12:15	2021-02-03 11:15	2021-03-03 13:30	2021-04-07 17:45	2021-05-05 8:20	2021-06-08 9:37
Parameter	**Units**	**Results**					
pH	pH	7.7	8.09	7.61	7.92	8	7.82
Total Suspended Solids	mg/L	12	16.5	21.9	12.7	14.3	16.2
Total Dissolved Solids	mg/L	5150	5430	5930	6860	6820	6870
Chloride (Cl)	mg/L	2340	2660	2830	3400	3420	3300
Cyanide, Free	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Cyanide, Total	mg/L	0.0706	0.0637	0.0675	0.07	0.0794	0.0713
Ammonia, Total (as N)	mg/L	6.52	6.89	6.43	7.36	7.98	7.92
Nitrate (as N)	mg/L	3.89	3.78	3.5	4.16	4.05	3.66
Nitrite (as N)	mg/L	0.349	0.13	0.119	<0.0500	0.109	0.0855
Orthophosphate-Dissolved (as P)	mg/L	<0.0010	<0.0010	<0.0010	0.0017	0.0012	0.0014
Phosphorus (P)-Total	mg/L	<0.250	<0.250	<0.250	<0.500	<0.500	<0.250
Aluminum (Al)-Total	mg/L	0.17	0.0904	0.302	0.165	0.171	0.287
Arsenic (As)-Total	mg/L	0.00303	0.00248	0.00342	0.00268	0.00323	0.00306
Cadmium (Cd)-Total	mg/L	<0.0000250	<0.0000250	0.0000298	<0.0000500	<0.0000500	<0.0000250
Calcium (Ca)-Total	mg/L	192	238	249	218	282	272
Chromium (Cr)-Total	mg/L	0.0006	<0.00050	0.00122	<0.00100	<0.00500	<0.00250
Copper (Cu)-Total	mg/L	0.0751	0.065	0.183	0.0879	0.0799	0.0794
Iron (Fe)-Total	mg/L	0.771	0.675	1.82	0.832	1.02	1.13
Lead (Pb)-Total	mg/L	<0.000250	<0.000250	0.000512	<0.000500	<0.000500	<0.000250
Magnesium (Mg)-Total	mg/L	157	178	193	187	240	225
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.0103	0.0105	0.00979	0.00881	0.01	0.0108

	Sample ID	TL1	TL1	TL1	TL1	TL1	TL1
	ALS ID	YL2100011-001	YL2100074-001	YL2100139-001	YL2100249-001	YL2100249-001	YL2100511-001
	Date Sampled	2021-01-05 12:15	2021-02-03 11:15	2021-03-03 13:30	2021-04-07 17:45	2021-05-05 8:20	2021-06-08 9:37
Parameter	**Units**	**Results**					
Nickel (Ni)-Total	mg/L	0.0161	0.0149	0.0155	0.014	0.0153	0.0154
Potassium (K)-Total	mg/L	60.7	60.8	64.3	63.4	82.3	77.2
Selenium (Se)-Total	mg/L	0.000482	0.000513	0.000599	<0.000500	0.000525	0.00044
Silver (Ag)-Total	mg/L	0.000073	0.00005	0.000123	<0.000100	<0.000100	0.000095
Sodium (Na)-Total	mg/L	1530	1630	1640	1830	2260	2060
Thallium (Tl)-Total	mg/L	<0.000050	<0.000050	<0.000050	<0.000100	<0.000100	<0.000050
Zinc (Zn)-Total	mg/L	<0.0150	<0.0150	0.0175	<0.0300	<0.0300	<0.0150
Fecal Coliforms	MPN/100mL	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Oil and Grease	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	*
Oil And Grease (Visible Sheen)		Absent	Absent	Absent	Absent	Absent	*
Benzene	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Toluene	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Ethylbenzene	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Dissolved Oxygen	mg/L						
Redox Potential	mV						
Biochemical Oxygen Demand (BOD5)	mg/L						

**Inadvertently omitted from the sample*

Table D1-25. Water Quality in the Tailings Impoundment Area (TL-1), July to December 2021

	Sample ID	TL1	TL1	TL1	TL1	TL1	TL1
	ALS ID	YL2100709-001	YL2100930-001	YL2101233-002	YL2101468-001	YL2101643-001	YL2101756-001
	Date Sampled	2021-07-06 17:00	2021-08-03 8:25	2021-09-07 10:15	2021-10-05 13:55	2021-11-02 8:00	2021-12-08 13:50
Parameter	**Units**	**Results**					
pH	pH	7.7	7.94	8.24	8.36	8.21	8.14
Total Suspended Solids	mg/L	15.7	11.5	15	23.4	15.6	13.2
Total Dissolved Solids	mg/L	7340	6660	4230	4090	4500	4600
Chloride (Cl)	mg/L	3450	3260	1920	2010	2230	2260
Cyanide, Free	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Cyanide, Total	mg/L	0.0549	0.0874	0.0111	0.0099	0.0127	0.0261
Ammonia, Total (as N)	mg/L	8.1	9.24	4.95	4.2	4.16	4.42
Nitrate (as N)	mg/L	4.02	4.57	4.18	4.45	5.21	5.29
Nitrite (as N)	mg/L	0.136	0.132	0.171	0.152	0.0914	0.107
Orthophosphate-Dissolved (as P)	mg/L	<0.0010	0.0016	0.0014	0.0012	0.002	0.0018
Phosphorus (P)-Total	mg/L	<0.500	0.0547	<0.250	0.0573	<0.250	0.0326
Aluminum (Al)-Total	mg/L	0.16	0.17	0.0829	0.0676	0.0717	0.0596
Arsenic (As)-Total	mg/L	0.00241	0.00259	0.00217	0.00219	0.00233	0.00261
Cadmium (Cd)-Total	mg/L	<0.0000500	<0.0000500	<0.0000250	<0.0000250	<0.0000250	<0.0000250
Calcium (Ca)-Total	mg/L	259	225	154	160	157	178
Chromium (Cr)-Total	mg/L	<0.00500	<0.00500	<0.00250	<0.00250	<0.00250	<0.00250
Copper (Cu)-Total	mg/L	0.0653	0.0805	0.0426	0.0362	0.0334	0.04
Iron (Fe)-Total	mg/L	1.13	0.942	1.6	0.258	0.272	0.305
Lead (Pb)-Total	mg/L	<0.000500	<0.000500	<0.000250	<0.000250	<0.000250	<0.000250
Magnesium (Mg)-Total	mg/L	198	182	114	130	134	137
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.00928	0.0103	0.00851	0.00838	0.00949	0.00893
Nickel (Ni)-Total	mg/L	0.0145	0.015	0.0108	0.0102	0.0101	0.0112

	Sample ID	TL1	TL1	TL1	TL1	TL1	TL1
	ALS ID	YL2100709-001	YL2100930-001	YL2101233-002	YL2101468-001	YL2101643-001	YL2101756-001
	Date Sampled	2021-07-06 17:00	2021-08-03 8:25	2021-09-07 10:15	2021-10-05 13:55	2021-11-02 8:00	2021-12-08 13:50
Parameter	**Units**	**Results**					
Potassium (K)-Total	mg/L	66.3	63.8	44.9	49.4	49.3	50.8
Selenium (Se)-Total	mg/L	<0.000500	<0.000500	0.000314	0.00029	0.000357	0.000332
Silver (Ag)-Total	mg/L	<0.000100	<0.000100	<0.000050	<0.000050	<0.000050	0.000066
Sodium (Na)-Total	mg/L	1840	1690	1170	1280	1300	1250
Thallium (Tl)-Total	mg/L	<0.000100	<0.000100	<0.000050	<0.000050	<0.000050	<0.000050
Zinc (Zn)-Total	mg/L	<0.0300	<0.0300	<0.0150	<0.0150	<0.0150	<0.0150
Fecal Coliforms	MPN/100mL	<1.0	<1.0	*	<1.0	<1.0	<1.0
Oil and Grease	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Oil And Grease (Visible Sheen)		Absent	Absent	Absent	Absent	Absent	Absent
Benzene	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Toluene	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Ethylbenzene	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Dissolved Oxygen	mg/L			*			
Redox Potential	mV		242	223			
Biochemical Oxygen Demand (BOD5)	mg/L		3				8.14

**Inadvertently omitted from the sample*

Table D1-26. Effluent from Process Plant Tailings Slurry Water (TL-5), January to June 2021

	Sample ID	TL5	TL5^	TL5	TL5	TL5	TL5	TL5
	ALS ID	YL2100037-001	YL2100037-002	YL2100125-001	YL2100160-001	YL2100292-001	YL2100435-001	YL2100680-001
	Date Sampled	2021-01-13 16:35	2021-01-13 16:35	2021-02-24 15:50	2021-03-09 16:45	2021-04-21 15:45	2021-05-22 13:45	2021-06-30 13:30
Parameter	**Units**				**Results**			
pH	pH Units	8.26	8.27	8.41	8.19	8.21	8.34	8.11
Total Suspended Solids	mg/L	17.7	19.1	10.4	228	16	6.6	111
Cyanide, Free	mg/L	0.409	0.386	0.438	0.0417	0.114	0.0261	0.0395
Cyanide, Total	mg/L	3.92	3.8	4.66	3.03	1.64	1.35	0.901
Cyanide, WAD	mg/L	0.731	0.688	0.492	0.127	0.121	0.0348	0.0817
Ammonia, Total (as N)	mg/L	26.7	26.6	47.2	44.9	46.4	33.6	39.1
Nitrate (as N)	mg/L	8.94	9.01	19	14.8	27.4	16.3	26.5
Nitrite (as N)	mg/L	0.72	0.694	1.38	0.879	1.22	0.792	1.19
Sulfate (SO4)	mg/L	1860	1870	1720	2040	2960	1770	1800
Aluminum (Al)-Total	mg/L	0.127	0.155	6.32	0.329	0.873	0.128	0.715
Antimony (Sb)-Total	mg/L	0.0028	0.00269	0.00412	0.00355	0.00495	0.0031	0.00397
Arsenic (As)-Total	mg/L	0.00523	0.00813	0.0115	0.0207	0.0122	0.00552	0.00501
Barium (Ba)-Total	mg/L	0.036	0.0345	0.052	0.0474	0.0608	0.0495	0.052
Beryllium (Be)-Total	mg/L	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Bismuth (Bi)-Total	mg/L	<0.000500	<0.000500	<0.000500	<0.000500	<0.000500	<0.000500	<0.000500
Boron (B)-Total	mg/L	0.875	0.885	1.14	1.27	1.42	1.25	1.42
Cadmium (Cd)-Total	mg/L	<0.0000500	<0.0000500	0.0000632	<0.0000500	0.0000657	<0.0000500	<0.0000500
Calcium (Ca)-Total	mg/L	177	175	248	231	264	226	237
Cesium (Cs)-Total	mg/L	<0.000100	<0.000100	0.000728	0.000347	0.000298	0.000683	0.00116
Chromium (Cr)-Total	mg/L	<0.00100	0.00102	0.0199	0.00252	<0.00500	<0.00500	<0.00500
Cobalt (Co)-Total	mg/L	0.0127	0.0137	0.0232	0.0367	0.013	0.0155	0.00689
Copper (Cu)-Total	mg/L	0.555	0.562	0.617	0.112	0.176	0.0314	0.104

Sample ID		TL5	TL5^	TL5	TL5	TL5	TL5	TL5
ALS ID		YL2100037-001	YL2100037-002	YL2100125-001	YL2100160-001	YL2100292-001	YL2100435-001	YL2100680-001
Date Sampled		2021-01-13 16:35	2021-01-13 16:35	2021-02-24 15:50	2021-03-09 16:45	2021-04-21 15:45	2021-05-22 13:45	2021-06-30 13:30
Parameter	**Units**	**Results**						
Iron (Fe)-Total	mg/L	1.64	2.2	43.2	5.9	9.03	1.41	4.81
Lead (Pb)-Total	mg/L	<0.000500	<0.000500	0.00109	0.000655	0.00133	<0.000500	<0.000500
Lithium (Li)-Total	mg/L	0.034	0.0344	0.05	0.0435	0.0579	0.0431	0.0423
Magnesium (Mg)-Total	mg/L	152	158	204	203	239	209	216
Manganese (Mn)-Total	mg/L	0.138	0.138	1.25	0.237	0.509	0.221	0.316
Mercury (Hg)-Total	mg/L	<0.0000500	<0.0000500	<0.0000500	<0.0000500	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.0306	0.0302	0.0307	0.0277	0.0355	0.0252	0.0261
Nickel (Ni)-Total	mg/L	0.141	0.144	0.127	0.0954	0.0187	0.0282	0.0382
Phosphorus (P)-Total	mg/L	<0.500	0.555	0.963	1.08	<0.500	0.842	0.943
Potassium (K)-Total	mg/L	111	110	128	129	124	116	121
Rubidium (Rb)-Total	mg/L	0.0254	0.0266	0.0583	0.0351	0.0541	0.0444	0.0759
Selenium (Se)-Total	mg/L	0.00351	0.00341	0.0055	0.00546	0.00446	0.00188	0.00343
Silicon (Si)-Total	mg/L	1.39	1.23	7.31	1.47	3.7	1.38	2.25
Silver (Ag)-Total	mg/L	0.000834	0.00072	0.000798	0.000394	0.000333	<0.000100	0.000116
Sodium (Na)-Total	mg/L	1940	1960	2420	2790	3340	2510	2680
Strontium (Sr)-Total	mg/L	1.61	1.58	2.12	2.05	2.57	2.16	2.29
Tellurium (Te)-Total	mg/L	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200
Thallium (Tl)-Total	mg/L	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100
Thorium (Th)-Total	mg/L	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Tin (Sn)-Total	mg/L	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Titanium (Ti)-Total	mg/L	<0.00300	<0.00300	0.0332	0.00322	<0.0225	<0.00300	0.00379
Tungsten (W)-Total	mg/L	0.00397	0.00394	0.00671	0.00424	0.00553	0.00674	0.00341
Uranium (U)-Total	mg/L	0.000724	0.0007	0.00027	0.000727	0.00037	0.000263	0.00035

	Sample ID	TL5	TL5^	TL5	TL5	TL5	TL5	TL5
	ALS ID	YL2100037-001	YL2100037-002	YL2100125-001	YL2100160-001	YL2100292-001	YL2100435-001	YL2100680-001
	Date Sampled	2021-01-13 16:35	2021-01-13 16:35	2021-02-24 15:50	2021-03-09 16:45	2021-04-21 15:45	2021-05-22 13:45	2021-06-30 13:30
Parameter	**Units**	**Results**						
Vanadium (V)-Total	mg/L	<0.00500	<0.00500	0.0182	<0.00500	<0.00500	<0.00500	<0.00500
Zinc (Zn)-Total	mg/L	<0.0300	<0.0300	0.042	<0.0300	<0.0300	<0.0300	<0.0300
Zirconium (Zr)-Total	mg/L	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200
Cyanate	mg/L	47.4	46.5	130	97.2	74.1	64.2	63
Thiocyanate	mg/L	18.7	18.2	36.2	51.4	20.6	24.2	11.8

^ *Indicates duplicate sample.*

Table D1-27. Effluent from Process Plant Tailings Slurry Water (TL-5), July to September 2021

	Sample ID	TL5	TL5	TL5
	ALS ID	YL2100774-001	YL2101008-001	YL2101368-001
	Date Sampled	2021-07-12 13:40	2021-08-10 13:15	2021-09-20 8:08
Parameter	**Units**	**Results**		
pH	pH Units	8.16	8.34	8.25
Total Suspended Solids	mg/L	257	14.1	34.1
Cyanide, Free	mg/L	0.0647	0.0468	<0.0400
Cyanide, Total	mg/L	1.07	0.946	1.14
Cyanide, WAD	mg/L	0.128	0.0698	<0.0400
Ammonia, Total (as N)	mg/L	40.1	37	25
Nitrate (as N)	mg/L	28.8	15.1	20.6
Nitrite (as N)	mg/L	3.34	0.765	0.665
Sulfate (SO4)	mg/L	1860	1870	1270
Aluminum (Al)-Total	mg/L	0.844	0.283	1.34
Antimony (Sb)-Total	mg/L	0.00337	0.00396	0.00286

	Sample ID	TL5	TL5	TL5
	ALS ID	YL2100774-001	YL2101008-001	YL2101368-001
	Date Sampled	2021-07-12 13:40	2021-08-10 13:15	2021-09-20 8:08
Parameter	Units	Results		
Arsenic (As)-Total	mg/L	0.0228	0.0315	0.0281
Barium (Ba)-Total	mg/L	0.0543	0.0472	0.0337
Beryllium (Be)-Total	mg/L	<0.00100	<0.00100	<0.000500
Bismuth (Bi)-Total	mg/L	<0.000500	<0.000500	0.000255
Boron (B)-Total	mg/L	1.36	0.946	1.14
Cadmium (Cd)-Total	mg/L	<0.000130	0.000086	0.000127
Calcium (Ca)-Total	mg/L	239	149	161
Cesium (Cs)-Total	mg/L	0.0007	0.000424	0.000666
Chromium (Cr)-Total	mg/L	0.00559	<0.00500	0.0111
Cobalt (Co)-Total	mg/L	0.0187	0.0134	0.0219
Copper (Cu)-Total	mg/L	0.13	0.103	0.137
Iron (Fe)-Total	mg/L	8.82	5.43	16.5
Lead (Pb)-Total	mg/L	0.00118	0.000564	0.00136
Lithium (Li)-Total	mg/L	0.0585	0.0442	0.0314
Magnesium (Mg)-Total	mg/L	205	146	132
Manganese (Mn)-Total	mg/L	0.397	0.198	0.428
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000500	<0.000100
Molybdenum (Mo)-Total	mg/L	0.0348	0.0294	0.0215
Nickel (Ni)-Total	mg/L	0.0779	0.0382	0.0166
Phosphorus (P)-Total	mg/L	0.638	1.18	0.606
Potassium (K)-Total	mg/L	135	107	112
Rubidium (Rb)-Total	mg/L	0.0542	0.0473	0.0502
Selenium (Se)-Total	mg/L	0.00316	0.00269	0.00267
Silicon (Si)-Total	mg/L	3.19	2.47	3.51
Silver (Ag)-Total	mg/L	0.000319	0.000567	0.000614

	Sample ID	TL5	TL5	TL5
	ALS ID	YL2100774-001	YL2101008-001	YL2101368-001
	Date Sampled	2021-07-12 13:40	2021-08-10 13:15	2021-09-20 8:08
Parameter	**Units**		**Results**	
Sodium (Na)-Total	mg/L	2550	2030	1740
Strontium (Sr)-Total	mg/L	2.38	1.53	1.31
Tellurium (Te)-Total	mg/L	<0.00200	<0.00200	<0.00100
Thallium (Tl)-Total	mg/L	<0.000100	<0.000100	<0.000050
Thorium (Th)-Total	mg/L	<0.00100	<0.00100	<0.00050
Tin (Sn)-Total	mg/L	<0.00100	<0.00100	<0.00050
Titanium (Ti)-Total	mg/L	0.0159	<0.00300	<0.00960
Tungsten (W)-Total	mg/L	0.00285	0.00352	0.00257
Uranium (U)-Total	mg/L	0.000462	0.000343	0.000187
Vanadium (V)-Total	mg/L	<0.00500	<0.00500	0.00436
Zinc (Zn)-Total	mg/L	0.0403	<0.0300	0.0446
Zirconium (Zr)-Total	mg/L	<0.00200	<0.00200	<0.00100
Cyanate	mg/L	60.9	75.3	41.1
Thiocyanate	mg/L	23.2	40.4	32.8

Table D1-28. Effluent from Process Plant Tailings Slurry Solids (TL-6), January to September 2021

	Sample ID	TL6	TL6	TL6	TL6	TL6	TL6^	TL6
	ALS ID	ZG9050	ZM9293	ZW9774	ZZ9319	AFY773	AFY774	AKY412
	Date Sampled	2021-01-26	2021-03-09	2021-04-20	2021-05-31	2021-08-24	2021-08-24	9/28/2021
Parameter	**Units**	**Results**						
Aluminum (Al)	%	0.83	0.99	0.88	0.86	0.64	0.62	0.47
Antimony (Sb)	mg/kg	<0.1	<0.1	<0.1	<0.1	0.1	0.1	< 0.1
Arsenic (As)	mg/kg	22	16.3	11	9.7	27.2	27.3	9.4
Barium (Ba)	mg/kg	9	8	7	6	6	6	8.4
Bismuth (Bi)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	< 0.1
Boron (B)	mg/kg	<20	<20	<20	<20	<20	<20	< 20
Cadmium (Cd)	mg/kg	0.2	<0.1	0.1	<0.1	<0.1	0.1	0.2
Calcium (Ca)	%	5.71	5.59	5.01	4.83	4.35	4.31	4.25
Chromium (Cr)	mg/kg	43	50	65	33	59	52	26
Cobalt (Co)	mg/kg	18.8	16.6	11.4	12.5	12.2	12	10.2
Copper (Cu)	mg/kg	51.8	64.3	28.9	28.6	41.4	37.2	29.8
Iron (Fe)	%	6.09	5.96	5.55	5.22	4.83	4.75	5.09
Lead (Pb)	mg/kg	4	1.8	1.4	2.4	2.6	4.7	7.8
Magnesium (Mg)	%	1.86	1.58	1.64	1.51	1.51	1.48	1.28
Manganese (Mn)	mg/kg	1580	1440	1400	1430	1290	1290	1220
Mercury (Hg)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.23
Molybdenum (Mo)	mg/kg	0.5	0.5	0.4	0.3	0.3	0.3	0.4
Nickel (Ni)	mg/kg	37.1	31	23.4	20.8	32.5	31.9	18.8
Phosphorus (P)	mg/kg	0.047	0.044	0.044	0.045	0.059	0.054	0.053
Potassium (K)	%	0.05	0.05	0.05	0.04	0.05	0.05	0.04
Selenium (Se)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	< 0.5
Silver (Ag)	mg/kg	0.2	0.3	0.2	0.2	0.2	0.2	0.3
Sodium (Na)	%	0.108	0.119	0.103	0.124	0.082	0.08	0.065

	Sample ID	TL6	TL6	TL6	TL6	TL6	TL6^	TL6
	ALS ID	ZG9050	ZM9293	ZW9774	ZZ9319	AFY773	AFY774	AKY412
	Date Sampled	2021-01-26	2021-03-09	2021-04-20	2021-05-31	2021-08-24	2021-08-24	9/28/2021
Parameter	**Units**	**Results**						
Strontium (Sr)	mg/kg	34	29	28	28	36	35	27
Tellurium (Te)	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	< 0.2
Thallium (Tl)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	< 0.1
Thorium (Th)	mg/kg	0.2	0.2	0.2	0.3	0.4	0.3	0.2
Titanium (Ti)	%	0.004	0.015	0.004	0.017	0.012	0.011	0.004
Tungsten (W)	mg/kg	0.6	0.9	0.7	1.7	1.4	1.2	1.6
Uranium (U)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	< 0.1
Vanadium (V)	mg/kg	27	33	25	29	25	24	19
Zinc (Zn)	mg/kg	63	61	43	52	49	50	91
$CaCO_3$ Equiv. (Kg $CaCO_3$/T)	kg/T	278.4	235	251.6	198.2	206.4	205.2	231.8
CO_2	wt%	12.25	10.34	11.07	8.72	9.08	9.03	10.2
Sulphur (S)	%	0.26	0.23	0.13	0.11	0.18	0.16	< 1

^ *Indicates duplicate sample.*

Table D1-29. Detoxified Tailings Solids (TL-7a), January to June 2021

	Sample ID	TL7A	TL7A	TL7A	TL7A	TL7A	TL7A
	ALS ID	ZG9070	ZM9324	ZM9348	ZW9784	ZZ9331	ACN324
	Date Sampled	2021-01-24	2021-02-24	2021-03-09	2021-04-20	2021-05-22	2021-06-30
Parameter	**Units**	**Results**					
Aluminum (Al)	%	0.52	0.59	0.66	0.34	0.62	0.23
Antimony (Sb)	mg/kg	1.3	0.6	0.6	1.4	1	1.7
Arsenic (As)	mg/kg	1220	827	788	590	889	886
Barium (Ba)	mg/kg	6	8	8	5	7	4
Bismuth (Bi)	mg/kg	2.4	2.1	2	10.7	2.7	6.7
Boron (B)	mg/kg	<20	<20	<20	<20	<20	<20
Cadmium (Cd)	mg/kg	3.1	1.8	2	1.6	3.8	4.5
Calcium (Ca)	%	3.19	2.74	3.25	2.09	3.06	1.74
Chromium (Cr)	mg/kg	301	289	299	343	316	408
Cobalt (Co)	mg/kg	400	347	343	264	307	364
Copper (Cu)	mg/kg	3310	3120	1940	3360	2020	4780
Iron (Fe)	%	22.4	22.4	20.4	26.8	20.7	30.1
Lead (Pb)	mg/kg	147	32.8	38.2	47.6	91.1	55.7
Magnesium (Mg)	%	1.01	0.88	1.1	0.66	0.94	0.51
Manganese (Mn)	mg/kg	974	907	1020	727	1050	681
Mercury (Hg)	mg/kg	0.06	0.05	0.05	0.06	0.08	0.05
Molybdenum (Mo)	mg/kg	4.1	4	3.3	3.3	4.5	4
Nickel (Ni)	mg/kg	365	199	245	125	175	171
Phosphorus (P)	%	0.028	0.028	0.027	0.026	0.027	0.024
Potassium (K)	%	0.04	0.06	0.06	0.04	0.04	0.03
Selenium (Se)	mg/kg	19.1	14	13	14.8	17.2	18.1
Silver (Ag)	mg/kg	19.3	15.5	21.6	22.4	12.7	19.3
Sodium (Na)	%	0.222	0.21	0.288	0.232	0.232	0.14

Sample ID		TL7A	TL7A	TL7A	TL7A	TL7A	TL7A
ALS ID		ZG9070	ZM9324	ZM9348	ZW9784	ZZ9331	ACN324
Date Sampled		2021-01-24	2021-02-24	2021-03-09	2021-04-20	2021-05-22	2021-06-30
Parameter	**Units**	**Results**					
Strontium (Sr)	mg/kg	28	23	23	19	26	19
Tellurium (Te)	mg/kg	4	3	3.3	10.7	2.9	7.4
Thallium (Tl)	mg/kg	0.3	<0.1	0.1	0.1	0.2	<0.1
Thorium (Th)	mg/kg	0.2	0.1	0.1	1.3	0.5	0.3
Titanium (Ti)	%	0.007	0.004	0.006	0.003	0.008	0.002
Tungsten (W)	mg/kg	2	2.9	3.9	3	5.6	2.6
Uranium (U)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium (V)	mg/kg	20	19	22	13	23	11
Zinc (Zn)	mg/kg	941	503	602	384	1140	1170
Moisture	%	21	17	21	12.7	18	19
CaCO3 Equiv. (Kg CaCO3/T)	kg/T	160	124.6	160	106.8	149.6	89.32
CO2	wt%	7.04	5.48	7.04	4.7	6.58	3.93
Sulphur (S)	wt%	23.89	25.13	19.43	28.83	22.97	32.78

Table D1-30. Detoxified Tailings Solids (TL-7a), July to September 2021

	Sample ID	TL7A	TL7A	TL7A
	ALS ID	ACN325	AFZ122	AOB943
	Date Sampled	2021-07-14	2021-08-10	6-Sep-2020
Parameter	**Units**		**Results**	
Aluminum (Al)	%	0.33	0.32	0.26
Antimony (Sb)	mg/kg	1.4	1.9	0.8
Arsenic (As)	mg/kg	1180	1410	181
Barium (Ba)	mg/kg	6	4	1.8
Bismuth (Bi)	mg/kg	4.1	2.5	3.4
Boron (B)	mg/kg	<20	<20	< 20
Cadmium (Cd)	mg/kg	3.2	2	3.2
Calcium (Ca)	%	2.32	2.02	1.66
Chromium (Cr)	mg/kg	369	262	478
Cobalt (Co)	mg/kg	380	296	165
Copper (Cu)	mg/kg	2200	2320	2970
Iron (Fe)	%	27.9	24.7	12.6
Lead (Pb)	mg/kg	61.7	38.3	37.5
Magnesium (Mg)	%	0.65	0.86	0.49
Manganese (Mn)	mg/kg	800	666	631
Mercury (Hg)	mg/kg	0.08	0.02	0.08
Molybdenum (Mo)	mg/kg	5.1	3.5	1.4
Nickel (Ni)	mg/kg	253	484	139
Phosphorus (P)	%	0.024	0.02	0.023
Potassium (K)	%	0.03	0.03	0.03
Selenium (Se)	mg/kg	16.9	14.4	1.5
Silver (Ag)	mg/kg	21.8	14.7	8.9
Sodium (Na)	%	0.186	0.121	0.13

Sample ID		TL7A	TL7A	TL7A
ALS ID		ACN325	AFZ122	AOB943
Date Sampled		2021-07-14	2021-08-10	6-Sep-2020
Parameter	**Units**	**Results**		
Strontium (Sr)	mg/kg	22	29	14
Tellurium (Te)	mg/kg	5.1	4.2	4.2
Thallium (Tl)	mg/kg	0.2	0.1	< 0.1
Thorium (Th)	mg/kg	0.2	0.3	0.2
Titanium (Ti)	%	0.004	0.003	0.005
Tungsten (W)	mg/kg	3	3.8	3.2
Uranium (U)	mg/kg	0.1	<0.1	-
Vanadium (V)	mg/kg	14	15	6
Zinc (Zn)	mg/kg	890	527	1110
Moisture	%	18	17	16.0
CaCO3 Equiv. (Kg CaCO3/T)	kg/T	108.2	108.4	112.1
CO2	wt%	4.76	4.77	4.93
Sulphur (S)	wt%	30.17	30.61	36.90

Table D1-31. Detoxified Tailings Filtrate (TL-7b), January to June 2021

Sample ID		TL-7B	TL-7B	TL-7B	TL-7B^	TL-7B	TL-7B	TL-7B
ALS ID		YL2100060-001	YL2100124-001	YL2100156-001	YL2100156-002	YL2100293-001	YL2100293-001	YL2100674-001
Date Sampled		2021-01-24 17:30	2021-02-24 16:00	2021-03-09 16:30	2021-03-09 16:30	2021-04-21 15:40	2021-05-22 9:25	2021-06-30 13:25
Parameter	**Units**	**Results**						
Cyanate	mg/L	654	959	1100	1120	568	825	804
Thiocyanate	mg/L	436	287	584	569	190	484	194
Cyanide, WAD	mg/L	0.0956	0.176	<0.500	<0.500	0.133	<0.500	<0.0400
Aluminum (Al)-Total	mg/L	1.06	0.897	0.934	0.775	0.241	0.554	0.592
Antimony (Sb)-Total	mg/L	0.027	0.0368	0.0369	0.0279	0.0248	0.0346	0.0348
Arsenic (As)-Total	mg/L	0.172	0.0474	0.0702	0.0523	0.0478	0.084	0.0554
Barium (Ba)-Total	mg/L	0.0429	0.0428	0.0419	0.0445	0.0317	0.0447	0.0411
Beryllium (Be)-Total	mg/L	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Boron (B)-Total	mg/L	1.22	1.32	1.54	1.42	1.38	1.65	1.35
Cadmium (Cd)-Total	mg/L	<0.000250	<0.000250	<0.000250	<0.000250	<0.000250	<0.000250	0.000336
Calcium (Ca)-Total	mg/L	51.3	86.6	71.7	68.4	65	61.5	65.1
Chromium (Cr)-Total	mg/L	0.0333	<0.0250	0.0406	<0.0250	<0.0250	<0.0250	0.0259
Cobalt (Co)-Total	mg/L	0.207	0.0506	0.323	0.316	0.0343	0.186	0.0286
Copper (Cu)-Total	mg/L	5.46	4.46	1.5	1.33	8.05	2.31	11.2
Iron (Fe)-Total	mg/L	12.9	4.3	7.68	5.59	8.03	9.9	7.52
Lead (Pb)-Total	mg/L	0.0132	<0.00250	0.00304	0.0028	<0.00250	0.00546	0.0121
Lithium (Li)-Total	mg/L	<0.0500	<0.0500	<0.0500	<0.0500	0.0725	<0.0500	0.0592
Magnesium (Mg)-Total	mg/L	69	99.4	87.1	86.3	90.8	92.9	70.4
Manganese (Mn)-Total	mg/L	0.224	0.249	0.179	0.192	0.244	0.183	0.283
Molybdenum (Mo)-Total	mg/L	0.116	0.0775	0.0979	0.0478	0.103	0.131	0.0987
Nickel (Ni)-Total	mg/L	0.0359	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250
Potassium (K)-Total	mg/L	54	58.2	70.2	69.2	76.3	87.4	71.9
Selenium (Se)-Total	mg/L	0.0166	0.0424	0.0129	0.00922	0.0379	0.00564	0.0167

Sample ID		TL-7B	TL-7B	TL-7B	TL-7B^	TL-7B	TL-7B	TL-7B
ALS ID		YL2100060-001	YL2100124-001	YL2100156-001	YL2100156-002	YL2100293-001	YL2100293-001	YL2100674-001
Date Sampled		2021-01-24 17:30	2021-02-24 16:00	2021-03-09 16:30	2021-03-09 16:30	2021-04-21 15:40	2021-05-22 9:25	2021-06-30 13:25
Parameter	**Units**	**Results**						
Silver (Ag)-Total	mg/L	0.0372	0.0115	0.0417	0.0034	0.0143	0.0143	0.00714
Sodium (Na)-Total	mg/L	9900	7200	11200	11200	10600	9530	9240
Sulfur (S) - Total	mg/L	6410	4340	6750	6320	6350	5460	5290
Thallium (Tl)-Total	mg/L	<0.000500	<0.000500	<0.000500	<0.000500	<0.000500	<0.000500	<0.000500
Tin (Sn)-Total	mg/L	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Titanium (Ti)-Total	mg/L	<0.0150	<0.0204	<0.0150	<0.0150	<0.0150	<0.0150	<0.0150
Uranium (U)-Total	mg/L	<0.000500	<0.000500	0.00143	0.00138	<0.000500	0.000546	0.00055
Vanadium (V)-Total	mg/L	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250
Zinc (Zn)-Total	mg/L	<0.150	<0.150	<0.150	<0.150	<0.150	<0.150	<0.150

^ *Indicates duplicate sample.*

Table D1-32. Detoxified Tailings Filtrate (TL-7b), July to September 2021

	Sample ID	TL-7B	TL-7B	TL-7B
	ALS ID	YL2100779-001	YL2101014-001	YL2101367-001
	Date Sampled	2021-07-12 9:45	2021-08-10 15:50	2021-09-20 15:00
Parameter	**Units**		**Results**	
Cyanate	mg/L	804	702	538
Thiocyanate	mg/L	194	400	381
Cyanide, WAD	mg/L	<0.0400	0.052	0.267
Aluminum (Al)-Total	mg/L	0.592	0.229	0.125
Antimony (Sb)-Total	mg/L	0.0348	0.0427	0.0251
Arsenic (As)-Total	mg/L	0.0554	0.234	0.0409
Barium (Ba)-Total	mg/L	0.0411	0.0346	0.014
Beryllium (Be)-Total	mg/L	<0.00100	<0.00100	<0.000400
Boron (B)-Total	mg/L	1.35	1.01	1.13
Cadmium (Cd)-Total	mg/L	0.000336	<0.000250	<0.000120
Calcium (Ca)-Total	mg/L	65.1	43.1	61.7
Chromium (Cr)-Total	mg/L	0.0259	<0.0250	0.0126
Cobalt (Co)-Total	mg/L	0.0286	0.055	0.122
Copper (Cu)-Total	mg/L	11.2	6.86	2.45
Iron (Fe)-Total	mg/L	7.52	3.08	2.77
Lead (Pb)-Total	mg/L	0.0121	<0.00250	0.00121
Lithium (Li)-Total	mg/L	0.0592	<0.0500	0.0386
Magnesium (Mg)-Total	mg/L	70.4	56.4	61.4
Manganese (Mn)-Total	mg/L	0.283	0.162	0.175
Molybdenum (Mo)-Total	mg/L	0.0987	0.117	0.102
Nickel (Ni)-Total	mg/L	<0.0250	0.0356	<0.0100
Potassium (K)-Total	mg/L	71.9	68.1	54.3
Selenium (Se)-Total	mg/L	0.0167	0.00784	0.0331
Silver (Ag)-Total	mg/L	0.00714	0.0142	0.00286
Sodium (Na)-Total	mg/L	9240	7820	7540
Sulfur (S) - Total	mg/L	5290	4420	4600
Thallium (Tl)-Total	mg/L	<0.000500	<0.000500	<0.000200
Tin (Sn)-Total	mg/L	<0.00500	<0.00500	<0.00200
Titanium (Ti)-Total	mg/L	<0.0150	<0.0150	<0.00600
Uranium (U)-Total	mg/L	0.00055	<0.000500	0.000389
Vanadium (V)-Total	mg/L	<0.0250	<0.0250	<0.0100
Zinc (Zn)-Total	mg/L	<0.150	<0.150	<0.0600

Table D1-33. Seepage from Underground Backfilled Stopes (TL-11), August 2021

	Sample ID	TL11-A	TL11-A^	TL11-B	TL11-C
	ALS ID	YL2101179-001	YL2101179-002	YL2101179-003	YL2101179-004
	Date Sampled	2021-08-29 11:41	2021-08-29 11:41	2021-08-29 11:55	2021-08-29 12:10
Parameter	Units	Results			
pH	pH	8.11	8.09	8.21	8
Conductivity	µS/cm	20100	20300	7160	21800
Cyanide, Free	mg/L	<0.0050	<0.0050	<0.0050	0.0056
Cyanide, Total	mg/L	0.026	0.0109	0.328	0.0236
Cyanide, WAD	mg/L	<0.0050	<0.0050	<0.0050	<0.0050
Ammonia, Total (as N)	mg/L	1.81	1.74	1.6	34.2
Nitrate (as N)	mg/L	6.65	6.35	0.71	62.2
Nitrite (as N)	mg/L	0.364	0.348	0.106	2.43
Sulfate (SO4)	mg/L	829	808	156	1910
Aluminum (Al)-Dissolved	mg/L	<0.0200	<0.0200	<0.0050	<0.0200
Antimony (Sb)-Dissolved	mg/L	<0.00200	<0.00200	0.00239	0.0024
Arsenic (As)-Dissolved	mg/L	0.00366	0.00387	0.00231	0.0049
Barium (Ba)-Dissolved	mg/L	0.0386	0.0371	0.0353	0.0378
Beryllium (Be)-Dissolved	mg/L	<0.00200	<0.00200	<0.000500	<0.00200
Bismuth (Bi)-Dissolved	mg/L	<0.00100	<0.00100	<0.000250	<0.00100
Boron (B)-Dissolved	mg/L	2.03	2.03	1.05	2.6
Cadmium (Cd)-Dissolved	mg/L	0.000175	0.000132	0.0000579	0.000453
Calcium (Ca)-Dissolved	mg/L	296	296	124	548
Chromium (Cr)-Dissolved	mg/L	<0.0100	<0.0100	<0.00250	<0.0100
Cobalt (Co)-Dissolved	mg/L	0.018	0.0172	0.0152	0.139
Copper (Cu)-Dissolved	mg/L	0.0139	0.0136	0.0101	0.0422
Iron (Fe)-Dissolved	mg/L	<0.200	<0.200	<0.050	<0.200
Lead (Pb)-Dissolved	mg/L	<0.00100	<0.00100	<0.000250	<0.00100
Lithium (Li)-Dissolved	mg/L	0.0718	0.0713	0.0326	0.0935
Magnesium (Mg)-Dissolved	mg/L	405	408	148	540
Manganese (Mn)-Dissolved	mg/L	0.777	0.774	0.199	2.78
Mercury (Hg)-Dissolved	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Dissolved	mg/L	0.00366	0.00346	0.00323	0.00932
Nickel (Ni)-Dissolved	mg/L	0.0343	0.0338	0.00911	0.358
Phosphorus (P)-Dissolved	mg/L	<1.00	<1.00	<0.250	<1.00
Potassium (K)-Dissolved	mg/L	117	117	45.1	143
Selenium (Se)-Dissolved	mg/L	<0.00100	0.00118	0.000713	0.00816
Silicon (Si)-Dissolved	mg/L	4.04	3.62	2.44	3.29
Silver (Ag)-Dissolved	mg/L	<0.000200	<0.000200	0.000061	0.000268

Sample ID		TL11-A	TL11-A^	TL11-B	TL11-C
ALS ID		YL2101179-001	YL2101179-002	YL2101179-003	YL2101179-004
Date Sampled		2021-08-29 11:41	2021-08-29 11:41	2021-08-29 11:55	2021-08-29 12:10
Parameter	**Units**	**Results**			
Sodium (Na)-Dissolved	mg/L	3790	3720	1220	3880
Strontium (Sr) - Dissolved	mg/L	4.27	4.27	1.57	5.24
Sulphur (S)-Dissolved	mg/L	312	292	124	758
Thallium (Tl)-Dissolved	mg/L	<0.000200	<0.000200	<0.000050	<0.000200
Tin (Sn)-Dissolved	mg/L	<0.00200	<0.00200	<0.00050	<0.00200
Titanium (Ti)-Dissolved	mg/L	<0.00600	<0.00600	<0.00150	<0.00600
Uranium (U)-Dissolved	mg/L	0.000227	0.000227	0.000941	0.000541
Vanadium (V)-Dissolved	mg/L	<0.0100	<0.0100	<0.00250	<0.0100
Zinc (Zn)-Dissolved	mg/L	<0.0200	<0.0200	0.024	0.0408
Zirconium (Zr)-Dissolved	mg/L	<0.00400	<0.00400	<0.00100	<0.00400
Alkalinity, Total (as CaCO3)	mg/L	218	217	194	256
Acidity as CaCO3	mg/L	8	8.2	2.8	18.5

^ *Indicates duplicate sample.*

Table D1-34. Seepage from Underground Backfilled Stopes (TL-11), December 2021

Sample ID		TL11-A	TL11-A^	TL11-B	TL11-C
ALS ID		YL2101778-001	YL2101778-002	YL2101799-001	YL2101799-002
Date Sampled		2021-12-14 14:50	2021-12-14 15:00	2021-12-17 8:40	2021-12-17 9:15
Parameter	**Units**	**Results**			
pH	pH	8.11	8.11	7.99	7.62
Conductivity	µS/cm	20100	20000	7910	279
Cyanide, Free	mg/L	<0.0050	<0.0050	<0.0100	<0.0050
Cyanide, Total	mg/L	0.0071	<0.0050	0.062	0.0173
Cyanide, WAD	mg/L	<0.0050	<0.0050	<0.0100	<0.0050
Ammonia, Total (as N)	mg/L	1.18	1.17	1.17	0.0117
Nitrate (as N)	mg/L	5.63	5.56	2.97	0.13
Nitrite (as N)	mg/L	0.372	0.402	0.117	<0.0010
Sulfate (SO4)	mg/L	822	847	333	4.23
Aluminum (Al)-Dissolved	mg/L	<0.0200	<0.0200	0.0178	0.0114
Antimony (Sb)-Dissolved	mg/L	<0.00200	<0.00200	0.00165	0.00015
Arsenic (As)-Dissolved	mg/L	0.00357	0.00369	0.00233	0.00044
Barium (Ba)-Dissolved	mg/L	0.0298	0.0303	0.0352	0.00274
Beryllium (Be)-Dissolved	mg/L	<0.00200	<0.00200	<0.000500	<0.000100
Bismuth (Bi)-Dissolved	mg/L	<0.00100	<0.00100	<0.000250	<0.000050

	Sample ID	TL11-A	TL11-A^	TL11-B	TL11-C
	ALS ID	YL2101778-001	YL2101778-002	YL2101799-001	YL2101799-002
	Date Sampled	2021-12-14 14:50	2021-12-14 15:00	2021-12-17 8:40	2021-12-17 9:15
Parameter	**Units**	**Results**			
Boron (B)-Dissolved	mg/L	2.01	2.04	1.43	0.03
Cadmium (Cd)-Dissolved	mg/L	0.000163	0.000103	0.0000274	<0.0000050
Calcium (Ca)-Dissolved	mg/L	282	279	152	12
Chromium (Cr)-Dissolved	mg/L	298	290	<0.00250	<0.00050
Cobalt (Co)-Dissolved	mg/L	0.015	0.0153	0.00833	<0.00010
Copper (Cu)-Dissolved	mg/L	0.0125	0.0118	0.0129	0.00433
Iron (Fe)-Dissolved	mg/L	<0.200	<0.200	<0.050	<0.010
Lead (Pb)-Dissolved	mg/L	<0.00100	<0.00100	<0.000250	<0.000050
Lithium (Li)-Dissolved	mg/L	0.0663	0.0658	0.0381	0.0032
Magnesium (Mg)-Dissolved	mg/L	431	430	186	7.17
Manganese (Mn)-Dissolved	mg/L	0.777	0.774	0.26	0.00193
Mercury (Hg)-Dissolved	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Dissolved	mg/L	0.00346	0.0033	0.00368	0.000313
Nickel (Ni)-Dissolved	mg/L	0.024	0.0245	0.00964	<0.00050
Phosphorus (P)-Dissolved	mg/L	<1.00	<1.00	<0.250	<0.050
Potassium (K)-Dissolved	mg/L	115	114	56.8	2.41
Selenium (Se)-Dissolved	mg/L	<0.00100	<0.00100	0.000438	0.000096
Silicon (Si)-Dissolved	mg/L	3.68	3.72	3.04	1.4
Silver (Ag)-Dissolved	mg/L	<0.000200	<0.000200	<0.000050	<0.000010
Sodium (Na)-Dissolved	mg/L	3660	3720	1470	30.8
Strontium (Sr) - Dissolved	mg/L	3.93	3.83	1.85	0.0439
Sulphur (S)-Dissolved	mg/L	291	291	149	1.55
Thallium (Tl)-Dissolved	mg/L	<0.000200	<0.000200	<0.000050	<0.000010
Tin (Sn)-Dissolved	mg/L	<0.00200	<0.00200	<0.00050	<0.00010
Titanium (Ti)-Dissolved	mg/L	<0.00600	<0.00600	<0.00150	<0.00030
Uranium (U)-Dissolved	mg/L	0.000217	<0.000200	0.000763	0.000094
Vanadium (V)-Dissolved	mg/L	<0.0100	<0.0100	<0.00250	<0.00050
Zinc (Zn)-Dissolved	mg/L	<0.0200	<0.0200	0.0148	0.0062
Zirconium (Zr)-Dissolved	mg/L	<0.00600	<0.00600	<0.00100	<0.00020
Alkalinity, Total (as CaCO3)	mg/L	216	223	214	45.4
Acidity as CaCO3	mg/L	8.8	7.1	9.1	3.7

^ *Indicates duplicate sample.*

TL-12 Monitoring of Underground Dewatering

Dewatering of the Doris underground workings continued in 2021. Groundwater inflow accumulating underground from mine development occurring in the Doris Connector and Doris Central zones was discharged to Roberts Bay through the Roberts Bay Discharge System (RBDS) from May to November 2021. Dewatering of the Doris underground workings to the Tailings Impoundment Area continued in 2021.

Table D-35 provides the dewatering volumes for the Doris mine in 2021. Water quality samples were collected weekly and submitted for laboratory analysis as outlined in Schedule I of the water licence. Results of this sampling is provided in Table D1-36 through Table D1-43.

Table D1-35. Doris Underground Mine Dewatering, 2021

Month	Monthly Volume (m^3)*	Cumulative Volume (m^3)*
January	39,708	39,708
February	43,119	82,827
March	54,940	137,767
April	54,667	192,434
May	62,740	255,174
June	59,803	314,977
July	34,047	349,024
August	34,295	383,319
September	21,889	405,208
October	36,267	441,475
November	24,007	465,482
December	48,893	514,375
Volume of Mine Water Dewatering for Doris Mine, 2021 (m^3)		**514,375**

** Values rounded to nearest whole cubic metre.*

Table D1-36. Water Sampling Monitoring Program Results for January to March 2021 Taken from TL-12A

Sample ID		TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A^
ALS ID		YL2100016-001	YL2100033-001	YL2100051-001	YL2100061-001	YL2100075-001	YL2100091-001	YL2100104-001	YL2100123-001	YL2100143-001	YL2100159-001	YL2100180-001	YL2100180-002
Date Sampled		2021-01-05 12:55	2021-01-13 15:45	2021-01-20 13:35	2021-01-26 14:50	2021-02-03 12:05	2021-02-10 14:20	2021-02-16 13:35	2021-02-24 15:00	2021-03-03 14:00	2021-03-09 14:00	2021-03-17 11:20	2021-03-17 11:20
Parameter	**Units**	**Results**											
pH	pH	7.9	7.89	7.96	8.02	8.07	8.03	8.08	8.11	7.87	7.93	8.06	8.07
Conductivity	µS/cm	22500				21700				18400			
Total Suspended Solids	mg/L	28.2	18.7	27.7	6.7	57.5	67.4	103	68.4	136	508	89.9	109
Total Dissolved Solids	mg/L	12400	15200	15300	14200	15300	13700	15000	12200	12400	11800	13600	13000
Chloride (Cl)	mg/L	7640	7910	8000	8050	7480	6650	7540	7530	6700	7790	6970	6950
Bromide (Br)	mg/L	27.1				28.4				23.6			
Fluoride (F)	mg/L	<2.00				<2.00				<2.00			
Cyanide, Total	mg/L	0.0239	0.0177	0.072	0.0178	0.049	0.0942	0.18	0.196	0.294	0.177	0.108	0.12
Cyanide, WAD	mg/L	<0.0100				<0.0050				<0.0050			
Ammonia, Total (as N)	mg/L	6.56	8.57	7.11	6.48	8.88	9.44	9.95	8.63	7.87	9.22	13.5	13.3
Nitrate (as N)	mg/L	5.91	8.04	6.6	5.87	10.2	8.54	9.5	7.67	7.04	8.92	14.2	14.3
Nitrite (as N)	mg/L	0.911				0.599				0.656			
Sulfate (SO4)	mg/L	815				792				800			
Aluminum (Al)-Total	mg/L	0.394	0.223	1.08	0.254	1.62	2.01	2.75	2.88	3.42	2.72	2.05	2.23
Antimony (Sb)-Total	mg/L	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00100	<0.00200	<0.00100	<0.00100
Arsenic (As)-Total	mg/L	0.00278	0.00352	0.0132	0.00535	0.00711	0.0141	0.0184	0.0245	0.0335	0.0141	0.0121	0.0126
Barium (Ba)-Total	mg/L	0.0485	0.0456	0.0547	0.0505	0.0476	0.0549	0.0839	0.0689	0.0687	0.0766	0.0545	0.0558
Beryllium (Be)-Total	mg/L	<0.000400	<0.00200	<0.00200	<0.00200	<0.000400	<0.00200	<0.00200	<0.00200	<0.000200	<0.00200	<0.00100	<0.00100
Bismuth (Bi)-Total	mg/L	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.000500	<0.00100	<0.000500	<0.000500
Boron (B)-Total	mg/L	2.26	2.11	2.39	2.2	2.31	2.21	2.18	2.28	2.04	1.94	2.04	2.09
Cadmium (Cd)-Total	mg/L	<0.000100	<0.000100	0.000146	<0.000100	0.000156	<0.000100	0.000101	0.000154	0.000115	<0.000100	0.000132	0.000101
Calcium (Ca)-Total	mg/L	497	507	606	605	526	530	564	499	437	526	446	453

Sample ID		TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A^
ALS ID		YL2100016-001	YL2100033-001	YL2100051-001	YL2100061-001	YL2100075-001	YL2100091-001	YL2100104-001	YL2100123-001	YL2100143-001	YL2100159-001	YL2100180-001	YL2100180-002
Date Sampled		2021-01-05 12:55	2021-01-13 15:45	2021-01-20 13:35	2021-01-26 14:50	2021-02-03 12:05	2021-02-10 14:20	2021-02-16 13:35	2021-02-24 15:00	2021-03-03 14:00	2021-03-09 14:00	2021-03-17 11:20	2021-03-17 11:20
Parameter	Units	Results											
Cesium (Cs)-Total	mg/L	0.000344	0.000206	0.000226	0.000269	0.000399	0.000372	0.000548	0.000295	0.000104	0.000482	0.000298	0.000314
Chromium (Cr)-Total	mg/L	<0.0100	0.00214	0.00529	0.00229	<0.0100	0.00672	0.0137	0.0131	0.0153	0.0103	0.00649	0.00661
Cobalt (Co)-Total	mg/L	0.00795	0.00732	0.0133	0.01	0.0107	0.00904	0.0116	0.0148	0.0208	0.0133	0.0154	0.0163
Copper (Cu)-Total	mg/L	0.0311	0.0526	0.236	0.104	0.0895	0.187	0.228	0.404	0.561	0.179	0.212	0.218
Iron (Fe)-Total	mg/L	1.76	1.17	4.87	1.42	5.75	8.12	12	10.4	13.6	11.3	9.43	9.9
Lead (Pb)-Total	mg/L	<0.00100	<0.00100	0.00201	<0.00100	<0.00100	0.00209	0.00264	0.00234	0.00294	0.00214	0.00206	0.00206
Lithium (Li)-Total	mg/L	0.0826	0.0711	0.093	0.0993	0.0866	0.0811	0.0883	0.0849	0.0713	0.0796	0.0783	0.0788
Magnesium (Mg)-Total	mg/L	500	484	551	556	498	464	464	488	416	474	439	439
Manganese (Mn)-Total	mg/L	1.09	1.09	1.29	1.24	1.16	1.06	0.582	0.956	0.932	1.16	1.08	1.1
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000500	0.0000071	<0.0000250	<0.0000250	<0.0000250
Molybdenum (Mo)-Total	mg/L	0.0053	0.00899	0.00647	0.00662	0.00676	0.00723	0.0103	0.00718	0.00809	0.00854	0.00592	0.00618
Nickel (Ni)-Total	mg/L	0.0177	0.0186	0.0242	0.0205	0.0199	0.0185	0.022	0.023	0.0293	0.0204	0.0246	0.0248
Phosphorus (P)-Total	mg/L	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<0.500	<1.00	<0.500	<0.500
Potassium (K)-Total	mg/L	138	128	149	145	129	129	132	134	113	127	117	118
Rubidium (Rb)-Total	mg/L	0.0607	0.0532	0.0546	0.0577	0.0624	0.0546	0.0799	0.0585	0.0327	0.0773	0.0567	0.0554
Selenium (Se)-Total	mg/L	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	0.00142	0.00122	0.000829	0.00107
Silicon (Si)-Total	mg/L	4.32	4.72	5.4	4.63	6.08	6.79	12.1	10.8	10.1	10	7.1	7.35
Silver (Ag)-Total	mg/L	<0.000200	0.000279	0.000923	0.000704	0.00109	0.000809	0.000977	0.00127	0.0022	0.000847	0.00102	0.00107
Sodium (Na)-Total	mg/L	4210	3930	4360	4610	4170	3920	3940	4040	3240	4310	3680	3660
Strontium (Sr)-Total	mg/L	6.86	6.85	7.96	8.47	6.76	6.39	6.31	6.57	5.24	6.44	6.1	6.27
Tellurium (Te)-Total	mg/L	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00200	<0.00400	<0.00200	<0.00200
Thallium (Tl)-Total	mg/L	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000100	<0.000200	<0.000100	<0.000100
Thorium (Th)-Total	mg/L	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00100	<0.00200	<0.00100	<0.00100

	Sample ID	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A^
	ALS ID	YL2100016-001	YL2100033-001	YL2100051-001	YL2100061-001	YL2100075-001	YL2100091-001	YL2100104-001	YL2100123-001	YL2100143-001	YL2100159-001	YL2100180-001	YL2100180-002
	Date Sampled	2021-01-05 12:55	2021-01-13 15:45	2021-01-20 13:35	2021-01-26 14:50	2021-02-03 12:05	2021-02-10 14:20	2021-02-16 13:35	2021-02-24 15:00	2021-03-03 14:00	2021-03-09 14:00	2021-03-17 11:20	2021-03-17 11:20
Parameter	**Units**	**Results**											
Tin (Sn)-Total	mg/L	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00100	<0.00200	<0.00100	<0.00100
Titanium (Ti)-Total	mg/L	<0.00600	<0.00600	<0.0198	<0.00600	0.0178	0.0381	0.0466	<0.0447	<0.0861	0.0442	0.0309	0.0338
Tungsten (W)-Total	mg/L	0.0031	0.00592	0.0151	0.0182	0.0166	0.0149	0.018	0.0164	0.0217	0.0137	0.0106	0.0107
Uranium (U)-Total	mg/L	<0.000200	0.000272	0.000292	0.000292	0.000332	0.000346	0.000407	0.000336	0.000226	0.000299	0.000368	0.000382
Vanadium (V)-Total	mg/L	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0154	<0.0100	0.0119	0.0107	0.00734	0.0084
Zinc (Zn)-Total	mg/L	<0.0600	<0.0600	<0.0600	0.0659	<0.0600	<0.0600	<0.0600	<0.0600	0.0887	0.078	0.0516	0.054
Zirconium (Zr)-Total	mg/L	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	0.00239	<0.00400	<0.00200	<0.00200
Alkalinity, Total (as CaCO3)	mg/L	197				196				195			

^ *Indicates duplicate sample.*

Table D1-37. Water Sampling Monitoring Program Results for March to June 2021 Taken from TL-12A

Sample ID		TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A
ALS ID		YL2100199-001	YL2100218-001	YL2100250-001	YL2100272-001	YL2100296-001	YL2100321-001	YL2100272-001	YL2100296-001	YL2100321-001	YL2100461-001	YL2100526-001
Date Sampled		2021-03-24 10:40	2021-03-30 11:00	2021-04-07 17:05	2021-04-15 5:30	2021-04-21 15:20	2021-04-28 16:50	2021-05-05 9:15	2021-05-11 14:00	2021-05-20 5:10	2021-06-01 13:50	2021-06-08 10:19
Parameter	**Units**	**Results**										
pH	pH	7.87	7.84	7.59	7.61	7.93	7.96	7.97	7.28	7.43	7.95	7.52
Conductivity	µS/cm			23400				22900			26600	22200
Total Suspended Solids	mg/L	132	104	437	210	91.8	242	5.5	9.4	193	352	209
Total Dissolved Solids	mg/L	13100	15200	15300	13800	13000	16200	14700	14100	12100	17500	15200
Chloride (Cl)	mg/L	7140	7650	8070	7460	7760	10600	8030	8060	6550	9620	7760
Bromide (Br)	mg/L			28.4				27.7				26
Fluoride (F)	mg/L			<2.00				<2.00				<2.00
Cyanide, Total	mg/L	0.112	0.124	0.162	0.0576	0.0959	0.0531	0.048	0.0866	0.107	0.127	0.0256
Cyanide, WAD	mg/L			<0.100				<0.0100				<0.0200
Ammonia, Total (as N)	mg/L	11.8	6.16	6.4	5.22	6.84	7.84	7.15	11.9	6.06	12.2	7.88
Nitrate (as N)	mg/L	12.1	5.93	7.8	5.39	7.55	10.1	7.34	<0.500	5.96	11.9	7
Nitrite (as N)	mg/L			2.18				0.682				0.661
Sulfate (SO4)	mg/L			865				861				828
Aluminum (Al)-Total	mg/L	3.55	2.83	32.1	31.2	0.559	7.82	0.662	0.0734	19	25.5	24.8
Antimony (Sb)-Total	mg/L	<0.00200	<0.00100	<0.00200	<0.00100	<0.00100	<0.00200	<0.00200	<0.00100	<0.00200	<0.00200	<0.00200
Arsenic (As)-Total	mg/L	0.0161	0.0146	0.0273	0.052	0.00897	0.0107	<0.00200	0.00865	0.0312	0.0178	0.0112
Barium (Ba)-Total	mg/L	0.0526	0.0529	0.075	0.0708	0.0622	0.0562	0.0572	0.0788	0.0525	0.0694	0.0634
Beryllium (Be)-Total	mg/L	<0.00200	<0.00100	<0.000400	<0.00100	<0.00100	<0.00200	<0.000400	<0.00100	<0.00200	<0.00200	<0.000400
Bismuth (Bi)-Total	mg/L	<0.00100	<0.000500	<0.00100	<0.000500	<0.000500	<0.00100	<0.00100	<0.000500	<0.00100	<0.00100	<0.00100
Boron (B)-Total	mg/L	2.16	2.24	2.1	1.92	2.21	2.11	2.35	2.31	1.68	2.56	2.22
Cadmium (Cd)-Total	mg/L	0.000118	0.0000824	<0.000100	0.000206	0.0000652	0.000102	<0.000100	0.0000925	0.000192	<0.000100	0.000108
Calcium (Ca)-Total	mg/L	442	617	507	491	477	540	541	538	393	664	536

Sample ID		TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A
ALS ID		YL2100199-001	YL2100218-001	YL2100250-001	YL2100272-001	YL2100296-001	YL2100321-001	YL2100272-001	YL2100296-001	YL2100321-001	YL2100461-001	YL2100526-001
Date Sampled		2021-03-24 10:40	2021-03-30 11:00	2021-04-07 17:05	2021-04-15 5:30	2021-04-21 15:20	2021-04-28 16:50	2021-05-05 9:15	2021-05-11 14:00	2021-05-20 5:10	2021-06-01 13:50	2021-06-08 10:19
Parameter	**Units**	**Results**										
Cesium (Cs)-Total	mg/L	0.000265	0.000416	0.000502	0.000328	0.000277	0.000502	0.000401	0.000453	0.000205	0.000677	0.000376
Chromium (Cr)-Total	mg/L	0.00798	0.0104	0.0165	0.0252	0.00594	0.011	<0.0100	<0.00500	0.019	0.0152	0.0117
Cobalt (Co)-Total	mg/L	0.0173	0.0147	0.0249	0.0376	0.00895	0.0144	0.00426	0.00567	0.0222	0.015	0.0116
Copper (Cu)-Total	mg/L	0.257	0.246	0.392	0.485	0.117	0.127	0.027	0.353	0.41	0.173	0.12
Iron (Fe)-Total	mg/L	14.6	10.9	40.9	62.2	3.58	24.1	1.17	0.505	16.8	29.2	16.6
Lead (Pb)-Total	mg/L	0.00378	0.0023	0.00696	0.0095	0.00187	0.00316	<0.00100	<0.000500	0.00425	0.00422	0.00248
Lithium (Li)-Total	mg/L	0.0744	0.0896	0.0944	0.0877	0.0795	0.0905	0.0953	0.0644	0.0634	0.105	0.0854
Magnesium (Mg)-Total	mg/L	425	466	491	423	468	507	584	482	374	569	514
Manganese (Mn)-Total	mg/L	1.16	1.18	1.72	1.98	1.03	1.45	1.19	1.92	1.02	1.63	1.16
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050	<0.0000500	<0.0000250	0.0000089	<0.0000500	<0.0000050	<0.0000050	<0.0000500	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.00625	0.00556	0.00747	0.00983	0.0078	0.0059	0.00843	0.0072	0.00695	0.00836	0.00665
Nickel (Ni)-Total	mg/L	0.0269	0.0229	0.0267	0.0354	0.0173	0.021	0.0111	0.0439	0.0278	0.0156	0.0182
Phosphorus (P)-Total	mg/L	<1.00	<0.500	<1.00	0.783	<0.500	<1.00	<1.00	<0.500	<1.00	<1.00	<1.00
Potassium (K)-Total	mg/L	108	117	122	122	120	118	150	135	100	142	131
Rubidium (Rb)-Total	mg/L	0.0502	0.0616	0.059	0.0475	0.0575	0.0633	0.0722	0.126	0.0347	0.0797	0.0632
Selenium (Se)-Total	mg/L	<0.00100	0.000905	0.00101	0.00154	0.000827	<0.00100	<0.00100	0.00178	0.00104	<0.00100	<0.00100
Silicon (Si)-Total	mg/L	7.81	8.63	19.6	22.4	5.29	13.3	4.85	6.18	7.37	16.5	11.5
Silver (Ag)-Total	mg/L	0.00129	0.00103	0.00162	0.00237	0.000872	0.00115	<0.000200	0.000534	0.00129	0.001	0.000703
Sodium (Na)-Total	mg/L	3540	4010	4250	3940	4010	3990	4940	4070	2980	4780	4250
Strontium (Sr)-Total	mg/L	5.56	7.39	6.76	5.34	6.73	6.88	7.2	7.31	5.1	8.57	6.77
Tellurium (Te)-Total	mg/L	<0.00400	<0.00200	<0.00400	<0.00200	<0.00200	<0.00400	<0.00400	<0.00200	<0.00400	<0.00400	<0.00400
Thallium (Tl)-Total	mg/L	<0.000200	<0.000100	<0.000200	<0.000100	<0.000100	<0.000200	<0.000200	<0.000100	<0.000200	<0.000200	<0.000200
Thorium (Th)-Total	mg/L	<0.00200	<0.00100	<0.00200	<0.00100	<0.00100	<0.00200	<0.00200	<0.00100	<0.00200	<0.00200	<0.00200

Sample ID		TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A
ALS ID		YL2100199-001	YL2100218-001	YL2100250-001	YL2100272-001	YL2100296-001	YL2100321-001	YL2100272-001	YL2100296-001	YL2100321-001	YL2100461-001	YL2100526-001
Date Sampled		2021-03-24 10:40	2021-03-30 11:00	2021-04-07 17:05	2021-04-15 5:30	2021-04-21 15:20	2021-04-28 16:50	2021-05-05 9:15	2021-05-11 14:00	2021-05-20 5:10	2021-06-01 13:50	2021-06-08 10:19
Parameter	**Units**	**Results**										
Tin (Sn)-Total	mg/L	<0.00200	<0.00100	<0.00200	<0.00100	<0.00100	<0.00200	<0.00200	0.00423	<0.00200	<0.00200	<0.00200
Titanium (Ti)-Total	mg/L	0.0516	<0.0555	0.343	0.351	0.00914	0.183	0.0162	<0.00300	<0.0600	0.225	0.14
Tungsten (W)-Total	mg/L	0.00985	0.00643	0.00623	0.0105	0.00616	0.0104	0.00887	0.00511	0.00777	0.0159	0.00892
Uranium (U)-Total	mg/L	0.000346	0.000352	0.000299	0.000139	0.000407	0.000346	0.000422	0.000277	0.000343	0.000448	0.000522
Vanadium (V)-Total	mg/L	0.0113	0.0102	0.0407	0.0598	<0.00500	0.025	<0.0100	<0.00500	0.0117	0.0365	0.0272
Zinc (Zn)-Total	mg/L	<0.0600	0.0471	0.203	0.177	0.0336	<0.0600	<0.0600	<0.0300	<0.0600	0.0857	<0.0600
Zirconium (Zr)-Total	mg/L	<0.00400	<0.00200	<0.00400	<0.00200	<0.00200	<0.00400	<0.00400	<0.00200	<0.00400	<0.00400	<0.00400
Alkalinity, Total (as CaCO3)	mg/L			157				197				151

Table D1-38. Water Sampling Monitoring Program Results for June to August 2021 Taken from TL-12A

Sample ID		TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A
ALS ID		YL2100565-001	YL2100616-001	YL2100664-001	YL2100777-001	YL2100822-001	YL2100934-001	YL2101002-001	YL2101091-001	YL2101118-001	YL2101169-001
Date Sampled		2021-06-15 8:45	2021-06-23 14:35	2021-06-29 14:35	2021-07-13 10:15	2021-07-20 8:20	2021-08-03 14:20	2021-08-10 11:45	2021-08-19 17:00	2021-08-24 11:10	2021-08-31 11:25
Parameter	**Units**	**Results**									
pH	pH	7.44	7.58	7.66	7.96	7.82	7.85	7.94	7.69	7.74	7.81
Conductivity	µS/cm						30700				
Total Suspended Solids	mg/L	228	163	336	237	218	167	113	204	208	163
Total Dissolved Solids	mg/L	17800	20300	17400	15700	16800	22900	17500	13800	15300	11700
Chloride (Cl)	mg/L	8980	9610	8560	7740	8830	10900	9170	6240	7410	6420
Bromide (Br)	mg/L						39.3				
Fluoride (F)	mg/L						<2.00				
Cyanide, Total	mg/L	<0.0200	0.0403	<0.200	0.108	0.0478	0.0231	0.0419	0.0738	0.0583	0.0255
Cyanide, WAD	mg/L						<0.0200				
Ammonia, Total (as N)	mg/L	6.92	11.8	10.3	7.93	12.4	10.7	7.15	18.8	8.95	17.1
Nitrate (as N)	mg/L	6.16	11.9	11.1	9.71	11.6	9.7	8.2	23.1	9.38	25.3
Nitrite (as N)	mg/L						0.536				
Sulfate (SO4)	mg/L						1020				
Aluminum (Al)-Total	mg/L	27.4	19.3	31.2	18.6	13.5	13.6	8.65	16.4	16.1	14.5
Antimony (Sb)-Total	mg/L	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200
Arsenic (As)-Total	mg/L	0.00734	0.00751	0.013	0.0241	0.016	0.00716	0.0063	0.00719	0.0105	0.00672
Barium (Ba)-Total	mg/L	0.0536	0.0558	0.0586	0.0536	0.0554	0.0634	0.0741	0.0659	0.0561	0.0953
Beryllium (Be)-Total	mg/L	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200
Bismuth (Bi)-Total	mg/L	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Boron (B)-Total	mg/L	2.25	2.55	2.3	2.16	2.14	2.53	2.31	1.94	1.98	1.89
Cadmium (Cd)-Total	mg/L	0.000104	<0.000100	0.000128	0.000135	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	0.000134
Calcium (Ca)-Total	mg/L	556	608	531	494	578	632	558	416	425	567

Sample ID		TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A
ALS ID		YL2100565-001	YL2100616-001	YL2100664-001	YL2100777-001	YL2100822-001	YL2100934-001	YL2101002-001	YL2101091-001	YL2101118-001	YL2101169-001
Date Sampled		2021-06-15 8:45	2021-06-23 14:35	2021-06-29 14:35	2021-07-13 10:15	2021-07-20 8:20	2021-08-03 14:20	2021-08-10 11:45	2021-08-19 17:00	2021-08-24 11:10	2021-08-31 11:25
Parameter	**Units**	**Results**									
Cesium (Cs)-Total	mg/L	0.000515	0.000809	0.000607	0.000462	0.000507	0.000992	0.000989	0.000484	0.000398	0.00087
Chromium (Cr)-Total	mg/L	<0.0100	<0.0100	0.0159	0.0148	0.0141	0.0109	0.012	<0.0100	<0.0100	0.0146
Cobalt (Co)-Total	mg/L	0.012	0.00913	0.0165	0.0183	0.0134	0.00669	0.00616	0.0088	0.00937	0.0118
Copper (Cu)-Total	mg/L	0.0788	0.0857	0.123	0.185	0.188	0.0641	0.0653	0.0607	0.0884	0.062
Iron (Fe)-Total	mg/L	18.6	14.5	29.4	24.4	20.5	14.2	10.3	14.8	14.6	14.1
Lead (Pb)-Total	mg/L	0.0024	0.00195	0.00455	0.00373	0.00308	0.00233	0.0019	0.00316	0.00306	0.00182
Lithium (Li)-Total	mg/L	0.0915	0.1	0.0856	0.0845	0.0831	0.102	0.0948	0.0642	0.0788	0.0759
Magnesium (Mg)-Total	mg/L	565	615	520	477	570	638	518	370	435	410
Manganese (Mn)-Total	mg/L	1.66	1.55	1.59	1.37	1.59	1.43	1.14	0.747	1.09	0.731
Mercury (Hg)-Total	mg/L	<0.0000250	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.00512	0.00643	0.00786	0.00725	0.0065	0.00897	0.0124	0.0115	0.00768	0.0113
Nickel (Ni)-Total	mg/L	0.0177	0.0132	0.0254	0.0224	0.016	<0.0100	0.011	0.0171	0.0169	0.0288
Phosphorus (P)-Total	mg/L	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Potassium (K)-Total	mg/L	142	148	119	118	140	152	143	108	111	123
Rubidium (Rb)-Total	mg/L	0.0709	0.083	0.0636	0.0607	0.076	0.0918	0.106	0.0589	0.0545	0.088
Selenium (Se)-Total	mg/L	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	0.00126
Silicon (Si)-Total	mg/L	12.6	9.74	17.4	11.6	10.8	12.2	10.8	10.7	9.66	13.8
Silver (Ag)-Total	mg/L	0.000494	0.00044	0.000829	0.000873	0.000896	0.000816	0.000558	0.000483	0.000502	0.000317
Sodium (Na)-Total	mg/L	4800	4990	4160	3840	4770	5400	4410	3240	3670	3770
Strontium (Sr)-Total	mg/L	7.62	8.52	7.2	6.62	8.34	8.98	7.12	4.98	5.49	5.62
Tellurium (Te)-Total	mg/L	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400
Thallium (Tl)-Total	mg/L	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200
Thorium (Th)-Total	mg/L	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200

	Sample ID	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A
	ALS ID	YL2100565-001	YL2100616-001	YL2100664-001	YL2100777-001	YL2100822-001	YL2100934-001	YL2101002-001	YL2101091-001	YL2101118-001	YL2101169-001
	Date Sampled	2021-06-15 8:45	2021-06-23 14:35	2021-06-29 14:35	2021-07-13 10:15	2021-07-20 8:20	2021-08-03 14:20	2021-08-10 11:45	2021-08-19 17:00	2021-08-24 11:10	2021-08-31 11:25
Parameter	**Units**	**Results**									
Tin (Sn)-Total	mg/L	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200
Titanium (Ti)-Total	mg/L	0.222	<0.111	0.213	0.159	0.107	<0.104	<0.0798	0.0827	0.102	0.122
Tungsten (W)-Total	mg/L	0.00643	0.00669	0.0158	0.0116	0.0069	0.00672	0.0117	0.0213	0.0149	0.0141
Uranium (U)-Total	mg/L	0.000374	0.0004	0.000424	0.000396	0.000338	0.000444	0.000376	0.000546	0.000467	0.000492
Vanadium (V)-Total	mg/L	0.0257	0.0195	0.0368	0.0325	0.0253	0.0205	0.0166	0.0203	0.0214	0.0257
Zinc (Zn)-Total	mg/L	<0.0600	<0.0600	0.0762	0.073	0.0821	<0.0600	<0.0600	<0.0600	<0.0600	<0.0600
Zirconium (Zr)-Total	mg/L	<0.00400	<0.00400	<0.00400	0.00769	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	0.00925
Alkalinity, Total (as CaCO3)	mg/L						153				

Table D1-39. Water Sampling Monitoring Program Results for September to December 2021 Taken from TL-12A

	Sample ID	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A
	ALS ID	YL2101279-001	YL2101318-001	YL2101370-001	YL2101433-001	YL2101470-001	YL2101514-001	YL2101557-001	YL2101632-001	YL2101757-001	YL2101780-001	YL2101795-001	YL2101811-001
	Date Sampled	2021-09-09 16:16	2021-09-15 11:00	2021-09-21 15:50	2021-09-28 10:30	2021-10-05 15:20	2021-10-12 10:10	2021-10-19 17:00	2021-10-26 9:15	2021-12-07 9:40	2021-12-14 13:47	2021-12-21 8:50	2021-12-28 7:50
Parameter	**Units**	**Results**											
pH	pH	7.56	7.64	7.28	7.89	7.19	8.01	7.98	7.9	7.88	8.03	7.92	8.08
Conductivity	µS/cm	25600				19800				20900			
Total Suspended Solids	mg/L	175	142	254	284	136	104	63.2	204	132	104	107	270
Total Dissolved Solids	mg/L	17600	21700	9990	14000	15100	17800	13400	13300	11700	11800	11600	12400
Chloride (Cl)	mg/L	8550	8820	4880	6770	7050	6380	6450	7260	7210	6380	6870	6500
Bromide (Br)	mg/L	32.1				24.7				26.2			
Fluoride (F)	mg/L	<2.00				<2.00				<1.00			
Cyanide, Total	mg/L	0.0202	0.0482	0.0488	0.037	0.0224	0.0224	0.0185	0.0275	0.106	0.0319	0.0911	0.0436
Cyanide, WAD	mg/L	<0.0050				<0.0050				0.0061			
Ammonia, Total (as N)	mg/L	13.3	8.73	20.8	12.1	4.42	5.46	4.07	3.41	20	10.1	8.76	6.38
Nitrate (as N)	mg/L	12.6	9.04	22.9	12.5	5.01	5.81	4.97	3.13	22.1	12.6	9.17	7.79
Nitrite (as N)	mg/L	0.636				0.439				1.13			
Sulfate (SO4)	mg/L	803				728				723			
Aluminum (Al)-Total	mg/L	22.8	13.6	20.4	14.7	25.4	13.7	2.74	6.98	3.82	2.03	0.564	8.35
Antimony (Sb)-Total	mg/L	<0.00200	<0.00200	<0.00100	<0.00100	<0.00100	<0.00200	<0.00200	<0.00200	<0.00200	<0.00100	<0.00200	<0.00100
Arsenic (As)-Total	mg/L	0.00731	0.00506	0.00598	0.0104	0.00556	0.00516	0.00484	0.00842	0.00359	0.00301	<0.00200	0.0101
Barium (Ba)-Total	mg/L	0.075	0.0563	0.0576	0.0617	0.0486	0.0426	0.0505	0.0485	0.0788	0.0529	0.0599	0.0505
Beryllium (Be)-Total	mg/L	<0.000400	<0.00200	<0.00100	<0.00100	<0.000200	<0.00200	<0.00200	<0.00200	<0.000400	<0.000200	<0.00200	<0.00100
Bismuth (Bi)-Total	mg/L	<0.00100	<0.00100	<0.000500	<0.000500	<0.000500	<0.00100	<0.00100	<0.00100	<0.00100	<0.000500	<0.00100	<0.000500
Boron (B)-Total	mg/L	2.19	2.15	1.74	2	1.82	1.83	1.82	2.03	2.11	1.91	1.97	1.96
Cadmium (Cd)-Total	mg/L	<0.000100	<0.000100	0.0000902	0.0000544	0.0000559	<0.000100	<0.000100	<0.000100	<0.000100	0.0000789	<0.000100	0.0000731
Calcium (Ca)-Total	mg/L	593	551	402	426	416	409	425	520	499	458	490	445

	Sample ID	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A
	ALS ID	**YL2101279-001**	**YL2101318-001**	**YL2101370-001**	**YL2101433-001**	**YL2101470-001**	**YL2101514-001**	**YL2101557-001**	**YL2101632-001**	**YL2101757-001**	**YL2101780-001**	**YL2101795-001**	**YL2101811-001**
	Date Sampled	**2021-09-09 16:16**	**2021-09-15 11:00**	**2021-09-21 15:50**	**2021-09-28 10:30**	**2021-10-05 15:20**	**2021-10-12 10:10**	**2021-10-19 17:00**	**2021-10-26 9:15**	**2021-12-07 9:40**	**2021-12-14 13:47**	**2021-12-21 8:50**	**2021-12-28 7:50**
Parameter	**Units**	**Results**											
Cesium (Cs)-Total	mg/L	0.000916	0.00087	0.000606	0.0003	0.000652	0.00055	0.000571	0.000576	0.00104	0.000692	0.000695	0.000494
Chromium (Cr)-Total	mg/L	<0.0100	<0.0100	0.00921	0.00692	<0.00500	<0.0100	<0.0100	0.0101	<0.0100	<0.00500	<0.0100	0.0133
Cobalt (Co)-Total	mg/L	0.00688	0.00834	0.0156	0.00808	0.00865	0.00963	0.0093	0.0122	0.00503	0.00702	0.00201	0.0145
Copper (Cu)-Total	mg/L	0.0794	0.0402	0.0469	0.0847	0.0512	0.0551	0.0404	0.0732	0.0239	0.0163	0.0141	0.0827
Iron (Fe)-Total	mg/L	13.4	11.1	16.6	11.5	6.67	6.42	6.62	19.1	12.5	7.25	1.53	24.3
Lead (Pb)-Total	mg/L	0.00277	0.00201	0.0025	0.00379	0.00136	0.00109	0.00131	0.00286	0.00266	0.00134	<0.00100	0.00357
Lithium (Li)-Total	mg/L	0.0929	0.0857	0.0589	0.0707	0.0677	0.0715	0.0686	0.0813	0.0718	0.0661	0.0866	0.077
Magnesium (Mg)-Total	mg/L	487	488	341	374	408	373	412	416	398	380	408	401
Manganese (Mn)-Total	mg/L	1.2	1.12	1.14	0.967	1.01	1.06	0.943	1.24	0.68	0.965	0.705	1.31
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050		<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.00938	0.00663	0.0067	0.00774	0.00468	0.00497	0.00418	0.00432	0.0103	0.00659	0.00736	0.00566
Nickel (Ni)-Total	mg/L	<0.0100	0.012	0.0246	0.0165	0.0151	0.0164	0.0161	0.017	<0.0100	0.015	<0.0100	0.0215
Phosphorus (P)-Total	mg/L	<1.00	<1.00	<0.500	<0.500	<0.500	<1.00	<1.00	<1.00	<1.00	<0.500	<1.00	<0.500
Potassium (K)-Total	mg/L	132	124	106	102	112	102	103	107	110	108	109	112
Rubidium (Rb)-Total	mg/L	0.0957	0.076	0.0589	0.0572	0.057	0.0518	0.0562	0.0606	0.0752	0.062	0.0628	0.0598
Selenium (Se)-Total	mg/L	<0.00100	<0.00100	0.000923	0.000727	0.000577	<0.00100	<0.00100	<0.00100	<0.00100	0.000775	<0.00100	0.000575
Silicon (Si)-Total	mg/L	9.47	9.05	11.2	6.31	6.82	5.67	7.54	11.8	11.8	6.64	5.47	13.8
Silver (Ag)-Total	mg/L	0.000402	0.000258	0.00021	0.000585	0.000248	0.000252	0.000229	0.000304	0.000228	0.000133	<0.000200	0.000454
Sodium (Na)-Total	mg/L	4470	4150	3040	3170	3750	3420	3190	3510	3410	3320	3540	3450
Strontium (Sr)-Total	mg/L	8.03	7.06	4.44	5.4	5.66	5.24	5.3	6.65	6.32	5.59	6.11	5.61
Tellurium (Te)-Total	mg/L	<0.00400	<0.00400	<0.00200	<0.00200	<0.00200	<0.00400	<0.00400	<0.00400	<0.00400	<0.00200	<0.00400	<0.00200
Thallium (Tl)-Total	mg/L	<0.000200	<0.000200	<0.000100	<0.000100	<0.000100	<0.000200	<0.000200	<0.000200	<0.000200	<0.000100	<0.000200	<0.000100
Thorium (Th)-Total	mg/L	<0.00200	<0.00200	<0.00100	<0.00100	<0.00100	<0.00200	<0.00200	<0.00200	<0.00200	<0.00100	<0.00200	<0.00100

Sample ID		TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A	TL-12A
ALS ID		YL2101279-001	YL2101318-001	YL2101370-001	YL2101433-001	YL2101470-001	YL2101514-001	YL2101557-001	YL2101632-001	YL2101757-001	YL2101780-001	YL2101795-001	YL2101811-001
Date Sampled		2021-09-09 16:16	2021-09-15 11:00	2021-09-21 15:50	2021-09-28 10:30	2021-10-05 15:20	2021-10-12 10:10	2021-10-19 17:00	2021-10-26 9:15	2021-12-07 9:40	2021-12-14 13:47	2021-12-21 8:50	2021-12-28 7:50
Parameter	**Units**	**Results**											
Tin (Sn)-Total	mg/L	<0.00200	<0.00200	<0.00100	<0.00100	<0.00100	<0.00200	<0.00200	<0.00200	<0.00200	<0.00100	<0.00200	<0.00100
Titanium (Ti)-Total	mg/L	0.103	0.0896	0.114	0.0354	0.0431	<0.0396	0.0984	0.161	<0.0660	0.0251	0.00916	0.202
Tungsten (W)-Total	mg/L	0.0134	0.00931	0.0111	0.00879	0.00405	0.0055	0.00485	0.0037	0.0191	0.00807	0.0121	0.00417
Uranium (U)-Total	mg/L	0.000565	0.000414	0.000504	0.000478	0.0005	0.000369	0.000369	0.000281	0.000452	0.000294	0.000361	0.000326
Vanadium (V)-Total	mg/L	0.0179	0.0146	0.0258	0.00958	0.00959	<0.0100	0.0113	0.0289	0.0135	0.0071	<0.0100	0.0317
Zinc (Zn)-Total	mg/L	<0.0600	<0.0600	0.0431	0.0488	0.0355	<0.0600	<0.0600	0.0625	<0.0600	0.0381	<0.0600	0.0573
Zirconium (Zr)-Total	mg/L	<0.00400	<0.00400	<0.00200	<0.00200	<0.00200	<0.00400	<0.00400	<0.00400	<0.00400	<0.00200	<0.00400	<0.00200
Alkalinity, Total (as CaCO3)	mg/L	123				134				153			

Table D1-41. Water Sampling Monitoring Program Results for March to June 2021 Taken from TL-12B

	Sample ID	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B
	ALS ID	YL2100180-003	YL2100246-001	YL2100251-001	YL2100273-001	YL2100291-004	YL2100291-007	YL2100349-004	YL2100400-001	YL2100433-001	YL2100431-001	YL2100460-001	YL2100523-001
	Date Sampled	3/17/2021 11:30	4/5/2021 14:49	4/7/2021 16:05	4/15/2021 5:05	4/17/2021 14:50	4/19/2021 12:50	5/3/2021 15:30	5/20/2021 5:00	5/22/2021 16:25	5/26/2021 15:50	6/1/2021 13:40	6/8/2021 10:06
Parameter	**Units**	**Results**											
pH	pH	8.08		7.63	7.74	7.29	7.62		7.72	7.71	7.8	7.97	7.59
Conductivity	µS/cm			22500									22000
Total Suspended Solids	mg/L	43.5		9.5	12	8.2	2.1	22.8	<2.0	<2.0	<2.0	<2.0	<2.0
Total Dissolved Solids	mg/L	13300		15100	13300	10300	11600		12900	17500	15200	17800	15000
Chloride (Cl)	mg/L	6890		8040	7520	7290	7520		7000	9800	7670	9710	7660
Bromide (Br)	mg/L			28.5									26.5
Fluoride (F)	mg/L			<2.00									<2.00
Cyanide, Total	mg/L	0.0764	0.0218	0.026	<0.0050	0.0746	0.0278	0.0207	0.0097	0.0197	0.0136	0.123	0.0253
Cyanide, WAD	mg/L			0.0075									<0.0050
Ammonia, Total (as N)	mg/L	12.9	6.25	6.43	5.51	7.54	5.84	10	6.32	6.89	7.46	13.1	8.43
Nitrate (as N)	mg/L	13.6		7.51	5.3	7.93	4.96		6.24	7.02	7.15	12.6	7.63
Nitrite (as N)	mg/L			1.86									0.682
Sulfate (SO4)	mg/L			852									818
Aluminum (Al)-Total	mg/L	0.965	2.08		1.29	0.856	0.31	2.12	0.0579	0.0507	0.111	0.0701	0.0797
Antimony (Sb)-Total	mg/L	<0.00100	<0.00200		<0.00100	<0.00200	<0.00200	<0.00100	<0.00100	<0.00100	<0.00100	<0.00200	<0.00200
Arsenic (As)-Total	mg/L	0.00545	0.0027		0.00182	<0.00200	<0.00200	0.0025	0.00102	<0.00100	0.00103	<0.00200	<0.00200
Barium (Ba)-Total	mg/L	0.0539	0.0512		0.0621	0.103	0.0588	0.0539	0.0498	0.0578	0.0534	0.0603	0.0582
Beryllium (Be)-Total	mg/L	<0.00100	<0.00200		<0.00100	<0.00200	<0.00200	<0.00100	<0.00100	<0.00100	<0.00100	<0.00200	<0.000400
Bismuth (Bi)-Total	mg/L	<0.000500	<0.00100		<0.000500	<0.00100	<0.00100	<0.000500	<0.000500	<0.000500	<0.000500	<0.00100	<0.00100
Boron (B)-Total	mg/L	2	1.93		1.9	1.53	1.92	2.17	1.67	2.47	2.34	2.46	2.22
Cadmium (Cd)-Total	mg/L	0.000105	<0.000100		0.0000882	<0.000100	<0.000100	0.0000504	0.000103	<0.0000500	0.0000568	<0.000100	<0.000100
Calcium (Ca)-Total	mg/L	434	435		461	519	469	512	399	553	484	656	515

Sample ID		TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B
ALS ID		YL2100180-003	YL2100246-001	YL2100251-001	YL2100273-001	YL2100291-004	YL2100291-007	YL2100349-004	YL2100400-001	YL2100433-001	YL2100431-001	YL2100460-001	YL2100523-001
Date Sampled		3/17/2021 11:30	4/5/2021 14:49	4/7/2021 16:05	4/15/2021 5:05	4/17/2021 14:50	4/19/2021 12:50	5/3/2021 15:30	5/20/2021 5:00	5/22/2021 16:25	5/26/2021 15:50	6/1/2021 13:40	6/8/2021 10:06
Parameter	**Units**	**Results**											
Cesium (Cs)-Total	mg/L	0.000239	<0.000200		0.000118	0.000494	<0.000200	0.000235	0.000105	0.000289	<0.000100	0.000564	0.00024
Chromium (Cr)-Total	mg/L	0.00236	<0.00200	<0.0100	<0.00100	0.012	<0.0100	<0.00500	<0.00500	<0.00500	<0.00500	<0.0100	<0.0100
Cobalt (Co)-Total	mg/L	0.0111	0.00476		0.00495	0.00214	0.00481	0.0049	0.00736	0.00162	0.00486	<0.00200	0.00383
Copper (Cu)-Total	mg/L	0.101	0.0532		0.0263	0.0141	0.0138	0.0396	0.00929	0.00951	0.0258	<0.0100	<0.0100
Iron (Fe)-Total	mg/L	3.42	0.78		0.889	<0.200	<0.200	1.96	<0.100	<0.100	<0.100	<0.200	<0.200
Lead (Pb)-Total	mg/L	0.000898	<0.00100		<0.000500	<0.00100	<0.00100	<0.000500	<0.000500	<0.000500	<0.000500	<0.00100	<0.00100
Lithium (Li)-Total	mg/L	0.0748	0.0764		0.0746	0.0779	0.0692	0.0856	0.0608	0.0858	0.0769	0.0956	0.0784
Magnesium (Mg)-Total	mg/L	420	439		414	403	441	456	399	533	474	569	498
Manganese (Mn)-Total	mg/L	0.973	0.897		1.03	0.262	0.759	1.15	0.89	1.14	1.06	1.16	0.879
Mercury (Hg)-Total	mg/L	<0.0000250	<0.0000050	<0.0000050	<0.0000250	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.00574	0.00725		0.0082	0.0142	0.00749	0.00625	0.00588	0.00655	0.00715	0.00798	0.00615
Nickel (Ni)-Total	mg/L	0.0208	0.0112		0.0111	<0.0100	<0.0100	0.0113	0.0156	0.0053	0.0109	<0.0100	0.0102
Phosphorus (P)-Total	mg/L	<0.500	<1.00		<0.500	<1.00	<1.00	<0.500	<0.500	<0.500	<0.500	<1.00	<1.00
Potassium (K)-Total	mg/L	112	116		120	140	122	114	114	138	121	138	123
Rubidium (Rb)-Total	mg/L	0.0522	0.0483		0.0442	0.107	0.0537	0.0537	0.0348	0.0654	0.0362	0.0767	0.0606
Selenium (Se)-Total	mg/L	0.000607	<0.00100		<0.000500	<0.00100	<0.00100	0.000623	0.000987	<0.000500	0.000716	<0.00100	<0.00100
Silicon (Si)-Total	mg/L	5.63	4.26		3.6	7.69	5.72	4.54	3.84	3.66	3.53	3.68	4.72
Silver (Ag)-Total	mg/L	0.000567	0.000491		0.000278	<0.000200	0.000249	0.000394	0.000102	<0.000100	0.00033	<0.000200	<0.000200
Sodium (Na)-Total	mg/L	3500	3880		3910	3700	3760	4270	3350	4430	4060	4820	4180
Strontium (Sr)-Total	mg/L	6.08	5.99		5.26	6.09	6.08	6.88	5.19	7.82	6.35	8.77	6.63
Tellurium (Te)-Total	mg/L	<0.00200	<0.00400		<0.00200	<0.00400	<0.00400	<0.00200	<0.00200	<0.00200	<0.00200	<0.00400	<0.00400
Thallium (Tl)-Total	mg/L	<0.000100	<0.000200		<0.000100	<0.000200	<0.000200	<0.000100	<0.000100	<0.000100	<0.000100	<0.000200	<0.000200
Thorium (Th)-Total	mg/L	<0.00100	<0.00200		<0.00100	<0.00200	<0.00200	<0.00100	<0.00100	<0.00100	<0.00100	<0.00200	<0.00200

Sample ID		TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B
ALS ID		YL2100180-003	YL2100246-001	YL2100251-001	YL2100273-001	YL2100291-004	YL2100291-007	YL2100349-004	YL2100400-001	YL2100433-001	YL2100431-001	YL2100460-001	YL2100523-001
Date Sampled		3/17/2021 11:30	4/5/2021 14:49	4/7/2021 16:05	4/15/2021 5:05	4/17/2021 14:50	4/19/2021 12:50	5/3/2021 15:30	5/20/2021 5:00	5/22/2021 16:25	5/26/2021 15:50	6/1/2021 13:40	6/8/2021 10:06
Parameter	**Units**	**Results**											
Tin (Sn)-Total	mg/L	<0.00100	<0.00200		<0.00100	<0.00200	<0.00200	<0.00100	<0.00100	<0.00100	<0.00100	<0.00200	<0.00200
Titanium (Ti)-Total	mg/L	0.0156	<0.00600		<0.00750	<0.00600	<0.00600	0.0111	<0.00300	<0.00300	<0.00300	<0.00600	<0.00600
Tungsten (W)-Total	mg/L	0.0109	0.0112		0.0104	0.00527	0.00535	0.0129	0.00552	0.00429	0.00452	0.0143	0.00689
Uranium (U)-Total	mg/L	0.000378	<0.000200		<0.000100	<0.000200	<0.000200	0.000272	0.000113	0.000103	<0.000100	<0.000200	<0.000200
Vanadium (V)-Total	mg/L	<0.00500	<0.0100		<0.00500	<0.0100	<0.0100	<0.00500	<0.00500	<0.00500	<0.00500	<0.0100	<0.0100
Zinc (Zn)-Total	mg/L	0.0336	<0.0600		<0.0300	<0.0600	<0.0600	<0.0300	<0.0300	<0.0300	<0.0300	<0.0600	<0.0600
Zirconium (Zr)-Total	mg/L	<0.00200	<0.00400		<0.00200	<0.00400	<0.00400	<0.00200	<0.00200	<0.00200	<0.00200	<0.00400	<0.00400
Alkalinity, Total (as CaCO3)	mg/L			134									133

Table D1-42. Water Sampling Monitoring Program Results for June to September 2021 Taken from TL-12B

Sample ID		TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B
ALS ID		YL2100566-001	YL2100614-001	YL2100670-001	YL2100778-001	YL2100821-001	YL2100936-001	YL2101007-001	YL2101093-001	YL2101119-001	YL2101170-001	YL2101280-001	YL2101317-001
Date Sampled		6/15/2021 8:30	6/23/2021 14:25	6/29/2021 14:25	7/13/2021 10:00	7/20/2021 8:05	8/3/2021 14:40	8/10/2021 11:35	8/19/2021 17:15	8/24/2021 11:00	8/31/2021 10:15	9/9/2021 16:03	9/15/2021 10:47
Parameter	**Units**	**Results**											
pH	pH	7.44	7.58	7.77	7.97	7.88	7.88	7.95	7.62	7.77	7.81	7.56	7.73
Conductivity	µS/cm			23700			30500					26100	
Total Suspended Solids	mg/L	<2.0	<2.0	<2.0	<2.0	4	<2.0	3.4	<2.0	2.7	9.4	7.5	12.8
Total Dissolved Solids	mg/L	17500	19800	14100	14000	18300	23200	17200	12700	16500	11600	17600	16900
Chloride (Cl)	mg/L	8520	9570	11800	8240	8690	11400	9490	6150	7280	6540	8970	6780
Bromide (Br)	mg/L						41.5					31.5	
Fluoride (F)	mg/L						<2.00					<2.00	
Cyanide, Total	mg/L	<0.0200	0.0184	0.0474	0.032	0.0235	0.0317	0.0443	0.0919	0.0401	0.0642	0.0258	0.0576
Cyanide, WAD	mg/L						<0.0200					<0.0050	
Ammonia, Total (as N)	mg/L	7.04	11.5	10.8	8.5	12.3	10.6	7.28	17.6	9.24	14.9	13.3	8.63
Nitrate (as N)	mg/L	5.86	11.4	15.6	10.3	11.4	10	8	22.1	9.39	20.6	13.5	7.25
Nitrite (as N)	mg/L						0.582					0.668	
Sulfate (SO4)	mg/L						1070					845	
Aluminum (Al)-Total	mg/L	0.0902	0.0636	<0.0600	0.119	0.106	0.0691	0.123	0.122	0.203	1.02	1.12	1.12
Antimony (Sb)-Total	mg/L	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200
Arsenic (As)-Total	mg/L	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200
Barium (Ba)-Total	mg/L	0.0481	0.051	0.048	0.0483	0.0518	0.0616	0.0707	0.0616	0.0517	0.0906	0.0726	0.0546
Beryllium (Be)-Total	mg/L	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.000400	<0.00200	<0.00200	<0.00200	<0.00200	<0.000400	<0.00200
Bismuth (Bi)-Total	mg/L	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Boron (B)-Total	mg/L	2.33	2.49	2.34	2.14	2.08	2.65	2.34	1.99	2.06	1.84	2.48	2.03
Cadmium (Cd)-Total	mg/L	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100
Calcium (Ca)-Total	mg/L	585	628	523	488	549	650	562	440	435	514	596	537

	Sample ID	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B
	ALS ID	YL2100566-001	YL2100614-001	YL2100670-001	YL2100778-001	YL2100821-001	YL2100936-001	YL2101007-001	YL2101093-001	YL2101119-001	YL2101170-001	YL2101280-001	YL2101317-001
	Date Sampled	6/15/2021 8:30	6/23/2021 14:25	6/29/2021 14:25	7/13/2021 10:00	7/20/2021 8:05	8/3/2021 14:40	8/10/2021 11:35	8/19/2021 17:15	8/24/2021 11:00	8/31/2021 10:15	9/9/2021 16:03	9/15/2021 10:47
Parameter	**Units**	**Results**											
Cesium (Cs)-Total	mg/L	0.000522	0.000671	0.000417	0.000406	0.000506	0.000844	0.000894	0.00037	0.00035	0.000712	0.000836	0.000759
Chromium (Cr)-Total	mg/L	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Cobalt (Co)-Total	mg/L	0.00421	0.00284	0.00458	0.00368	0.00323	<0.00200	<0.00200	0.00376	0.00274	0.00431	<0.00200	0.00406
Copper (Cu)-Total	mg/L	<0.0100	<0.0100	<0.0100	<0.0100	0.01	<0.0100	<0.0100	<0.0100	0.0101	<0.0100	0.014	<0.0100
Iron (Fe)-Total	mg/L	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	0.379	0.365	0.701
Lead (Pb)-Total	mg/L	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Lithium (Li)-Total	mg/L	0.0935	0.0973	0.0806	0.0791	0.0777	0.102	0.0931	0.0645	0.0778	0.0722	0.091	0.0802
Magnesium (Mg)-Total	mg/L	602	608	528	473	547	650	543	386	444	435	581	479
Manganese (Mn)-Total	mg/L	1.44	1.34	1.18	1.01	1.29	1.21	1.01	0.601	0.867	0.422	1.1	0.959
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.00485	0.0066	0.00683	0.00732	0.00599	0.00846	0.0127	0.0107	0.00743	0.0106	0.00878	0.00584
Nickel (Ni)-Total	mg/L	0.0108	<0.0100	0.0144	<0.0100	<0.0100	<0.0100	<0.0100	0.0152	<0.0100	0.0168	<0.0100	<0.0100
Phosphorus (P)-Total	mg/L	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Potassium (K)-Total	mg/L	151	151	120	119	134	154	145	119	116	128	141	123
Rubidium (Rb)-Total	mg/L	0.074	0.0827	0.0656	0.0616	0.0742	0.0926	0.11	0.0606	0.0544	0.086	0.102	0.076
Selenium (Se)-Total	mg/L	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	0.00117	<0.00100	0.0015	<0.00100	<0.00100
Silicon (Si)-Total	mg/L	3.46	4.07	3.56	3.31	3.57	5.16	4.68	4.66	3.85	6.37	4.15	4.44
Silver (Ag)-Total	mg/L	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200
Sodium (Na)-Total	mg/L	5120	4980	4220	3920	4800	5520	4730	3570	3800	3980	5110	4060
Strontium (Sr)-Total	mg/L	7.69	8.62	7.34	6.65	8.32	8.7	7.46	5.1	5.67	5.52	8.15	6.94
Tellurium (Te)-Total	mg/L	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400
Thallium (Tl)-Total	mg/L	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200
Thorium (Th)-Total	mg/L	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200

Sample ID		TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B
ALS ID		YL2100566-001	YL2100614-001	YL2100670-001	YL2100778-001	YL2100821-001	YL2100936-001	YL2101007-001	YL2101093-001	YL2101119-001	YL2101170-001	YL2101280-001	YL2101317-001
Date Sampled		6/15/2021 8:30	6/23/2021 14:25	6/29/2021 14:25	7/13/2021 10:00	7/20/2021 8:05	8/3/2021 14:40	8/10/2021 11:35	8/19/2021 17:15	8/24/2021 11:00	8/31/2021 10:15	9/9/2021 16:03	9/15/2021 10:47
Parameter	**Units**	**Results**											
Tin (Sn)-Total	mg/L	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200
Titanium (Ti)-Total	mg/L	<0.00600	<0.00600	<0.00600	<0.00600	<0.00600	<0.00600	<0.00600	<0.00600	<0.00600	<0.00600	<0.00600	<0.00600
Tungsten (W)-Total	mg/L	0.00414	0.00562	0.0135	0.0104	0.00653	0.00572	0.0111	0.0172	0.0144	0.0135	0.00977	0.00951
Uranium (U)-Total	mg/L	<0.000200	<0.000200	<0.000200	<0.000200	0.000202	0.000269	0.0003	<0.000200	0.000224	0.000285	<0.000200	0.000263
Vanadium (V)-Total	mg/L	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Zinc (Zn)-Total	mg/L	<0.0600	<0.0600	<0.0600	<0.0600	<0.0600	<0.0600	<0.0600	<0.0600	<0.0600	<0.0600	<0.0600	<0.0600
Zirconium (Zr)-Total	mg/L	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400
Alkalinity, Total (as CaCO3)	mg/L						141					114	

Table D1-43. Water Sampling Monitoring Program Results for June to September 2021 Taken from TL-12B

Sample ID		TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B
ALS ID		YL2101317-002	YL2101371-001	YL2101434-001	YL2101471-001	YL2101522-001	YL2101558-001	YL2101633-001	YL2101647-001	YL2101715-001	YL2101730-001
Date Sampled		9/15/2021 10:47	9/21/2021 15:37	9/28/2021 10:25	10/5/2021 15:05	10/12/2021 9:50	10/19/2021 16:35	10/26/2021 8:55	11/2/2021 8:30	11/23/2021 9:31	11/28/2021 16:50
Parameter	**Units**	**Results**									
pH	pH	7.74	7.31	7.89	7.32	8.02	7.13	7.22	7.84	7.47	7.46
Conductivity	µS/cm				19800				19800		
Total Suspended Solids	mg/L	14	11.7	8.8	6	13.8	11.6	4.5	4.4	12.3	4.7
Total Dissolved Solids	mg/L	17800	11500	13700	14800	19100	13600	12600	12900	14500	8840
Chloride (Cl)	mg/L	7790	5330	6820	7040	6400	6540	7590	6350	8740	6880
Bromide (Br)	mg/L				24.9				21.6		
Fluoride (F)	mg/L				<2.00				<2.00		

Sample ID		TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B
ALS ID		YL2101317-002	YL2101371-001	YL2101434-001	YL2101471-001	YL2101522-001	YL2101558-001	YL2101633-001	YL2101647-001	YL2101715-001	YL2101730-001
Date Sampled		9/15/2021 10:47	9/21/2021 15:37	9/28/2021 10:25	10/5/2021 15:05	10/12/2021 9:50	10/19/2021 16:35	10/26/2021 8:55	11/2/2021 8:30	11/23/2021 9:31	11/28/2021 16:50
Parameter	**Units**	**Results**									
Cyanide, Total	mg/L	0.0501	0.0874	0.0415	0.0126	0.0151	0.0094	0.0151	0.0115	0.0337	0.0205
Cyanide, WAD	mg/L				<0.0050				<0.0050		
Ammonia, Total (as N)	mg/L	8.63	20.7	12.3	4.39	5.27	4.22	3.64	3.36	12.2	7.74
Nitrate (as N)	mg/L	8.03	26	12.8	4.94	5.81	4.83	3.56	4.82	14.4	8.77
Nitrite (as N)	mg/L				0.424				0.297		
Sulfate (SO4)	mg/L				723				731		
Aluminum (Al)-Total	mg/L	1.09	0.932	0.844	1.52	1.1	1.33	0.784	1.13	0.874	1.05
Antimony (Sb)-Total	mg/L	<0.00200	<0.00100	<0.00100	<0.00100	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200
Arsenic (As)-Total	mg/L	<0.00200	<0.00100	<0.00100	<0.00100	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200
Barium (Ba)-Total	mg/L	0.0538	0.0534	0.0581	0.0456	0.04	0.0447	0.0445	0.0433	0.0587	0.0446
Beryllium (Be)-Total	mg/L	<0.00200	<0.00100	<0.00100	<0.000200	<0.00200	<0.00200	<0.00200	<0.000400	<0.00200	<0.00200
Bismuth (Bi)-Total	mg/L	<0.00100	<0.000500	<0.000500	<0.000500	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Boron (B)-Total	mg/L	2.12	1.68	2.11	2.01	1.78	1.85	2.02	1.71	1.91	2.01
Cadmium (Cd)-Total	mg/L	<0.000100	0.0000801	<0.0000500	<0.0000500	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100
Calcium (Ca)-Total	mg/L	533	395	426	441	401	414	517	404	575	458
Cesium (Cs)-Total	mg/L	0.000808	0.000537	0.000326	0.000579	0.000446	0.000557	0.000501	0.000345	0.00073	0.000514
Chromium (Cr)-Total	mg/L	<0.0100	<0.00500	<0.00500	<0.00500	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Cobalt (Co)-Total	mg/L	0.00442	0.00812	0.00298	0.00529	0.00699	0.00563	0.00465	0.0086	0.00243	0.00521
Copper (Cu)-Total	mg/L	<0.0100	0.0076	0.0108	0.00633	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Iron (Fe)-Total	mg/L	0.613	0.322	0.237	0.152	<0.200	<0.200	<0.200	0.307	<0.200	<0.200
Lead (Pb)-Total	mg/L	<0.00100	<0.000500	<0.000500	<0.000500	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Lithium (Li)-Total	mg/L	0.0813	0.0548	0.0705	0.0707	0.0681	0.0685	0.0777	0.0622	0.0798	0.0701
Magnesium (Mg)-Total	mg/L	477	338	381	414	386	414	416	399	449	417

Sample ID		TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B	TL-12B
ALS ID		YL2101317-002	YL2101371-001	YL2101434-001	YL2101471-001	YL2101522-001	YL2101558-001	YL2101633-001	YL2101647-001	YL2101715-001	YL2101730-001
Date Sampled		9/15/2021 10:47	9/21/2021 15:37	9/28/2021 10:25	10/5/2021 15:05	10/12/2021 9:50	10/19/2021 16:35	10/26/2021 8:55	11/2/2021 8:30	11/23/2021 9:31	11/28/2021 16:50
Parameter	**Units**	**Results**									
Manganese (Mn)-Total	mg/L	0.934	0.813	0.71	0.916	0.959	0.84	0.981	0.994	0.887	0.917
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.0062	0.00626	0.00774	0.00425	0.0044	0.00356	0.00377	0.00428	0.00601	0.00472
Nickel (Ni)-Total	mg/L	<0.0100	0.0172	0.0116	0.0113	0.0147	0.0116	<0.0100	0.0181	<0.0100	0.0131
Phosphorus (P)-Total	mg/L	<1.00	<0.500	<0.500	<0.500	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Potassium (K)-Total	mg/L	120	105	106	113	105	104	109	105	114	103
Rubidium (Rb)-Total	mg/L	0.0751	0.06	0.0596	0.0575	0.0485	0.0532	0.0602	0.0523	0.0663	0.0554
Selenium (Se)-Total	mg/L	<0.00100	0.00124	<0.000500	<0.000500	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Silicon (Si)-Total	mg/L	4.3	4.02	3.49	3.61	3.26	3.36	3.22	3.74	3.82	3.25
Silver (Ag)-Total	mg/L	<0.000200	<0.000100	<0.000100	<0.000100	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200
Sodium (Na)-Total	mg/L	4030	3060	3240	3670	3440	3280	3660	3460	3760	3470
Strontium (Sr)-Total	mg/L	6.87	4.55	5.5	5.57	5.18	5.48	6.53	5.07	7.31	6.05
Tellurium (Te)-Total	mg/L	<0.00400	<0.00200	<0.00200	<0.00200	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400
Thallium (Tl)-Total	mg/L	<0.000200	<0.000100	<0.000100	<0.000100	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200
Thorium (Th)-Total	mg/L	<0.00200	<0.00100	<0.00100	<0.00100	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200
Tin (Sn)-Total	mg/L	<0.00200	<0.00100	<0.00100	<0.00100	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200
Titanium (Ti)-Total	mg/L	<0.00600	<0.00300	<0.00300	<0.00300	<0.00600	<0.00600	<0.00600	<0.00600	<0.00600	<0.00600
Tungsten (W)-Total	mg/L	0.0093	0.0105	0.00784	0.00285	0.00478	0.00245	0.00233	0.00266	0.0128	0.0045
Uranium (U)-Total	mg/L	0.000268	0.000176	0.00017	0.000111	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200
Vanadium (V)-Total	mg/L	<0.0100	<0.00500	<0.00500	<0.00500	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Zinc (Zn)-Total	mg/L	<0.0600	<0.0300	<0.0300	<0.0300	<0.0600	<0.0600	<0.0600	<0.0600	<0.0600	<0.0600
Zirconium (Zr)-Total	mg/L	<0.00400	<0.00200	<0.00200	<0.00200	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400
Alkalinity, Total (as CaCO3)	mg/L				122				117		

MMS-1 Madrid North Contact Water Pond

The Madrid North Contact Water Pond (MMS-1) was constructed in 2019 to support the commencement of mining activities at the Madid North site. The pond incorporates a rockfill berm with a geomembrane liner anchored to bedrock to capture contact water runoff from the Madrid North Waste Rock storage pad. Contact water is then either discharged to tundra from the Contact Water Pond if water quality meets the criteria outlined in Part F Item 18(a) of the licence or is transferred to the TIA via water truck.

Water quality samples were collected from this facility from June through September 2021 and results met the criteria outlined in Part F Item 18(a) of the licence. Notification of discharge from this facility was provided to the Inspector on May 10, 2021. Results of this sampling is provided in Table D1-44. In 2021, a total of 74 m^3 of water was discharged to tundra (location 13W 433443 7549897) from this facility. An additional 256 m^3 of water was transferred to the TIA via water truck from this facility in 2021 and a further 684 m^3 were transferred to Naartok E pit by water truck.

A spill was reported at this facility in June 2021, due a failure in the remedial works conducted in 2020 to fully seal the bedrock cracks/fissures in the foundations. The estimated amount of mine contact water released is 350m^3. To remediate this issue, a water management structure is due to be installed on the downstream toe prior to freshet 2022 to capture any seepage and return it to the pond.

MMS-6 Brine Mixing Facility

Brine mixing was conducted from January to February 2021 to support underground mining at Madrid North. Brine was mixed in a tank on surface located adjacent to the portal entrance for use underground.

No samples were collected in 2021 from the brine mixing tank (MMS-6) located at the Madrid North Portal entrance as it was demobilized before sampling could occur.

MMS-9 Site Runoff from Sediment Controls

Monitoring at Madrid Site runoff from sediment controls (MMS-9) was not conducted in 2021 as no new infrastructure was constructed in the Madrid area.

No earthworks were conducted in the Madrid area in 2021 and no samples were collected.

Table D1-44. Water Quality Monitoring Program Results for MMS-1, June to September 2021

Sample ID		MMS-1/MAE-04S	MMS-1/MAE-04S	MMS-1/MAE-04S	MMS-1/MAE-04N	MMS-1/MAE-04S	MMS-1/MAE-04S	MMS-1/MAE-04N	Part F Item 18(a)	
ALS ID		YL2100560-001	YL2100748-005	YL2100748-005	YL2100966-001	YL2100966-005	YL2101234-004	YL2101234-001	Maximum Monthly Mean Concentration (mg/L)	Maximum Concentration of Any Grab Sample (mg/L)
Date Sampled		2021-06-14 11:45	2021-07-07 13:45	2021-07-07 13:45	2021-08-04 14:50	2021-08-04 14:50	2021-09-06 16:05	2021-09-06 16:20		
Parameter	**Units**	**Results**								
pH	pH Units	7.53	7.79	7.79	8.05	7.8	8.21	7.96	6.0-9.5	6.0-9.5
Total Suspended Solids	mg/L	13.6	7	7	7.5	<3.0	19.4	39.2	50	100
Chloride (Cl)	mg/L	324	1510	1510	959	1160	1040	399		
Cyanide, Total	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050		
Ammonia, Total (as N)	mg/L	0.766	0.743	0.743	0.362	0.368	0.403	0.227		
Nitrate (as N)	mg/L	1.76	5.81	5.81	1.72	3.85	1.33	1.12		
Nitrite (as N)	mg/L	0.0277	0.0872	0.0872	0.0365	0.0424	0.038	0.0195		
Sulfate (SO4)	mg/L	41.7	177	177	381	227	420	148		
Aluminum (Al)-Total	mg/L	0.655	0.0682	0.0682	0.357	0.0153	0.455	1.27		
Antimony (Sb)-Total	mg/L	0.00127	0.00029	0.00029	0.00097	0.00028	0.00093	0.00025		
Arsenic (As)-Total	mg/L	0.222	0.0447	0.0447	0.0348	0.0466	0.054	0.0268	0.5	1
Barium (Ba)-Total	mg/L	0.0198	0.109	0.109	0.0638	0.0806	0.0615	0.0262		
Beryllium (Be)-Total	mg/L	<0.000100	<0.000200	<0.000200	<0.000200	<0.000200	<0.000200	<0.000100		
Boron (B)-Total	mg/L	0.08	0.102	0.102	0.166	0.155	0.225	0.072		
Cadmium (Cd)-Total	mg/L	0.000029	0.000377	0.000377	0.0000596	0.000575	0.0000382	0.000106		
Calcium (Ca)-Total	mg/L	141	535	535	212	415	213	99.3		
Chromium (Cr)-Total	mg/L	0.00197	<0.00100	<0.00100	0.00199	<0.00100	0.0026	0.00477		
Cobalt (Co)-Total	mg/L	0.00147	0.00606	0.00606	0.00437	0.01	0.0045	0.00459		
Copper (Cu)-Total	mg/L	0.00304	0.00536	0.00536	0.0109	0.0084	0.00804	0.00668		
Iron (Fe)-Total	mg/L	1.04	0.222	0.222	0.527	0.023	0.786	2.22		
Lead (Pb)-Total	mg/L	0.000143	<0.000100	<0.000100	0.000187	<0.000100	0.000244	0.000385		

Sample ID		MMS-1/MAE-04S	MMS-1/MAE-04S	MMS-1/MAE-04S	MMS-1/MAE-04N	MMS-1/MAE-04S	MMS-1/MAE-04S	MMS-1/MAE-04N	Part F Item 18(a)	
ALS ID		YL2100560-001	YL2100748-005	YL2100748-005	YL2100966-001	YL2100966-005	YL2101234-004	YL2101234-001	Maximum Monthly Mean Concentration (mg/L)	Maximum Concentration of Any Grab Sample (mg/L)
Date Sampled		2021-06-14 11:45	2021-07-07 13:45	2021-07-07 13:45	2021-08-04 14:50	2021-08-04 14:50	2021-09-06 16:05	2021-09-06 16:20		
Parameter	**Units**	**Results**								
Lithium (Li)-Total	mg/L	0.0058	0.0088	0.0088	0.0122	0.0092	0.0106	0.0046		
Magnesium (Mg)-Total	mg/L	13.6	75.7	75.7	78.1	65	88.9	22.4		
Manganese (Mn)-Total	mg/L	0.0546	0.492	0.492	0.926	0.247	0.933	0.214		
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050		
Molybdenum (Mo)-Total	mg/L	0.00213	0.000783	0.000783	0.00514	0.00075	0.00528	0.00122		
Nickel (Ni)-Total	mg/L	0.0165	0.0129	0.0129	0.0154	0.0158	0.0287	0.0126	0.5	1
Potassium (K)-Total	mg/L	7.34	15.7	15.7	21.8	18	28.4	7.28		
Selenium (Se)-Total	mg/L	0.00126	0.00338	0.00338	0.00166	0.00264	0.00134	0.000742		
Silver (Ag)-Total	mg/L	<0.000010	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	0.000013		
Sodium (Na)-Total	mg/L	60.2	255	255	441	286	514	127		
Thallium (Tl)-Total	mg/L	<0.000010	<0.000020	<0.000020	<0.000020	0.000051	<0.000020	0.000015		
Tin (Sn)-Total	mg/L	<0.00010	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00010		
Titanium (Ti)-Total	mg/L	0.0227	0.00459	0.00459	0.0113	<0.00060	0.0134	0.0328		
Uranium (U)-Total	mg/L	0.000513	0.00139	0.00139	0.00507	0.000893	0.00413	0.000817		
Vanadium (V)-Total	mg/L	0.00321	0.00113	0.00113	0.00228	<0.00100	0.00267	0.00583		
Zinc (Zn)-Total	mg/L	0.0057	0.0157	0.0157	<0.0060	0.0295	<0.0060	0.0076		
Alkalinity, Total (as CaCO3)	mg/L	30.2	88.2	88.2	219	126	244	93.1		
Oil and Grease	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5	10
Oil And Grease (Visible Sheen)		Absent	Absent	Absent	Absent	Absent	Absent	Absent	No Visible Sheen	No Visible Sheen

Notes:

No exceedance of Part F Item 18(a) Maximum Concentration occurred in 2021.

N denotes north section of pond. S denotes south section of pond

Appendix D.2. 2BE-HOP1222

Appendix D.2. 2BE-HOP1222

Table D2-1 summarizes the sampling stations, sampling frequency and monitoring parameters required as part of the SNP for water licence 2BE-HOP1222. The location of each sampling point is illustrated in Figure D2-1 below.

Table D2-1. 2BE-HOP1222 Sample Stations, Sample Frequency and Analytical Parameters

SNP Station	Description	Monitoring Parameters	Frequency
HOP-1	Raw water supply intake at Windy Lake	D	Daily during periods of pumping
HOP-2*	WWTF effluent discharge at the surge tank prior to being pumped over the ridge east of the Windy Camp Facilities	G, B, Oil and Grease	Monthly
HOP-3*	WWTF effluent at a point of entry into Windy lake	G, B, Oil and Grease	Monthly
		Acute Lethality	Annually
		D	Daily during periods of discharge
HOP-4*	Effluent from the Landfarm Treatment Facility pumped to the WWTF surge tank	No monitoring requirements	N/A
HOP-5*	Effluent from the Bulk Fuel Storage Facility located at the Windy Camp, prior to release	MT, Oil and Grease, BTEX, TPH, PAH,T-Hg, T-Cd, T-Cr Nitrate, Nitrite, Total Phenols, Total Hardness, Total Alkalinity, Calcium, Potassium, Sulphate, Sodium, Magnesium	Once before any discharge, monthly when discharging onto the tundra
		D	Daily during periods of discharge
HOP-6*	Effluent from the Bulk Fuel Storage Facility located at the Patch Lake location, prior to release to a location approved by an Inspector	MT, Oil and Grease, BTEX, TPH, PAH,T-Hg, T-Cd, T-Cr Nitrate, Nitrite, Total Phenols, Total Hardness, Total Alkalinity, Calcium, Potassium, Sulphate, Sodium, Magnesium	Once before any discharge, monthly when discharging onto the tundra
		D	Daily during periods of discharge
HOP-7A, B, and D	Discharge from Quarries A, B, and D respectively	pH, T-Ammonia, Nitrate, ICP metals, Total Sulphate, Alkalinity, Oil and Grease, Electrical Conductivity and Reduction potential (Eh)	Once before any discharge, monthly when discharging onto the tundra
		D	Daily during periods of discharge

SNP Station	Description	Monitoring Parameters	Frequency
HOP-8*	Effluent from the Bulk Fuel Storage Facility located at the new Windy Camp location, prior to release to a location approved by an Inspector	MT, Oil and Grease, BTEX, TPH, PAH,T-Hg, T-Cd, T-Cr Nitrate, Nitrite, Total Phenols, Total Hardness, Total Alkalinity, Calcium, Potassium, Sulphate, Sodium, Magnesium	Once before any discharge, monthly when discharging onto the tundra
		D	Daily during periods of discharge
Drill Sites	Under-ice sampling before and after drilling	ICP total trace metals, Trace Arsenic, Trace Mercury, Electrical Conductivity	Before and after on-ice drilling
	Water intake from all sources	D	Daily during periods of operation

** Station not in use at this time.*

Figure D2-1. 2BE-HOP1222 Sample Stations Locations

SUMMARY OF MONITORING INFORMATION

The following tables summarize the results of sampling undertaken as part of the monitoring program detailed in Part J of 2BE-HOP1222.

The camp water treatment and wastewater treatment facility (WWTF) permitted under this licence were not operational in 2021, therefore no sampling was conducted at monitoring stations HOP-2 (WWTF discharge), or HOP-3 (point of entry of WWTF discharge to Windy Lake). Water was utilized from Windy Lake for domestic consumption at Doris Camp and the monitoring station ST-7a/MMS-4b (HOP-1 – freshwater intake) was sampled for the monitoring criteria under the Doris North Water Licence 2AM-DOH1335. For the ST-7a/MMS-4b results see Table D1-12 and Table D1-13 in Appendix D.1 of this report. The Landfarm at Windy Camp (HOP-4) was dismantled in 2008, so no sampling was conducted at this monitoring station.

The bulk fuel storage tanks at Windy Camp were moved to Doris Camp in winter 2009 for use there, and the bulk fuel storage berm (HOP-5) was dismantled in 2012. The bulk fuel storage berm at Patch Lake laydown (HOP-6) was also dismantled in 2012. No sampling was conducted at either of these monitoring stations.

No sampling occurred at monitoring stations HOP-7A or HOP-7B (located in Quarries A and B respectively) during 2021 because no discharge occurred from these locations.

A sample was taken at monitoring station HOP-7D located in Quarry D, on August 8, 2021. Notification of discharge was provided to the Inspector on May 10, 2021 and results of the monitoring are presented in Table D2-1. An estimated total of 800 m^3 of water was discharged to the tundra (13W 0432823 7551708), based on pumping times.

On-ice surface exploration was not conducted in the licence area in 2021, therefore under-ice water quality sampling outlined in Part F Item 7 and Part J Item 7 of the licence was not required. On-land exploration drilling was conducted in the licence area from April until September 2021 and from November to December 2021. In October, on-land exploration drilling was shut down in response to the COVID-19 pandemic and did not resume until 11 November in 2021.

Quantities of Water Utilized for Camp, Drilling and Other Purposes

Water used from Windy Lake for domestic purposes at Doris Camp is reported under monitoring station ST-7a/MMS-4b of water licence 2AM-DOH1335. For the ST-7a/MMS-4b water use see Table D1-9 in Appendix D.1 of this report.

1 m^3 of water was used in 2021 from Windy Lake for dust suppression on the Doris-Windy All-Weather Road. Table D2-2 details the water volumes used for dust suppression on the Doris-Windy All-Weather Road. Water used for dust suppression in the Doris area was taken from Doris Lake and is reported under the 2AM-DOH1335 licence.

A total of 2180 m^3 of water was used from Windy Lake (location 13W 432626 7550477) to support surface exploration in 2021. Water volumes used under licence 2BE-HOP1222 are presented in Table D2-1 below.

Table D2-2. Volume of Water Utilized for Drilling and Dust Suppression Purposes, 2021

Date	Dust Suppression (m^3)	Regional Drill Water Usage Total (m^3)	Total Usage (m^3)
January	0	144	144
February	0	321	465
March	0	234	699
April	0	315	1014
May	0	164	1178
June	0	324	1502
July	1	259	1762
August	0	230	1992
September	0	165	2157
October	0	0	2157
November	0	12	2169
December	0	12	2181
Total	**1**	**2180**	**2181**

Note:
Values rounded to nearest whole cubic metre.

Quantity of Effluent Discharged

Windy Camp was closed throughout 2021 therefore no discharges occurred related to the waste water treatment facility (WWTF) at monitoring station HOP-2.

No discharges occurred at the Windy Camp bulk fuel storage facility (HOP-5) in 2021 as this facility was decommissioned in 2012 and the containment berm removed.

No discharges occurred at the Patch Lake bulk fuel storage facility (HOP-6) in 2021 as this facility was decommissioned and the berm removed in 2012.

Volume of Sludge Removed from Sewage Disposal Facility

No sludge was removed from the Windy Camp WWTF in 2021 because this facility was not operational and the camp was closed.

Results of Toxicity Testing

Agnico did not perform toxicity testing to demonstrate the non-acute toxicity of the effluent discharged from the WWTF at HOP-3 (at a point of entry to Windy Lake), as the camp is closed and no effluent was discharged (this facility has been removed).

Hydrology Monitoring – Windy Lake Water Level

Windy Lake water level monitoring was conducted in 2021 as outlined in Part J Item 9 of the licence. In 2019, the station was relocated to the north end of Windy Lake (13W 431404 7554948) to facilitate discharge measurements of the Windy Lake outflow and water level monitoring as outlined in the Hope Bay Aquatic

Effects Monitoring Plan. The water level station was reactivated on June 25 after being deactivated during the winter. The station uses an INW PT2X vented pressure transducer with water level readings recorded every 15 minutes. The station operated throughout the open water season and was not demobilized prior to winter due to the COVID-19 pandemic. The final measurement prior to winter was taken on 19 August 2021. Agnico personnel performed under ice water level surveys on May 17. Three water level surveys and four discharge measurements were performed between June 25 and August 19. Observed data, and data that were estimated for the periods that were not observed, are reported as mean daily water level in meters above sea level and are shown in Table D2-3.

Table D2-3. Summary of Windy Lake Mean Daily Water Levels, in Metres above Sea Level (masl), 2020

Date	January	February	March	April	May	June	July	August	September	October	November	December
1	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	18.417	18.354	*18.282*	*18.345*	*18.303*	*18.196*
2	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	18.415	18.352	*18.281*	*18.346*	*18.285*	*18.196*
3	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	18.411	18.345	*18.279*	*18.347*	*18.270*	*18.196*
4	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	18.407	18.345	*18.278*	*18.349*	*18.256*	*18.196*
5	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	18.405	18.340	*18.280*	*18.353*	*18.244*	*18.196*
6	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	18.404	18.339	*18.275*	*18.354*	*18.233*	*18.196*
7	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	18.402	18.333	*18.275*	*18.356*	*18.224*	*18.196*
8	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	18.402	18.334	*18.287*	*18.357*	*18.216*	*18.196*
9	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	18.404	18.336	*18.314*	*18.357*	*18.208*	*18.196*
10	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	18.407	18.333	*18.324*	*18.357*	*18.202*	*18.196*
11	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.287*	18.408	18.327	*18.330*	*18.356*	*18.196*	*18.196*
12	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.379*	18.405	18.323	*18.336*	*18.355*	*18.191*	*18.196*
13	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.386*	18.405	18.320	*18.340*	*18.354*	*18.196*	*18.196*
14	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.397*	18.402	18.317	*18.341*	*18.353*	*18.196*	*18.196*
15	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.409*	18.396	18.313	*18.345*	*18.350*	*18.196*	*18.196*
16	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.415*	18.393	18.310	*18.347*	*18.349*	*18.196*	*18.196*
17	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.419*	18.389	18.307	*18.348*	*18.345*	*18.196*	*18.196*
18	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.421*	18.388	18.303	*18.350*	*18.348*	*18.196*	*18.196*
19	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.422*	18.385	18.302	*18.351*	*18.347*	*18.196*	*18.196*
20	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.422*	18.381	*18.305*	*18.351*	*18.350*	*18.196*	*18.196*
21	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.421*	18.378	*18.303*	*18.350*	*18.349*	*18.196*	*18.196*
22	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.421*	18.379	*18.300*	*18.349*	*18.346*	*18.196*	*18.196*
23	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.423*	18.372	*18.298*	*18.349*	*18.342*	*18.196*	*18.196*
24	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	*18.421*	18.367	*18.295*	*18.348*	*18.340*	*18.196*	*18.196*
25	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	18.421	18.364	*18.292*	*18.346*	*18.337*	*18.196*	*18.196*
26	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	18.420	18.362	*18.291*	*18.342*	*18.334*	*18.196*	*18.196*

Date	January	February	March	April	May	June	July	August	September	October	November	December
27	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	18.417	18.359	*18.289*	*18.340*	*18.331*	*18.196*	*18.196*
28	*18.196*	*18.196*	*18.196*	*18.196*	*18.196*	18.419	18.356	*18.287*	*18.340*	*18.330*	*18.196*	*18.196*
29	*18.196*		*18.196*	*18.196*	*18.196*	18.419	18.353	*18.284*	*18.340*	*18.328*	*18.196*	*18.196*
30	*18.196*		*18.196*	*18.196*	*18.196*	18.419	18.352	*18.282*	*18.344*	*18.325*	*18.196*	*18.196*
31	*18.196*		*18.196*		*18.196*		18.356	*18.283*		*18.324*		*18.196*
Minimum	18.196	18.196	18.196	18.196	18.196	18.196	18.352	18.282	18.275	18.324	18.191	18.196
Maximum	18.196	18.196	18.196	18.196	18.196	18.423	18.417	18.354	18.351	18.357	18.303	18.196
Mean	18.196	18.196	18.196	18.196	18.196	18.337	18.388	18.314	18.325	18.346	18.212	18.196

Note:

Estimated and modelled values are italicized.

Appendix D.3. 2BB-MAE1727

Appendix D.3. 2BB-MAE1727

Table D3-1 summarizes the sampling stations, sampling frequency and monitoring parameters required as part of the SNP for water licence 2BB-MAE1727. Sample station locations have not yet been established at this time as work has not commenced under this licence. Sample points and discharge locations for SNP stations under this licence will be established in consultation with the Inspector. The proposed sample point locations for SNP Stations MAE-14, MAE-15 and MAE-16 are illustrated in Figure D3-1 below.

Table D3-1. 2BB-MAE1727 Sample Stations, Sample Frequency and Analytical Parameters

SNP Station	Description	Monitoring Parameters	Frequency
MAE-01*	Madrid North, Freshwater intake at Windy Lake	D	Daily during periods of pumping
MAE-02*	Madrid South, Freshwater intake at Patch Lake	D	Daily during periods of pumping
MAE-03*	Freshwater intake at other Lakes	D	Daily during periods of pumping
MAE-04*	Madrid North Pollution Control Pond (PCP) Water at the point of discharge	pH, TSS, Electrical Conductivity, Oil and Grease, Total Ammonia, Nitrate-Nitrite, Total Phenols, Total Alkalinity, Total Hardness, Chloride, Sulphate, Magnesium, Sodium, Calcium, Potassium, Total As, Cd, Cu, Cr, Fe, Pb, Hg, and Ni	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge
MAE-05*	Madrid South Pollution Control Pond No.1 Water at the point of discharge	pH, TSS, Electrical Conductivity, Oil and Grease, Total Ammonia, Nitrate-Nitrite, Total Phenols, Total Alkalinity, Total Hardness, Chloride, Sulphate, Magnesium, Sodium, Calcium, Potassium, Total As, Cd, Cu, Cr, Fe, Pb, Hg, and Ni	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge
MAE-06*	Madrid South Pollution Control Pond No.2 Water at the point of discharge	pH, TSS, Electrical Conductivity, Oil and Grease, Total Ammonia, Nitrate-Nitrite, Total Phenols, Total Alkalinity, Total Hardness, Chloride, Sulphate, Magnesium, Sodium, Calcium, Potassium, Total As, Cd, Cu, Cr, Fe, Pb, Hg, and Ni	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge

SNP Station	Description	Monitoring Parameters	Frequency
MAE-07*	Madrid North Fuel Storage Area Water Sump	pH, TSS, Sulphate, Chloride, Electrical Conductivity, Oil and Grease, Total Ammonia, BTEX, Total Arsenic, Total Lead, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge
MAE-08*	Madrid North Fuel Transfer Station Water Sump	pH, TSS, Sulphate, Chloride, Electrical Conductivity, Oil and Grease, Total Ammonia, BTEX, Total Arsenic, Total Lead, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge
MAE-09*	Madrid South Fuel Storage Area Water Sump	pH, TSS, Sulphate, Chloride, Electrical Conductivity, Oil and Grease, Total Ammonia, BTEX, Total Arsenic, Total Lead, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge
MAE-10*	Madrid South Fuel Transfer Station Water Sump	pH, TSS, Sulphate, Chloride, Electrical Conductivity, Oil and Grease, Total Ammonia, BTEX, Total Arsenic, Total Lead, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge
MAE-11*	Quarry G Contact Water Sump	pH, TSS, Sulphate, Chloride, Electrical Conductivity, Total Ammonia, Total Arsenic, Total Nickel, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge

SNP Station	Description	Monitoring Parameters	Frequency
MAE-12*	Quarry H Contact Water Sump	pH, TSS, Sulphate, Chloride, Electrical Conductivity, Total Ammonia, Total Arsenic, Total Nickel, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge
MAE-13*	Quarry I Contact Water Sump	pH, TSS, Sulphate, Chloride, Electrical Conductivity, Total Ammonia, Total Arsenic, Total Nickel, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge
MAE-14*	Windy Lake immediately downgradient of the Pollution Control Pond Discharge	Chloride, Electrical Conductivity, Total Dissolved Solids (TDS)	Once prior to each discharge; and a maximum of two weeks post discharge
MAE-15*	Patch Lake immediately downgradient of the Pollution Control Pond Discharge	Chloride, Electrical Conductivity, Total Dissolved Solids (TDS)	Once prior to each discharge; and a maximum of two weeks post discharge
MAE-16*	Wolverine Lake immediately downgradient of the Pollution Control Pond Discharge	Chloride, Electrical Conductivity, Total Dissolved Solids (TDS)	Once prior to each discharge; and a maximum of two weeks post discharge
Drill Sites	Under-ice sampling before and after drilling	pH, TSS, Electrical Conductivity, Trace Arsenic, Trace Mercury Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo, Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Before and after on-ice drilling
	Water intake from all sources	D	Daily during periods of pumping
Mine Sumps*	Water from Madrid South Underground Mine Water Sumps	Total Dissolved Solids, pH, Electrical Conductivity, Chloride, Total Ammonia and Nitrate, Alkalinity, Sulfate, Trace Metals for a minimum of the following elements: As, Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo, Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Three times per year during periods of Water inflow

** Station not in use at this time.*

Figure D3-1. 2BB-MAE1727 Sample Stations Locations

SUMMARY OF MONITORING INFORMATION

The following summarizes the results of sampling undertaken as part of the monitoring program detailed in Part J of 2BB-MAE1727.

No activity occurred at the Madrid North or Madrid South sites under this licence in 2021. Monitoring was not undertaken at monitoring stations MAE-01 (Madrid North Windy Lake Freshwater intake), MAE-02 (Madrid South Patch Lake Freshwater intake) or MAE-03 (Freshwater intake at other lakes) as no water was obtained from these locations for use under this licence. No water was used for domestic, drilling or all other purposes and no waste was deposited under this licence in 2021. Location coordinates of all water sources and locations of waste deposit will be reported as required.

Monitoring of the Madrid North Contact Water Pond was conducted under water licence 2AM-DOH1335 (MMS-1). Results of this monitoring are presented in Appendix D.1 of this report. No discharge occurred and no monitoring was conducted at MAE-05 (Madrid South Pollution Control Pond No.1) or MAE-06 (Madrid South Pollution Control Pond No.2) as these facilities have not yet been constructed.

The Fuel Storage Areas and Transfer Stations at Madrid North (MAE-07 and MAE-08) and Madrid South (MAE-09 and MAE-10) have not yet been constructed. No water quality monitoring was conducted and no discharge occurred at these sampling locations.

Quarrying activities have not yet been undertaken at Quarry G (MAE-11), Quarry H (MAE-12) or Quarry I (MAE-13). No sampling or discharge was required for these monitoring locations in 2021.

No sampling was conducted at lakes located immediately downgradient of Madrid North and Madrid South Pollution Control Pond discharge locations (MAE-14, Windy Lake; MAE-15, Patch Lake; MAE-16, Wolverine Lake). The Madrid North Contact Water Pond is monitored under water licence 2AM-DOH1335 and the Madrid South Pollution Control Ponds have not yet been constructed.

Underground mining continued in Q1 of 2021 until all Madrid mining operations were stopped in February 2021, under water licence 2AM-DOH1335. Underground mining has not yet commenced at Madrid South. No water was discharged from underground sumps at Madrid North in 2020 and no water quality monitoring was conducted.

On-ice surface exploration was not conducted in the licence area in 2021, therefore under-ice water quality sampling as outlined in Part F Item 12 of the licence was not required.

Appendix D.4. 2BB-BOS1727

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Appendix D.4. 2BB-BOS1727

Table D4-1 summarizes the sampling stations, sampling frequency and monitoring parameters required as part of the SNP for water licence 2BB-BOS1727. The location of each sampling point is illustrated in Figure D4-1 below.

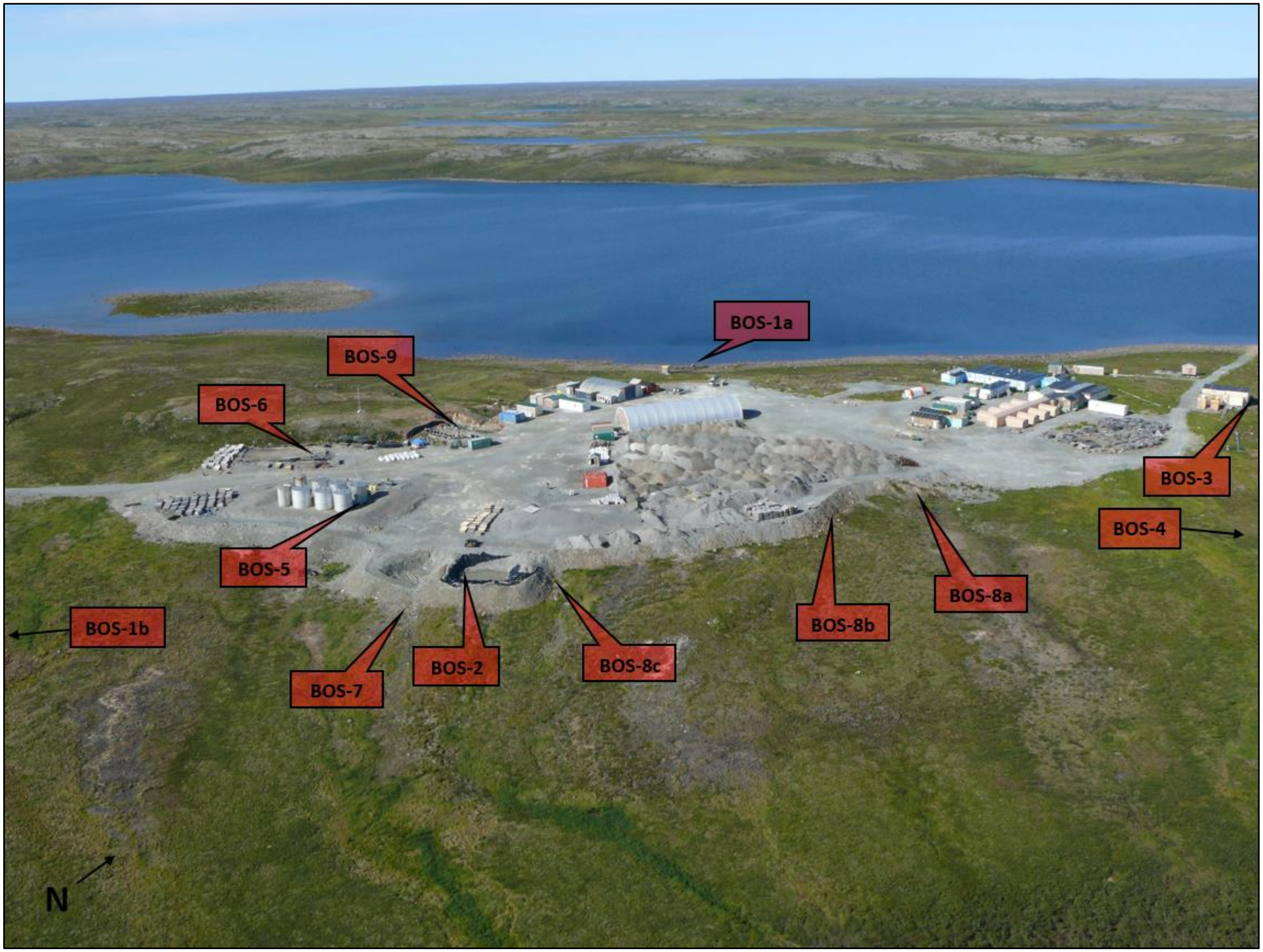
Table D4-1. 2BB-BOS1727 Sample Stations, Sample Frequency and Analytical Parameters

SNP Station	Description	Monitoring Parameters	Frequency
BOS-1a*	Raw water supply intake at Aimaokatalok (Spyder) Lake	D	Daily during periods of pumping
BOS-1b*	Raw water supply intake at Stickleback Lake	D	Daily during periods of pumping
BOS-2	Containment Pond discharge	pH, Nitrate as NO3-, Oil and Grease, Total Suspended Solids Total As, Cu, Pb, Ni and Zn.	Prior to discharge, weekly during periods of discharge
		TPH, PAH, BTEX, pH, Electrical Conductivity, Nitrate, Nitrite, Oil and Grease, Total Phenols, Total Alkalinity, Total Hardness, Total Suspended Solids, Calcium, Magnesium, Potassium, Sodium, Sulphate & Chloride, Total As, Cd, Cu, Cr, Fe, Pb, Hg, Ni, Se and Zn.	Prior to discharge, monthly during periods of discharge
		D	Daily during periods of discharge
BOS-3*	Sewage Disposal Facility treated effluent discharge	BOD_5, TSS, Oil and Grease (visual), Fecal Coliforms, pH	Once prior to discharge and monthly during periods of discharge
		D	Daily during periods of discharge
BOS-4*	Treated sewage effluent point prior to entry into Aimaokatalok (Spyder) Lake	BOD_5, TSS, Oil and Grease (visual), Fecal Coliforms, pH	Monthly during periods of discharge
		D	Daily during periods of discharge
BOS-5	Effluent from the Bulk Fuel Storage Facility prior to release to a location approved by an Inspector	TPH, PAH, BTEX, pH, Electrical Conductivity, Nitrate-Nitrite, Oil and Grease, Total Phenols, Total Alkalinity, Total Hardness, Calcium, Magnesium, Potassium, Sodium, Sulphate & Chloride, Total As, Cd, Cu, Cr, Fe, Pb, Hg, Ni, Se, and Zn.	Once before any discharge, monthly when discharging onto the tundra
		D	Daily during periods of discharge

SNP Station	Description	Monitoring Parameters	Frequency
BOS-6*	Effluent from the Landfarm Treatment Facility prior to release	TPH, PAH, BTEX, pH, TSS, Electrical Conductivity, Nitrate-Nitrite, Oil and Grease, Total Phenols, Total Alkalinity, Total Hardness, Calcium, Magnesium, Potassium, Sodium, Sulphate & Chloride, Total As, Cd, Cu, Cr, Fe, Pb, Hg, Ni and Se.	Once before any discharge, monthly when discharging onto the tundra
		D	Daily during periods of discharge
BOS-7*	Runoff from the temporary storage of hydrocarbon contaminated soils prior to discharge onto the tundra	TPH, PAH, BTEX, pH, TSS, Electrical Conductivity, Nitrate-Nitrite, Oil and Grease, Total Phenols, Total Alkalinity, Total Hardness, Calcium, Magnesium, Potassium, Sodium, Sulphate & Chloride, Total As, Cd, Cu, Cr, Fe, Pb, Hg, Ni, Se and Zn.	Once before any discharge, monthly when discharging onto the tundra
		D	Daily during periods of discharge
BOS-8	Seepage/runoff from the ore stockpiles and camp pad, monitored on the tundra to the east of the ore stockpiles	pH, Sulphate & Chloride, Electrical Conductivity, TSS, Total Ammonia, Total As, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo, Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Initially during spring thaw and monthly during periods of observed flow
BOS-9	Portal decline, surface water runoff discharged to onto the tundra West of Portal	pH, Sulphate & Chloride, Electrical Conductivity, TSS, Total Ammonia, Total As, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo, Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Once before any discharge
BOS-10*	Underground Mine Water Sumps pumped from Underground	pH, Sulphate & Chloride, Electrical Conductivity, TSS, Total Ammonia, Total As, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo, Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Three times a year, during periods of water inflow
		D	Daily during periods of discharge
Drill Sites	Under-ice sampling before and after drilling	pH, TSS, Electrical Conductivity, Total Trace Metals for a minimum of the following elements: As, Al, Sb, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Li, Mn, Mo, Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Before and after on-ice drilling
	Water intake from all sources	D	Daily during periods of discharge

** Station not in use at this time.*

Figure D4-1. 2BB-BOS1727 Sample Stations Locations



TABULAR SUMMARY OF MONITORING INFORMATION

The following tables summarize the results of sampling undertaken in 2021 as part of the monitoring program detailed in Part J of licence 2BB-BOS1727.

Boston Camp was not operational in 2021. No water was used from Aimaokatalok (Spyder) Lake (BOS-1a) or Stickleback Lake (BOS-1b) for domestic camp, surface drilling or any other purpose. No water quality samples were collected from these locations in 2021.

The Sewage Treatment Facility (BOS-3) was not active as the camp was not operational, therefore no effluent was discharged and no sewage sludge was produced from this facility in 2021. No effluent quality sampling was conducted at BOS-3 or at the point prior to treated effluent entering into Aimaokatalok (Spyder) Lake (BOS-4).

The Containment Pond (BOS-2) has been used to consolidate water from the smaller fuel containment berms and from the Bulk Fuel Storage Facility (BOS-5), to facilitate testing and treatment while allowing the fuel berms to be promptly vacated of water. As in previous years, water from the Containment Pond (BOS-2) is sampled for and screened against both BOS-2 and BOS-5 criteria. Results of the June 28 Contact Water Pond (BOS-2) water quality sample met the discharge criteria outlined in Part D Item 6 of the licence. Results of this sampling are presented in Table D4-2 below. 181 m^3 of water was discharged to tundra (13W 441332 7505378).

Water quality sampling was conducted at the Bulk Fuel Storage Facility (BOS-5) on June 28 prior to water management activities. Water quality treatment was conducted on the water within the Bulk Fuel Storage Facility (BOS-5) using the OWS containing activated carbon and Metsorb media and water quality samples were collected on July 18 post-water quality treatment. Results from the Bulk Fuel Storage Facility (BOS-5) did not pass the *Maximum Concentration in Any Grab Sample* allowable criteria for total arsenic and total lead as outlined in Part D Item 19 of the water licence.

Results of sampling conducted at the Bulk Fuel Storage Facility (BOS-5) are presented in Table D4-3 below. This water had been transferred to the Containment Pond to facilitate water quality treatment; no water was discharged to tundra from this facility in 2021. No additional water management was required at this facility in 2021. The discharge criteria for the Containment Pond (BOS-2) facility in 2022 will have to meet both the BOS-2 and BOS-5 discharge criteria before discharge is allowed.

Dewatering of the Landfarm Treatment Area (LTA; BOS-6) was not required in 2021. In 2017, TMAC commenced reclamation of the LTA at Boston with the excavation and stockpiling of contaminated soils from the LTA into mega-bags for future disposal. In March 2019, the contaminated soil from the LTA was transported to Doris Camp via a winter track and disposed of underground in the Doris Mine as approved in the Hope Bay Project Hazardous Waste Management Plan. The Boston LTA was decommissioned in 2019 and no additional materials will be placed in this facility. Hydrocarbon contaminated materials generated from future activities conducted at Boston will be packaged for backhaul to Doris until a new LTA facility is constructed.

No landfill exists at Boston and the status of monitoring station BOS-7 is inactive.

During 2021, TMAC opportunistically sampled at locations where seepage was observed during periods of runoff near the waste rock and ore storage pad (BOS-8). Sampling in June was conducted concurrently with the annual seepage sampling program (June 28, 2021). No seepage was identified at BOS-8 locations after June. Table D4-4 shows the results of this sampling. These monitoring results were compared with previously reported kinetic testing results from the ARD Characterization Data base for the Boston Deposit.

Further discussion regarding the waste rock and ore monitoring program at Boston Camp is presented in Appendix G.

The Portal Decline (BOS-9) was sampled on July 18 and results of this sample were compliant with the discharge criteria outlined in Part D Item 6 of the licence. Upon receipt of compliant results, a total of 250m^3 was dewatered from the facility to the tundra (13W 441219 7505378). Results of sampling conducted at the Portal Decline Facility (BOS-9) are presented in Table D4-5 below.

Underground mining activities were not conducted in 2021. Mine water was not pumped from underground and no water quality monitoring was conducted of the underground mine water sumps (BOS-10).

On-ice exploration drilling did not occur in the licence area in 2021, therefore no samples were taken through lake ice (required by Part F Item 6 and Part J Item 15) to establish water quality prior to, and upon completion of, an on-ice drilling program.

Table D4-2. Results of 2021 Containment Pond (BOS-2) Effluent Samples

	Sample ID	BOS2	BOS2	BOS2	Part D Item 6	
	ALS ID	YL2100665	YL2100795	YL2101193	Maximum Average Concentration (mg/L)	Maximum Concentration in Any Grab Sample (mg/L)
	Date Sampled	28-Jun-2021 13:10	18-Jul-2021 15:15	05-Sep-2021 13:34		
Parameter	**Units**	**Results**				
Conductivity	µS/cm	200	1020	1110		
Hardness (as CaCO3)	mg/L	82.2	563	625		
pH	pH Units	7.32	7.48	6.7	6.5-9.0	
Total Suspended Solids	mg/L	<3.0	6.9	**79.5**	15	30
Alkalinity, Total (as CaCO3)	mg/L	17.4	61	35.3		
Chloride (Cl)	mg/L	7.4	13.2	15		
Nitrate (as N)	mg/L	<0.0050	<0.0250	<0.0250	130	260
Nitrite (as N)	mg/L	<0.0010	<0.0050	<0.0050		
Sulfate (SO4)	mg/L	60.9	464	543		
Aluminum (Al)-Total	mg/L	0.095	0.0195	0.0825		
Antimony (Sb)-Total	mg/L	0.00055	0.00017	0.0003		
Arsenic (As)-Total	mg/L	0.0271	**0.0556**	0.0391	0.050	0.10
Barium (Ba)-Total	mg/L	0.00352	0.00043	0.00166		
Beryllium (Be)-Total	mg/L	<0.000100	<0.000100	<0.000100		
Boron (B)-Total	mg/L	0.027	0.147	0.103		
Cadmium (Cd)-Total	mg/L	0.0000135	0.0000221	0.0000273		
Calcium (Ca)-Total	mg/L	18.5	142	156		
Chromium (Cr)-Total	mg/L	0.00065	<0.00050	<0.00050		
Cobalt (Co)-Total	mg/L	0.00639	0.00272	0.0116		
Copper (Cu)-Total	mg/L	0.00358	0.00204	0.00736	0.02	0.04
Iron (Fe)-Total	mg/L	0.166	0.578	0.737		
Lead (Pb)-Total	mg/L	0.000329	0.0053	0.0015	0.01	0.02
Lithium (Li)-Total	mg/L	0.0017	0.0074	0.008		

Sample ID		BOS2	BOS2	BOS2	Part D Item 6	
ALS ID		YL2100665	YL2100795	YL2101193	Maximum Average Concentration (mg/L)	Maximum Concentration in Any Grab Sample (mg/L)
Date Sampled		28-Jun-2021 13:10	18-Jul-2021 15:15	05-Sep-2021 13:34		
Parameter	Units	Results				
Magnesium (Mg)-Total	mg/L	8.75	50.7	57.3		
Manganese (Mn)-Total	mg/L	0.0142	0.0128	0.0632		
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050	<0.0000250		
Molybdenum (Mo)-Total	mg/L	0.000517	0.000054	0.000055		
Nickel (Ni)-Total	mg/L	0.0222	0.0196	0.068	0.25	0.5
Potassium (K)-Total	mg/L	1.49	5.83	6.37		
Selenium (Se)-Total	mg/L	0.000092	0.000224	0.000252		
Silver (Ag)-Total	mg/L	<0.000020	<0.000010	0.000031		
Sodium (Na)-Total	mg/L	4.04	6.98	8.23		
Strontium (Sr)-Total	mg/L	0.0567	0.43	0.444		
Thallium (Tl)-Total	mg/L	<0.000010	<0.000010	<0.000010		
Tin (Sn)-Total	mg/L	<0.00010	<0.00010	0.00011		
Titanium (Ti)-Total	mg/L	0.00068	0.00094	<0.00030		
Uranium (U)-Total	mg/L	0.000015	<0.000010	0.000032		
Vanadium (V)-Total	mg/L	<0.00050	<0.00050	<0.00050		
Zinc (Zn)-Total	mg/L	0.0923	0.0437	0.125	0.3	0.6
Oil and Grease	mg/L	<5.0	<5.0	<5.0	5	10
Oil And Grease (Visible Sheen)		Absent	Absent	Absent	No visible sheen	No visible sheen
Phenols (4AAP)	mg/L	<0.0010	<0.0010	<0.0100		
Benzene	mg/L	<0.00050	<0.00050	<0.00050		
Ethylbenzene	mg/L	<0.00050	<0.00050	<0.00050		
Methyl t-butyl ether (MTBE)	mg/L	<0.00050	<0.00050	<0.00050		
Styrene	mg/L	<0.00050	<0.00050	<0.00050		
Toluene	mg/L	<0.00050	<0.00050	<0.00050		
ortho-Xylene	mg/L	<0.00075	<0.00075	<0.00075		
meta- & para-Xylene	mg/L	<0.000010	<0.000010	<0.000010		
Xylenes, Total	mg/L	<0.000010	<0.00075	<0.000010		
TPH10-32	mg/L	<0.000010	<0.000010	<0.000010		
Acenaphthene	mg/L	<0.000010	<0.000010	<0.000010		
Acenaphthylene	mg/L	<0.000010	<0.000010	<0.000010		
Acridine	mg/L	<0.0000050	<0.000010	<0.0000050		
Anthracene	mg/L	<0.000015	<0.000010	<0.000015		
Benz(a)anthracene	mg/L	<0.000010	<0.000010	<0.000010		
Benzo(a)pyrene	mg/L	<0.000010	<0.0000050	<0.000010		
Benzo(b&j)fluoranthene	mg/L	<0.000010	<0.000010	<0.000010		
Benzo(b+j+k)fluoranthene	mg/L	<0.0000050	<0.000015	<0.0000050		

Sample ID		BOS2	BOS2	BOS2	Part D Item 6	
ALS ID		YL2100665	YL2100795	YL2101193	Maximum Average Concentration (mg/L)	Maximum Concentration in Any Grab Sample (mg/L)
Date Sampled		28-Jun-2021 13:10	18-Jul-2021 15:15	05-Sep-2021 13:34		
Parameter	**Units**	**Results**				
Benzo(g,h,i)perylene	mg/L	<0.000010	<0.000010	<0.000010		
Benzo(k)fluoranthene	mg/L	<0.000010	<0.000010	<0.000010		
Chrysene	mg/L	<0.000010	<0.000010	<0.000010		
Dibenz(a,h)anthracene	mg/L	<0.000050	<0.0000050	<0.000050		
Fluoranthene	mg/L	<0.000020	<0.000010	<0.000020		
Fluorene	mg/L	<0.000010	<0.000010	<0.000010		
Indeno(1,2,3-c,d)pyrene	mg/L	<0.000050	<0.000010	<0.000050		
1-Methylnaphthalene	mg/L	200	1020	1110		
2-Methylnaphthalene	mg/L	82.2	563	625		
Naphthalene	mg/L	7.32	7.48	6.7		
Phenanthrene	mg/L	<3.0	6.9	**79.5**		
Pyrene	mg/L	17.4	61	35.3		
Quinoline	mg/L	7.4	13.2	15		

***Bold** indicates exceedance of Part D Item 6 Maximum Concentration.*

Table D4-3. Results of 2021 Bulk Fuel Storage Facility (BOS-5) Effluent Samples

	Sample ID	BOS5	Part D Item 19
	ALS ID	YL2100666	Maximum Concentration in Any Grab Sample
	Date Sampled	28-Jun-2021 16:20	
Parameter	**Units**	**Results**	
Conductivity	uS/cm	1060	
Hardness (as CaCO3)	mg/L	589	
pH	pH Units	7.87	6.5-9.0
Total Suspended Solids	mg/L	<3.0	15
Alkalinity, Total (as CaCO3)	mg/L	71.1	
Nitrate (as N)	mg/L	<0.0250	
Nitrite (as N)	mg/L	<0.0050	
Chloride (Cl)	mg/L	17.7	
Sulfate (SO4)	mg/L	497	
Aluminum (Al)-Total	mg/L	0.0069	
Antimony (Sb)-Total	mg/L	0.00026	
Arsenic (As)-Total	mg/L	**0.113**	0.05
Barium (Ba)-Total	mg/L	0.0005	
Beryllium (Be)-Total	mg/L	<0.000100	
Boron (B)-Total	mg/L	0.073	
Cadmium (Cd)-Total	mg/L	0.0000304	
Calcium (Ca)-Total	mg/L	145	
Chromium (Cr)-Total	mg/L	<0.00050	
Cobalt (Co)-Total	mg/L	0.00234	
Copper (Cu)-Total	mg/L	0.00347	0.04
Iron (Fe)-Total	mg/L	0.655	
Lead (Pb)-Total	mg/L	**0.0162**	0.01
Lithium (Li)-Total	mg/L	0.0073	
Magnesium (Mg)-Total	mg/L	55.2	
Manganese (Mn)-Total	mg/L	0.00428	
Mercury (Hg)-Total	mg/L	<0.0000050	
Molybdenum (Mo)-Total	mg/L	0.000061	
Nickel (Ni)-Total	mg/L	0.0276	0.5
Potassium (K)-Total	mg/L	5.35	
Selenium (Se)-Total	mg/L	0.000267	
Silver (Ag)-Total	mg/L	<0.000010	
Sodium (Na)-Total	mg/L	7.22	
Strontium (Sr)-Total	mg/L	0.416	
Thallium (Tl)-Total	mg/L	<0.000010	
Tin (Sn)-Total	mg/L	<0.00010	

Sample ID		BOS5	Part D Item 19
ALS ID		YL2100666	Maximum Concentration in Any Grab Sample
Date Sampled		28-Jun-2021 16:20	
Parameter	**Units**	**Results**	
Titanium (Ti)-Total	mg/L	<0.00030	
Uranium (U)-Total	mg/L	<0.000010	
Vanadium (V)-Total	mg/L	<0.00050	
Zinc (Zn)-Total	mg/L	0.0154	0.6
Oil and Grease	mg/L	<5.0	15
Oil And Grease (Visible Sheen)		Absent	No visible sheen
Benzene	mg/L	<0.00050	0.37
Ethylbenzene	mg/L	<0.00050	0.91
Methyl t-butyl ether (MTBE)	mg/L	<0.00050	
Styrene	mg/L	<0.00050	
Toluene	mg/L	<0.00050	0.002
Xylenes, Total	mg/L	<0.00075	
Acenaphthene	mg/L	<0.000010	
Acenaphthylene	mg/L	<0.000010	
Acridine	mg/L	<0.000010	
Anthracene	mg/L	<0.000010	
Benz(a)anthracene	mg/L	<0.000010	
Benzo(a)pyrene	mg/L	<0.0000050	
Benzo(b+j+k)fluoranthene	mg/L	<0.000015	
Benzo(g,h,i)perylene	mg/L	<0.000010	
Benzo(k)fluoranthene	mg/L	<0.000010	
Chrysene	mg/L	<0.000010	
Dibenz(a,h)anthracene	mg/L	<0.0000050	
Fluoranthene	mg/L	<0.000010	
Fluorene	mg/L	<0.000010	
Indeno(1,2,3-c,d)pyrene	mg/L	<0.000010	
Naphthalene	mg/L	<0.000050	
Phenanthrene	mg/L	<0.000020	
Pyrene	mg/L	<0.000010	
Quinoline	mg/L	<0.000050	

Bold *indicates exceedance of Part D Item 19 Maximum Concentration.*

Table D4-4. Opportunistic Seepage Sampling at Waste Rock and Ore Storage Pad (BOS-8) 2021

	Sample ID	BOS8A	BOS8A^	BOS8B	BOS8D
	ALS ID	YL2100668-2	YL2100668-1	YL2100668-3	YL2100668-4
	Date Sampled	28-Jun-2021 13:45	28-Jun-2021 13:45	28-Jun-2021 14:30	28-Jun-2021 14:50
Parameter	**Units**	**Results**			
Conductivity	uS/cm	800	786	580	1240
Hardness (as CaCO3)	mg/L	395	389	276	635
pH	pH	7.89	7.9	7.9	7.97
Total Suspended Solids	mg/L	5.4	5.2	14.4	130
Ammonia, Total (as N)	mg/L	0.0139	0.0101	1.02	0.259
Sulfate (SO4)	mg/L	329	330	198	396
Aluminum (Al)-Total	mg/L	0.134	0.108	0.166	1.31
Antimony (Sb)-Total	mg/L	0.00388	0.00381	0.0278	0.0282
Arsenic (As)-Total	mg/L	0.0478	0.0472	1.52	0.594
Barium (Ba)-Total	mg/L	0.00954	0.00948	0.00709	0.0251
Beryllium (Be)-Total	mg/L	<0.000020	<0.000020	<0.000020	<0.000020
Boron (B)-Total	mg/L	0.059	0.058	0.142	0.184
Cadmium (Cd)-Total	mg/L	0.0000365	0.0000121	0.0000165	0.0000101
Calcium (Ca)-Total	mg/L	98.4	97.1	68.3	179
Chromium (Cr)-Total	mg/L	0.00119	0.00099	0.00262	0.0286
Cobalt (Co)-Total	mg/L	0.0561	0.0552	0.147	0.426
Copper (Cu)-Total	mg/L	0.00596	0.00576	0.001	0.00388
Iron (Fe)-Total	mg/L	0.105	0.1	0.185	1.47
Lead (Pb)-Total	mg/L	0.000155	0.00015	0.000275	0.00144
Lithium (Li)-Total	mg/L	0.0049	0.0049	0.0129	0.0388
Magnesium (Mg)-Total	mg/L	36.3	35.6	25.7	45.6
Manganese (Mn)-Total	mg/L	0.0534	0.0522	0.0294	0.112
Molybdenum (Mo)-Total	mg/L	0.000663	0.000654	0.00188	0.00292
Nickel (Ni)-Total	mg/L	0.176	0.173	0.205	0.489
Potassium (K)-Total	mg/L	3.97	3.89	6.14	9.39
Selenium (Se)-Total	mg/L	0.000451	0.000423	0.00118	0.00203
Silver (Ag)-Total	mg/L	0.000016	0.000018	<0.000010	0.000045
Sodium (Na)-Total	mg/L	13.5	13.3	5.25	19.3
Strontium (Sr)-Total	mg/L	0.239	0.234	0.34	1.11
Thallium (Tl)-Total	mg/L	<0.000010	<0.000010	<0.000010	<0.000010
Tin (Sn)-Total	mg/L	<0.00010	<0.00010	<0.00010	<0.00010
Titanium (Ti)-Total	mg/L	<0.00120	<0.00060	<0.00270	<0.0108
Uranium (U)-Total	mg/L	0.000156	0.000153	0.000089	0.000246

Sample ID		BOS8A	BOS8A^	BOS8B	BOS8D
ALS ID		YL2100668-2	YL2100668-1	YL2100668-3	YL2100668-4
Date Sampled		28-Jun-2021 13:45	28-Jun-2021 13:45	28-Jun-2021 14:30	28-Jun-2021 14:50
Parameter	**Units**	**Results**			
Vanadium (V)-Total	mg/L	0.00065	0.00086	0.00199	0.0066
Zinc (Zn)-Total	mg/L	0.0099	<0.0030	0.0097	0.0034

^ *Indicates duplicate sample.*

Note:

Sampling Locations: BOS8A - 13W 441232 7505523; BOS8B - 13W 441264 7505469; BOS8D - 13W 441356 7505403

Table D4-5. Results of 2021 Portal Decline (BOS-9) Effluent Quality Sampling

	Sample ID	BOS9	BOS9^	Part D Item 6	
	ALS ID	YL2100796-1	YL2100796-2	Maximum Average Concentration	Maximum Concentration in Any Grab Sample
	Date Sampled	7/18/2021 10:55	7/18/2021 10:55		
Parameter	Units	Results			
Conductivity	uS/cm	397	400		
pH	pH	7.49	7.47	6.5-9.0	
Total Suspended Solids	mg/L	<3.0	<3.0	15	30
Ammonia, Total (as N)	mg/L	0.0326	0.0309		
Chloride (Cl)	mg/L	51.1	51		
Nitrate (as N)	mg/L	0.343	0.342	130	260
Sulfate (SO4)	mg/L	69.6	69.4		
Aluminum (Al)-Total	mg/L	0.0118	0.0132		
Antimony (Sb)-Total	mg/L	0.00098	0.00096		
Arsenic (As)-Total	mg/L	0.0216	0.0216	0.050	0.10
Barium (Ba)-Total	mg/L	0.00409	0.00424		
Beryllium (Be)-Total	mg/L	<0.000100	<0.000100		
Boron (B)-Total	mg/L	0.046	0.048		
Cadmium (Cd)-Total	mg/L	0.0000146	0.0000158		
Calcium (Ca)-Total	mg/L	36.5	36.7		
Chromium (Cr)-Total	mg/L	<0.00050	<0.00050		
Cobalt (Co)-Total	mg/L	0.0125	0.0126		
Copper (Cu)-Total	mg/L	0.00167	0.0017	0.02	0.04
Iron (Fe)-Total	mg/L	0.09	0.095		
Lead (Pb)-Total	mg/L	0.000081	0.000089	0.01	0.02
Lithium (Li)-Total	mg/L	0.0051	0.0052		
Magnesium (Mg)-Total	mg/L	12.1	12.2		

Sample ID		BOS9	BOS9^	Part D Item 6	
ALS ID		YL2100796-1	YL2100796-2	Maximum Average Concentration	Maximum Concentration in Any Grab Sample
Date Sampled		7/18/2021 10:55	7/18/2021 10:55		
Parameter	Units	Results			
Manganese (Mn)-Total	mg/L	0.0461	0.0463		
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050		
Molybdenum (Mo)-Total	mg/L	0.000408	0.000405		
Nickel (Ni)-Total	mg/L	0.0425	0.0426	0.25	0.5
Potassium (K)-Total	mg/L	2.52	2.52		
Selenium (Se)-Total	mg/L	0.000311	0.000239		
Silver (Ag)-Total	mg/L	<0.000010	<0.000010		
Sodium (Na)-Total	mg/L	17.6	17.7		
Thallium (Tl)-Total	mg/L	<0.000010	<0.000010		
Tin (Sn)-Total	mg/L	<0.00010	<0.00010		
Titanium (Ti)-Total	mg/L	<0.00030	<0.00030		
Uranium (U)-Total	mg/L	0.000458	0.000462		
Vanadium (V)-Total	mg/L	<0.00050	<0.00050		
Zinc (Zn)-Total	mg/L	<0.0030	0.0032	0.3	0.6
Oil and Grease	mg/L	<5.0	<5.0	5	10
Oil And Grease (Visible Sheen)		Absent	Absent	No visible sheen	No visible sheen

^ *Indicates duplicate sample.*

Appendix D.5. 2AM-BOS1835

Appendix D.5. 2AM-BOS1835

Table D5-1 summarizes the sampling stations, sampling frequency and monitoring parameters required as part of the SNP for water licence 2AM-BOS1835. Sample station locations have not yet been established at this time as work has not commenced under this licence. Sample points and discharge locations for SNP stations under this licence will be established in consultation with the Inspector.

Table D5-1. 2AM-BOS1835 Sample Stations, Sample Frequency and Analytical Parameters

SNP Station	Description	Monitoring Parameters	Frequency
BMS-1*	Contact Water Pond #1 and #2	G, N1, MT and Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, and Total metals by ICP-MS, D	Sampled twice annually; Weekly water levels
BMS-2*	Surge pond at intake to Contact Water Treatment Plant	G, N1, N2, MT, and TDS, Cl, Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-K, T-Mo, T-Mg, T-Na, T-Se, T-Tl, T-Radium 226, HC, D	Sampled monthly during discharge periods; Weekly water levels
BMS-3*	Discharge from Contact Water Treatment Plant	G, N1, N2, MT, and TDS, Cl, Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-K, T-Mo, T-Mg, T-Na, T-Se, T-Tl, T-Radium 226, D, AT	Sampled weekly during discharge periods and prior to discharge
BMS-4*	Reclaim line from TMA Contact Water Pond	G, N1, N2, MT, and TDS, Cl, Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-K, T-Mo, T-Mg, T-Na, T-Se, T-Tl, HC, D, Fecal coliform	Sampled monthly during reclaim periods; Weekly water levels
BMS-5*	Non-contact water pond	G, N1, MT and Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, and Total metals by ICP-MS, D	Sampled annually; Water levels after large inflow events
BMS-6*	Fresh Water intake at Aimaokatalok Lake	G, N1, N2, MT, and Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, T-Tl, and Total Oil and Grease, Cl, D	Sampled monthly during active pumping periods
BMS-7*	Landfill sump	G, MT and Total Ammonia-N, Total Sulphate, Total and Free CN, Total Oil and Grease, D	Annually. Once prior to every discharge onto the tundra
BMS-8*	Discharge of treated Sewage	G, B, and Total Oil and Grease, D	Sampled monthly during active pumping periods
BMS-9*	Landfarm sump	G, HC, Total Ammonium, Total Lead, D	Annually. Once prior to every discharge onto the tundra
BMS-10*	Site runoff from sediment controls during construction	TSS or Turbidity	Daily during periods of discharge

SNP Station	Description	Monitoring Parameters	Frequency
BMS-11*	Discharge from the Boston fuel storage and containment sumps	G, HC, Total Pb	Annually. Once prior to every discharge onto the tundra.
		D	Daily during periods of discharge

** Station not in use at this time.*

SUMMARY OF MONITORING INFORMATION

The following summarizes sampling undertaken as part of the monitoring program detailed in Part I of 2AM-BOS1835.

No activity occurred at the Boston site under this licence in 2021. Activities at Boston Camp conducted in 2021 to maintain environmental compliance are reported under water licence 2BB-BOS1727.

Monitoring was not undertaken at monitoring stations BMS-1 (Contact Water Pond #1 and #2) as these facilities have not yet been constructed. The Contact Water Treatment Plant and surge pond have not yet been constructed and no monitoring was conducted at BMS-2 or BMS-3. The Tailings Management Area (TMA) has not yet been constructed, therefore monitoring of the reclaim line from the TMA contact water pond (BMS-4) was not conducted in 2021. The Non-contact water pond (BMS-5) has not yet been constructed and no monitoring of this facility occurred in 2021.

No samples were collected under monitoring station BMS-6 as no fresh water was used from Aimaokatalok Lake in 2021.

No landfill exists at Boston at this time and no samples were collected from the landfill sump (BMS-7).

No samples were collected under monitoring station BMS-8 (Discharge of treated sewage) in 2021 as the Sewage Treatment Plant at Boston Camp was not operational under licence 2AM-BOS1835. Monitoring of the Sewage Treatment Plant at Boston Camp to support surface exploration drilling programs is completed under licence 2BB-BOS1727. The Boston Camp was not operational in 2021.

The Landfarm at Boston has not yet been constructed (BMS-9). No construction was conducted at Boston in 2021 and no monitoring was conducted under monitoring station BMS-10.

Monitoring of the Bulk Fuel Storage Facility at Boston was conducted under water licence 2BB-BOS1727. Results of this monitoring are presented in Table D4-7 in Appendix D.4 of this report. The Boston Fuel Storage Area and Containment sumps (BMS-11) listed under licence 2AM-BOS1835 has not been constructed at this time.

Appendix E

Doris Mine Annual Water and Load Balance Assessment – 2021 Calendar Year

AGNICO EAGLE

SRK Consulting (Canada) Inc.
1066 West Hastings Street, Suite 2200
Vancouver, BC V6E 3X2
Canada

+1 604 681 4196 office
+1 604 687 5532 fax

vancouver@srk.com
www.srk.com

Technical Memo

March 23, 2022

To	Nancy Duquet-Harvey and Ashley Mathai, Hope Bay Project
From	Nina Feng, SRK; Christina James, SRK
Cc	John Kurylo, SRK; Lisa Barazzol, SRK
Subject	Doris Mine – Annual Water and Load Balance Assessment – 2021 Calendar Year
Client	Agnico Eagle Mines Ltd.
Project	1CT022.076

1 Introduction

Monthly monitoring of the Doris Tailings Impoundment Area (TIA) is a requirement during operations under the Hope Bay Water Licence No: 2AM-DOH1335 – Amendment No. 2 (NWB 2018). The Doris TIA receives tailings slurry from the mine's process plant (mill); mine water from the Doris and Madrid underground mines; runoff from the Naartok East crown pillar recovery pit; runoff from the camp, ore and waste rock pads (and associated ponds); as well as natural runoff and direct precipitation.

SRK prepared a water and load balance model to support the FEIS (SRK 2017a) which is maintained to evaluate water management needs and predict water quality at the Project and downstream receptors, as well as to predict Doris TIA levels. Under Water Licence No: 2AM-DOH1335, Schedule B Item 4, a summary of the results for the monthly Doris TIA water balance and water quality model assessments, including any re-calibrations, is required to be reported. Model assessments are conducted each year. A summary of the past assessments is presented in Table 1.

Table 1: Previous Model Calibrations (2017, 2018, and 2019, 2020)

Model Reference	Monitoring Year	Calibration Changes	Key Conclusions and Model Changes
SRK 2017a	Final Environmental Impact Statement	Baseline Model	Baseline Model
SRK 2018	2017	None	*Water Balance:* predictions trending with measured elevations *Load Balance:* Doris Process Plant not at steady state, no changes made for underpredicted parameters
SRK 2019	2018	Hydrology, processing rate, mine water flows,	*Water Balance:* after updates, predictions trending with measured elevations

Model Reference	Monitoring Year	Calibration Changes	Key Conclusions and Model Changes
		stage storage curves	_Load Balance:_ most parameters at detection limits, overpredicted, or trending well with measured data. Update for underpredicted parameters as follows: _Doris process water:_ ammonia, total cyanide, free cyanide, sulphate, and the following total metals: aluminum, copper, iron, manganese, nickel, phosphorous and sodium _Doris Mine water:_ ammonia
SRK 2020	2019	Hydrology, processing rate, mine water flows, stage storage curves, sedimentation control ponds, degradation rates, process water source term, mine water source term	_Water Balance:_ after updates, predictions trending with measured elevations _Load Balance:_ most parameters at detection limits, overpredicted, or trending well with measured data. Update for underpredicted parameters as follows: _Degradation rates:_ increased ammonia degradation rate, changed total cyanide degradation rate and degradation products to free and Weak Acid Dissociable (WAD) cyanide. _Doris process water:_ cyanate, total and dissolved manganese _Doris Mine water:_ total and dissolved manganese
SRK 2021	2020	Hydrology, processing rate, mine water flows, sedimentation control ponds, process water source term	_Water Balance:_ after updates, predictions trending with measured elevations _Load Balance:_ most parameters at detection limits, overpredicted, or trending well with measured data. Update for underpredicted parameters as follows: _Doris process water:_ total and dissolved boron

Sources: SRK 2018, 2019, 2020, 2021

The previous annual assessments (i.e., for years 2017 through 2020) concluded that the overall mechanisms behind the water balance adequately represented the system (SRK 2018, 2019, 2020, 2021). Therefore, a similar approach was taken for the 2021 calibration (as presented in this memorandum). Measured 2021 elevations and water quality data were compared to the predictions from the calibrated SRK model adjusted for 2021 measured values (e.g. flows, precipitation, processing rate).

After the water balance adjustments, the model was assessed from a water quality perspective. Parameters were grouped based on the comparison of predicted and observed results for the Doris TIA. The following parameter groups were previously identified:

- Conservative predictions (measured values below the model predictions),
- Predictions trending well with measured data,
- Underpredicted, and,
- Detection limit greater than prediction (i.e., below testing detection)

The model was considered adequate for the parameters where predictions were conservative (overestimated in the model) and below permit limits, trending well with measured data, and where detection limits were greater than prediction. Underpredicted values or values that were overpredicted to be above permit limits were assessed individually and adjusted based on measured observations in the process water, mine water and the Doris TIA.

2 Model Inputs and Measured Data Comparison

The model set-up and mechanisms represented are detailed in the Final Environmental Impact Statement (FEIS) Water and Load Balance report (SRK 2017a). Since the original model development, some changes to source terms were made based on review of data from:

- 2018, as documented in the memo Doris Mine Annual Water and Load Balance Assessment – 2018 Calendar Year (SRK 2019).
- 2019, as documented in the memo Doris Mine Annual Water and Load Balance Assessment – 2019 Calendar Year (SRK 2020).
- 2020, as documented in the memo Doris Mine Annual Water and Load Balance Assessment – 2020 Calendar Year (SRK 2021).

This section will discuss the key differences between the SRK (2021) model assumptions and the measured inputs, or implemented infrastructure decisions, from 2021.

2.1 Review of Water Balance Inputs

The model calibration relies on a comparison of similar input assumptions. For example, if the model assumed an average hydrological year but the site measured a 1 in 50 wet year, it would be likely that the model would underpredict elevations in the Doris TIA. Therefore, inputs that were measured onsite were updated in the model. Any input not discussed in this section remained as per the original model assumptions documented in the FEIS model (SRK 2017a), or the previous calibration updates (SRK 2019, SRK 2020, SRK 2021).

2.1.1 Hydrology Update

The measured Doris meteorological data in the model was updated to include values from the 2021 calendar year for mean daily temperature, daily rainfall, and daily total precipitation. The 2021 dataset from the Doris meteorological station was complete and without data gaps. Therefore, measured data from the Cambridge Bay Stations were not required for gap-filling and patching.

A review of the meteorological baseline for the Doris site was conducted (SRK 2022) to provide an update to analyses summarized in the FEIS, which used data up to the end of 2015 (SRK 2017b, SRK 2017c). The updated review includes climate and hydrology data records to the end of 2020 from the Doris site meteorological station, the Cambridge Bay stations operated by Environment and Climate Change Canada (ECCC), and other available sources of climate information. This analysis comprised a detailed review of air temperature, total precipitation, wind speed, relative humidity (and dew point temperature), solar radiation, snow depth, snowmelt, potential evaporation, and sublimation, with estimates for the effect of climate change on annual air temperature and total precipitation.

Changes to the predictive climate and hydrology model inputs are summarized in Table 2. Inputs that are not explicitly listed remain the same as the FEIS inputs. Details on the hydrology analyses are provided in the Hope Bay Climate Update memorandum (SRK 2022).

Table 2: Summary of Model Updates to Predictive Climate and Hydrology Inputs

Analysis	Model Update
Frequency Analysis on Annual Precipitation	Updated synthetic time series for daily precipitation and mean air temperature used for frequency analysis to calculate precipitation and temperature for the average year, 1-in-20 wet year, 1-in-50 wet year, 1-in-100 wet year, 1-in-20 dry year, 1-in-50 dry year, and 1-in-100 dry year scenarios,
Snow Capture Efficiency	Updated average rain and snow undercatch factors for application if unadjusted historical Cambridge Bay climate data was required.
Potential Evaporation	Updated mean annual evaporation rate. Updated monthly average potential evaporation rates.
Potential Sublimation	Added monthly average potential sublimation rates and applied to accumulated snowpack.
Runoff	Updated monthly average runoff coefficients. Updated monthly average effective runoff distribution.
Climate Change	Updated climate change modelling approach to interpolate projected changes in mean annual air temperature and precipitation in the following time slices: 2011-2040, 2041-2070, and 2071-2100. The projections are based on the Medium Emissions case (RCP4.5) provided by the Intergovernmental Panel on Climate Change (IPCC) fifth assessment report (AR5).

Sources: Compiled in text

2.1.2 Processing Rate

In February 2021, underground mining activities were temporarily suspended at Madrid North Mine, with mining continuing at Doris Mine. The FEIS processing rate for 2021 was higher than the actual production rates and all the total processed ore was from Doris Mine, with no contribution from Madrid North Mine. The measured processing rates for 2021 are presented in Table 3 and Figure 1. Overall, 2021 measured processing (260,000 tonnes) was at an average of approximately 36% of the FEIS modelled amount (730,000 tonnes). The FEIS model also included a processing rate of 1,000 tpd of Madrid North ore to the Madrid North Concentrator in 2021. This infrastructure does not exist at site and this processing rate has there been set to zero throughout 2021.

Monthly processing rates were updated in the model to reflect the measured values for 2021. For 2022 to 2032, the forecasted processing rates in the model were left as the FEIS values, as presented in Attachment 1.

Table 3: Summary of FEIS Forecasted and Measured Processing Rates for 2021

Month	Ore Processing Rate in the Doris Process Plant (tpd)					
	Doris Mine		Madrid Mine		Total Processed	
	FEIS	Measured	FEIS	Measured	FEIS/Modelled	Measured
January	280	1,100	1,700	-	2,000	1,100
February	280	790	1,700	-	2,000	790
March	280	550	1,700	-	2,000	550
April	280	1,300	1,700	-	2,000	1,300
May	280	1,300	1,700	-	2,000	1,300
June	280	500	1,700	-	2,000	500
July	280	790	1,700	-	2,000	790
August	280	1,100	1,700	-	2,000	1,100
September	280	960	1,700	-	2,000	960
October	280	230	1,700	-	2,000	230
November	280	-	1,700	-	2,000	-
December	280	-	1,700	-	2,000	-
Total (tonnes)	100,000	260,000	630,000	-	730,000	260,000

Sources: https://srk.sharepoint.com/:x:/r/sites/NA1CT022.076/Internal/4_2021_AnnualWLB/Inputs/HopeBay_2021Inputs_1CT022-066_R00_ajb_nf.xlsx?d=w1f5e5cf44ca64e258620c218b584fe03&csf=1&web=1&e=3KqTYd

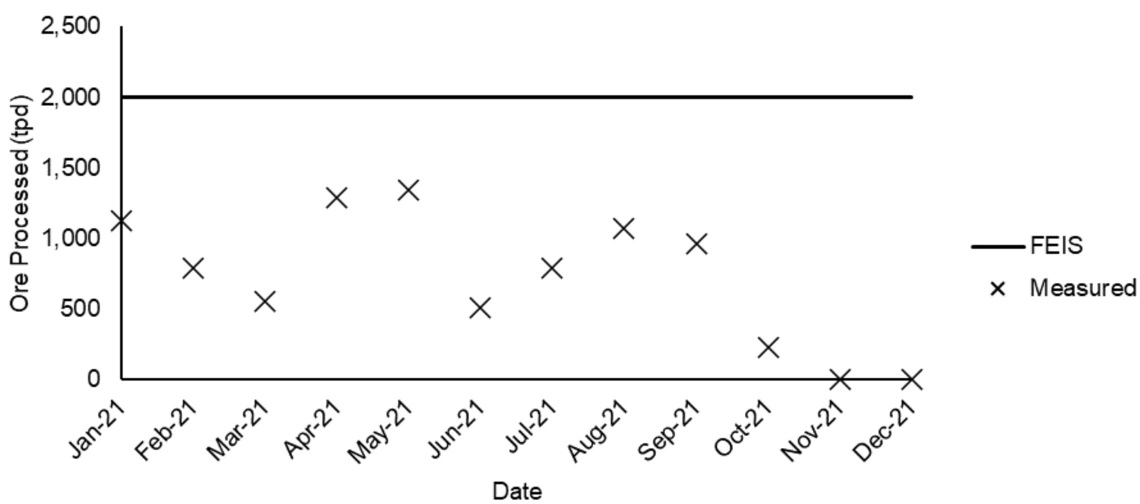


Figure 1: FEIS Forecasted and Measured Processing Rates for 2021

Sources: https://srk.sharepoint.com/:x:/r/sites/NA1CT022.076/Internal/4_2021_AnnualWLB/Inputs/HopeBay_2021Inputs_1CT022-066_R00_ajb_nf.xlsx?d=w1f5e5cf44ca64e258620c218b584fe03&csf=1&web=1&e=3KqTYd

2.1.3 Site Contact Water

Contact water at the Doris site from the ore, waste rock, and camp pads is collected in two ponds: the Doris pollution control and the sediment control ponds. Contact water is also collected in Sumps 1 to 3 at Doris Camp and pumped back up to the pollution control pond. Contact water is transferred from the pollution control pond to the sediment control pond, which is pumped to the Doris TIA during the open water season.

Transfer rates from the sediment control pond to the Doris TIA were updated to include rates from 2017 to 2021, presented in Table 4.

Table 4: Monthly Measured Flows from the Sediment Control Pond to the Doris TIA

Month	Sediment Control Pond to Doris TIA (m^3/month)				
	2017	2018	2019	2020	2021
January	-	-	-	-	-
February	-	-	-	-	-
March	-	-	-	-	-
April	-	-	-	-	-
May	-	-	-	-	-
June	-	12,000	9,800	15,000	2,500
July	3,800	6,900	43,000	7,600	16,000
August	3,000	22,000	39,000	3,900	2,200
September	-	12,000	33,000	1,600	5,700
October	-	-	-	-	1,900
November	-	-	-	-	-
December	-	-	-	-	-
Total	6,800	53,000	120,000	28,000	28,000

Sources: https://srk.sharepoint.com/:x:/r/sites/NA1CT022.076/Internal/4_2021_AnnualWLB/Inputs/HopeBay_2021Inputs_1CT022-066_R00_ajb_nf.xlsx?d=w1f5e5cf44ca64e258620c218b584fe03&csf=1&web=1&e=3KqTYd

Note that there is typically none or minimal pumping from the ponds to the TIA during the winter / ice covered months (approx. October to May)

2.1.4 Mine Water and Roberts Bay Marine Discharge Line

In 2021, mine water was directed either to the Doris TIA for storage or discharged to Roberts Bay, through the marine outfall / discharge line, after TSS treatment. Measured mine water encountered to date totaled 1,600,000 m^3, with 420,000 m^3 discharged to Roberts Bay, and the remaining 1,200,000 m^3 directed to the TIA. Mine water represented about 26% of the total volume of water held in the Doris TIA at the end of 2021. This corresponds to an elevation of 31.79 masl as observed on January 1, 2021 and a total of 1,900,000 tonnes of dry tailings deposited in the Doris TIA.

Continued mining at Doris contributed to the ongoing inflow from the Doris Mine. Madrid North mine water was 0% of the FEIS projections due to the cessation of mining at Madrid. Use of the Roberts Bay marine discharge line is a key component of the overall Doris TIA system that is used to help keep water levels within appropriate operational elevation ranges. Most of the Madrid North mine water was collected as contact water in the Naartok East crown pillar recovery pit. A comparison of modelled and measured mine water flows are presented in Table 5, Figure 2, and Figure 3. Flow rates for both Doris and Madrid Underground mine water were updated in the model to reflect measured values for 2021. In the model, all mine water was directed to Roberts Bay for discharge; this was updated to reflect the split to Roberts Bay and the Doris TIA. For 2022 to 2032, the forecasted mine water flows for Doris, Madrid North and Madrid South were left as the FEIS values (Attachment 1), where all are directed to Roberts Bay through the marine discharge line. Although the sources and destinations are different than originally modelled, the overall amount of mine water that was indicated as needing management in the FEIS was consistent with the total intercepted mine outflows, with measured flows being 97% of the predicted.

Table 5: Summary of FEIS Forecasted and Measured Mine Water Flows for 2021

Month	Mine Water (m^3/month)					
	Doris Mine				Madrid Mine	
	FEIS	Measured to Roberts Bay	Measured to Doris TIA	Measured Total	FEIS	Measured
January	53,000	-	40,000	40,000	3,900	-
February	48,000	-	43,000	43,000	3,400	-
March	53,000	-	49,000	49,000	3,700	-
April	51,000	-	55,000	55,000	3,500	-
May	53,000	710	45,000	46,000	8,100	-
June	51,000	40,000	18,000	58,000	13,000	-
July	52,000	23,000	11,000	34,000	15,000	-
August	-	30,000	4,600	34,000	17,000	-
September	-	21,000	1,300	22,000	17,000	-
October	-	36,000	83	36,000	19,000	-
November	-	18,000	5,600	24,000	19,000	-
December	-	-	49,000	49,000	20,000	-
Total	360,000	170,000	320,000	490,000	140,000	0

Sources: https://srk.sharepoint.com/:x:/r/sites/NA1CT022.076/Internal/4_2021_AnnualWLB/Inputs/HopeBay_2021Inputs_1CT022-066_R00_ajb_nf.xlsx?d=w1f5e5cf44ca64e258620c218b584fe03&csf=1&web=1&e=3KqTYd

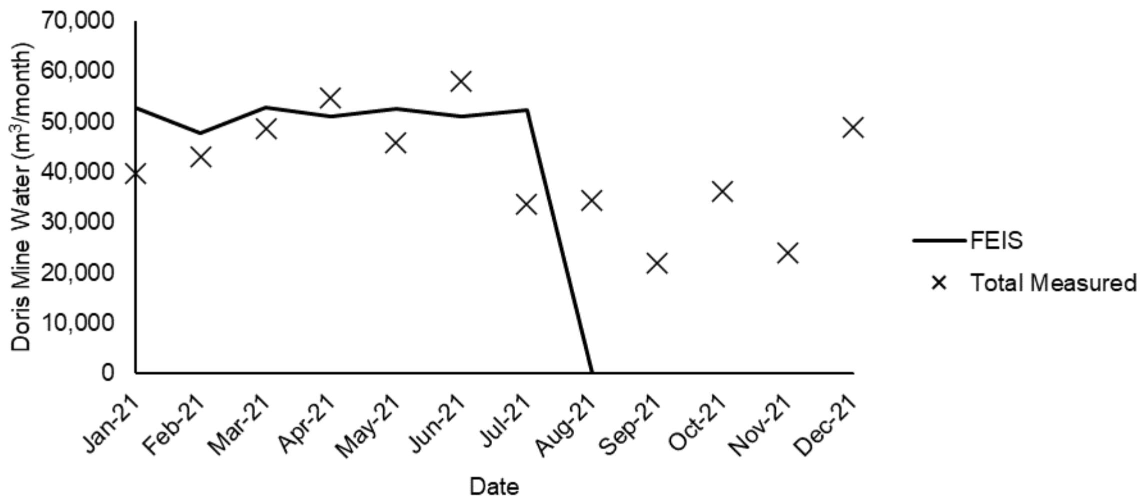


Figure 2: FEIS Forecasted and Measured Doris Mine Water Flows for 2021

Sources: https://srk.sharepoint.com/:x:/r/sites/NA1CT022.076/Internal/4_2021_AnnualWLB/Inputs/HopeBay_2021Inputs_1CT022-066_R00_ajb_nf.xlsx?d=w1f5e5cf44ca64e258620c218b584fe03&csf=1&web=1&e=3KqTYd

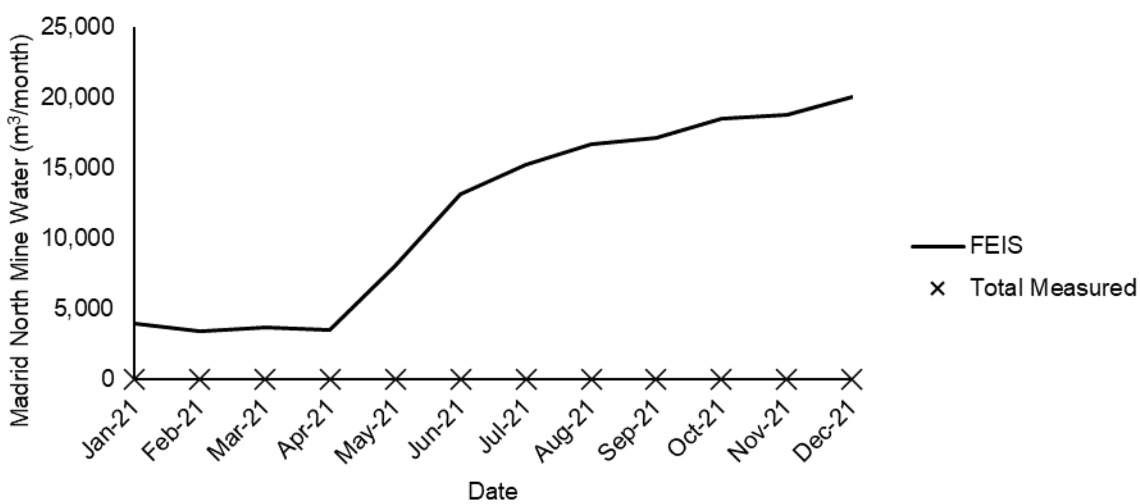


Figure 3: FEIS Forecasted and Measured Madrid North Mine Water Flows for 2021

Sources: https://srk.sharepoint.com/:x:/r/sites/NA1CT022.076/Internal/4_2021_AnnualWLB/Inputs/HopeBay_2021Inputs_1CT022-066_R00_ajb_nf.xlsx?d=w1f5e5cf44ca64e258620c218b584fe03&csf=1&web=1&e=3KqTYd

Discharge to Roberts Bay in the 2021 calendar year began in May. The pumping rate applied in the model was assumed to be 6,750 m^3/day and occurred between June and September; in 2021, the measured monthly pumping rates averaged approximately 5,800 m^3/day and occurred from May until the end of November. A comparison of modelled and measured discharge is presented in Table 6 and Figure 4.

Flow rates for Roberts Bay discharge were updated in the model to reflect measured values for 2021. For 2022 to 2032, the forecasted Roberts Bay discharge rates were left as the FEIS pumping rate.

Table 6: Summary of Monthly Forecasted and Measured Flows from the Doris TIA to Robert's Bay for 2021

Month	Doris TIA to Robert's Bay (m^3/month)	
	FEIS	Measured
January	-	-
February	-	-
March	-	-
April	-	-
May	-	-
June	210,000	190,000
July	210,000	150,000
August	210,000	170,000
September	210,000	140,000
October	-	85,000
November	-	210,000
December	-	-
Total	820,000	930,000

Sources: https://srk.sharepoint.com/:x:/r/sites/NA1CT022.076/Internal/4_2021_AnnualWLB/Inputs/HopeBay_2021Inputs_1CT022-066_R00_ajb_nf.xlsx?d=w1f5e5cf44ca64e258620c218b584fe03&csf=1&web=1&e=3KqTYd

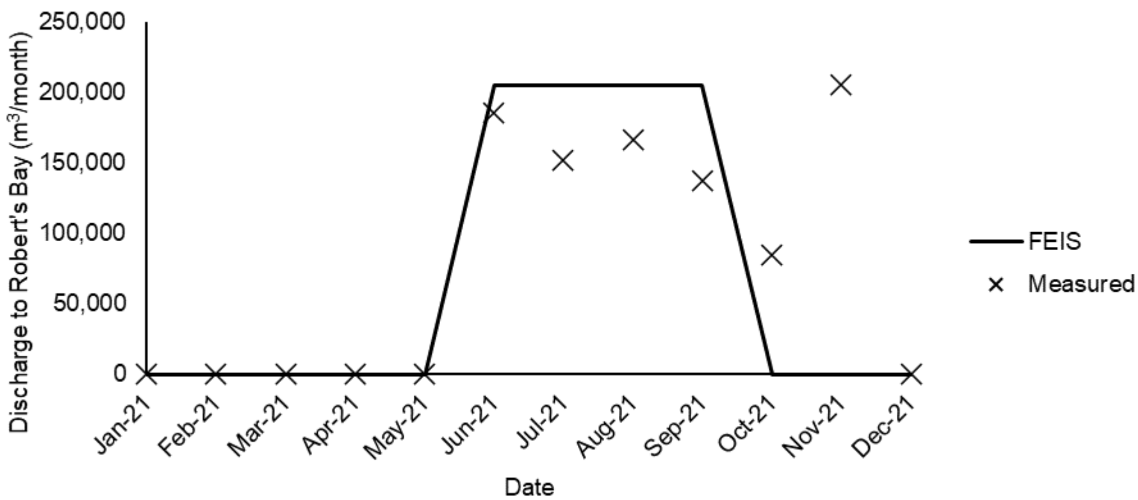


Figure 4: FEIS Forecasted and Measured Doris TIA to Robert's Bay Flows for 2021

Sources: https://srk.sharepoint.com/:x:/r/sites/NA1CT022.076/Internal/4_2021_AnnualWLB/Inputs/HopeBay_2021Inputs_1CT022-066_R00_ajb_nf.xlsx?d=w1f5e5cf44ca64e258620c218b584fe03&csf=1&web=1&e=3KqTYd

2.2 Review of Water Quality Inputs

The calibrated 2020 model (SRK 2021) was updated with the 2021 measured water balance inputs. Agnico Eagle provided 2021 water quality data collected in the Doris TIA at the reclaim pump station (TL-1), which was compared to the 2020 model predictions. Parameters were grouped into three categories identified through the previous reviews (as discussed in Section 1), and as presented in Table 7. For parameters that were conservative or trending well according to model predictions no further action was taken; however, parameters that were underpredicted or overpredicted and above permit limits are addressed in the sections below. TSS was not evaluated as the model is a conservation of mass balance that does not include a mechanism for TSS settlement (SRK 2021).

Table 7: Initial Screening Assessment of Water and Load Balance Parameters

Classification Type	Parameters Included	Comparison to Model Prediction
Conservative	F, nitrate (NO_3) Dissolved Metals: Al, Sb, As, Ba, Ca, Cd, Cr, Cu, Fe, Pb, Li, Hg, Mn, Mo, Ni, Se, Ag, Tl, V, P, Zn Total Metals: Al, Sb, As, Ba, Ca, Cd, Cr, Fe, Pb, Li, Hg, Mn, Mo, Ni, Se, Ag, Tl, V, P, Zn	Measured values are below the model prediction. The modeled values are reflective of conservative assumptions (typically higher predictions than measured parameter values). *Note: some values may be at or close to the method detection limit and slightly above the model prediction; these parameters were still considered to be in the conservative classification type.*
Trending Well	Total dissolved solids (TDS*), Cl*, ammonia (NH_4), nitrite (NO_2), total cyanide (CN-T), Free cyanide (CN-F), WAD cyanide (CN-WAD), thiocyanate (SCN) Dissolved Metals: Be, B*, Co, Mg*, Na*, U Total Metals: Be, B*, Co, Cu, Mg*, Na*, U	Measured values are tracking well with the model predictions. **Note: while predicted values were within measured ranges, some parameters tended to exhibit seasonal offsets from measured data.*
Underpredicted	cyanate (CNO)	Model predictions are lower than measured values. Corrective actions discussed in subsequent sections.

Sources: https://srk.sharepoint.com/:x:/r/sites/NA1CT022.076/Internal/4_2021_AnnualWLB/Inputs/HopeBay_2021Inputs_1CT022-066_R00_ajb_nf.xlsx?d=w1f5e5cf44ca64e258620c218b584fe03&csf=1&web=1&e=3KqTYd

To re-calibrate the model, TIA source terms were evaluated to determine how each would affect the results. The remainder of this section describes the model refinement while Section 3 presents the step-wise methodology for calibration. Section 4 discusses why the calibration was carried out and the results of the calibration.

2.2.1 Cyanate

Cyanate (CNO) concentrations in 2021 generally varied within a range of approximately 2 and 7 mg/L with values steadily increasing during ice cover, then decreasing during the open water season before the cycle repeats as ice formation repeats again. The modelled values follow a similar trend, but exhibit an offset at a lower range from measured values, ranging instead between 0 and 4 mg/L.

Comparing the measured data to the process water source term, it was found that since 2018, monthly average concentrations of cyanate in process water have increased above the source term concentration of 40 mg/L, with average 2021 concentrations being approximately 72 mg/L. However, there is high variability in the data, and predictions for other cyanide derivatives and nitrogen species (especially ammonia) trended well with measured values. Thiocyanate values in 2021 were predominantly at the method detection limit, and model accuracy was difficult to assess. No change was made to the calibrated SRK (2021) model; however, cyanate and other cyanide derivatives will continue to be monitored in the future to determine if cyanate in process water is maintained at an elevated concentration (indicating a need for a change in source term) or is increasing/decreasing (indicating a need for assessment of the mechanisms controlling cyanate).

Water from the Doris TIA is discharged to Roberts Bay in compliance with Metal and Diamond Mine Effluent Regulations (MDMER).

2.2.2 Cryoconcentration

Predictions for the following parameters tended to exhibit seasonal offsets for concentration peaks and troughs: total dissolved solids (TDS), chloride (Cl), total and dissolved boron (B), total and dissolved magnesium (Mg), and total and dissolved sodium (Na). Measured concentrations were compared to the model source terms for process water (TL-5), mine water (TL-12), and the sediment control pond (ST-1). While the accuracy of prediction for the magnitude of peak concentrations varied depending on parameter and calendar year, the modelled source terms could not be specifically isolated as the cause of the difference. The effect of other modelled mechanisms on concentration seasonality was evaluated, and ice formation (resulting in TIA volume reduction) was identified as a major factor affecting the timing and magnitude of concentration fluctuations in the Doris TIA. In the FEIS, ice formation on the Doris TIA followed a monthly distribution beginning in October and increasing to a maximum depth of 2.1 m in February, before melting from March until May. However, historical measured temperature at Doris site indicated that significant ice melt is more likely to occur later than modelled, as mean temperatures remain below freezing well past February.

A relationship between historical temperature and ice thickness was developed, with ice-freeze and ice-melt factors calibrated using historical concentrations. Retaining the assumption from the FEIS of maximum ice depth being 2.1 m, the modelling of ice formation and lake volume reduction was updated to be a function of mean daily temperature. Table 8 summarizes the estimates for ice thickness on Doris TIA for the 2021 water year (October 1, 2020 to September 30, 2021).

Table 8: Comparison of Doris TIA Ice Thickness Model Predictions for the 2021 Water Year

Month	Doris TIA Ice Thickness (m)	
	Predicted Ice Thickness – Previous Models	Predicted Ice Thickness – Temperature-Dependent
October	0.4	0
November	0.8	0.3
December	1.3	0.7
January	1.7	1.3
February	2.1	1.9
March	1.7	2.1
April	1.1	2.1
May	0.4	2.1
June	0	1.8
July	0	1.0
August	0	0
September	0	0

Sources: https://srk.sharepoint.com/:x:/r/sites/NA1CT022.076/Internal/4_2021_AnnualWLB/Inputs/HopeBay_2021Inputs_1CT022-066_R00_ajb_nf.xlsx?d=w1f5e5cf44ca64e258620c218b584fe03&csf=1&web=1&e=3KqTYd

3 Calibration Methodology

Changes to the model were applied one step at a time to assess the impact on the model results. A summary of the steps taken during the 2021 calibration were:

1. Water balance inputs updated:
   a. Includes: hydrology update, Doris mine water flows, and Doris Process Plant processing rate updated to include the measured data for 2021.
   b. Predicted concentrations were compared to measured Doris TIA data at station TL-1. Water quality screening assessment results are presented in Table 6.
2. Calibration evaluation and updates (if applicable):
   a. Evaluation of source terms and mechanisms affecting parameters identified for re-calibration.
   b. Adjustment of modelling approach to calculating ice formation on the Doris TIA based on historical concentration data.
   c. Predicted concentrations were compared back to measured Doris TIA data at station TL-1.
3. Final results generation:
   a. All adopted values were reviewed and accepted.

4 Calibration Evaluation

Model validity is assessed based on predictions for the Doris TIA elevation and for water quality in the TIA, compared with measured data. A summary of the results considered in the assessment of the 2021 model is presented in Table 9.

Table 9: Description of the Predictive Cases Discussed

Graphed Prediction	Description
Predicted – 2020	Model results generated for 2021 (forward-looking) based on calibration with 2020 data (SRK 2021)
Predicted – WB	Model results generated for 2021 (backward-looking) after water balance updates with 2021 measured data (hydrology update, mine water, process rate, sedimentation flows)
Predicted – 2021	Model results after the full 2021 assessment presented herein.

4.1 Doris TIA Elevation

TMAC provided measured water elevations for the Doris TIA for 2021. These were compared to the 2020 model predictions (Predicted Elevation – 2020) as well as the updated predictions (Predicted Elevation – WB). The results of the measured elevations and the two predicted elevation cases are shown in Table 10 and Figure 5.

Although some months show an elevation difference, the general trend of the measured elevation data matches the updated predictions. Based on a visual inspection of goodness of fit, the mechanisms affecting model calibration are trending well with measured data and no further recalibration of the model is required at this time regarding water inventory.

Table 10: Doris TIA Elevation Comparison to Model Predictions

Month	Doris TIA Elevation (masl)		
	Average Measured Monthly Elevation	Predicted Elevation – 2020	Predicted Elevation – WB
January	31.7	31.7	31.6
February	31.7	31.7	31.7
March	31.8	31.7	31.7
April	31.9	31.7	31.8
May	31.9	31.7	31.9
June	32.1	32.1	32.1
July	32.1	32.0	32.2
August	32.0	31.8	32.1
September	32.0	31.7	32.1
October	32.0	31.6	32.1
November	31.9	31.7	32.1
December	31.8	31.7	32.0

Sources: https://srk.sharepoint.com/:x:/r/sites/NA1CT022.076/Internal/4_2021_AnnualWLB/Inputs/HopeBay_2021Inputs_1CT022-066_R00_ajb_nf.xlsx?d=w1f5e5cf44ca64e258620c218b584fe03&csf=1&web=1&e=3KqTYd

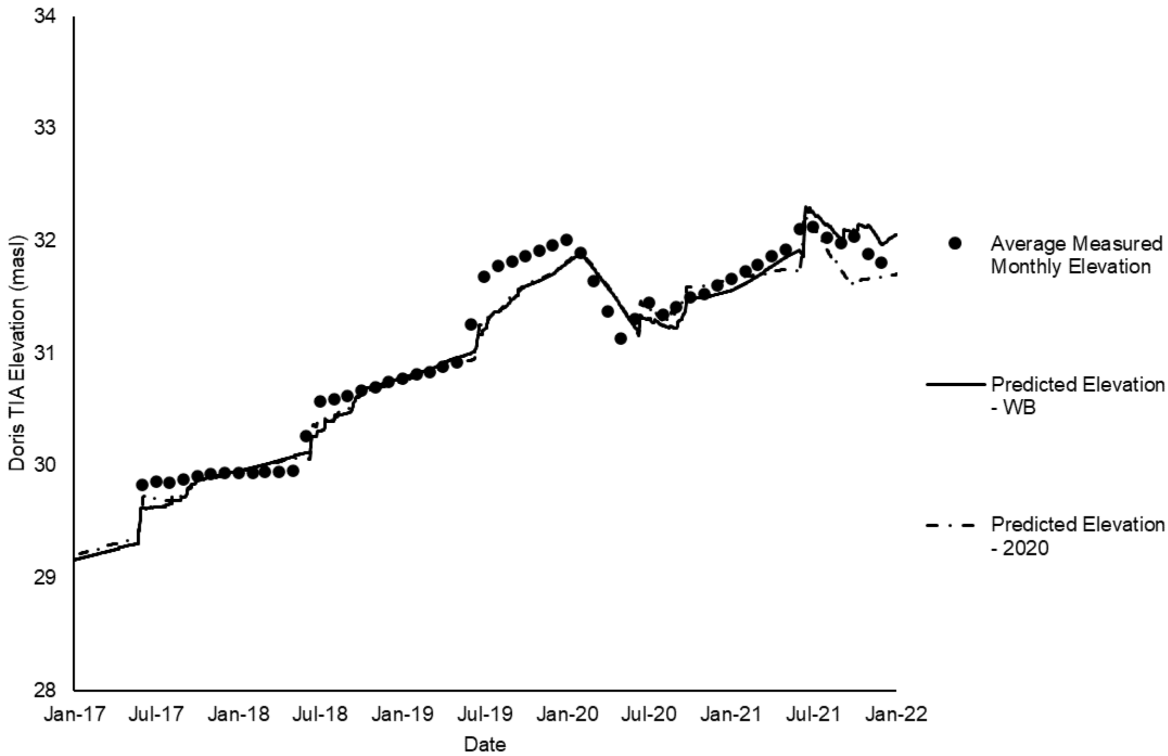


Figure 5: Modeled and Predicted Elevations in the Doris TIA

Sources: https://srk.sharepoint.com/:x:/r/sites/NA1CT022.076/Internal/4_2021_AnnualWLB/Inputs/HopeBay_2021Inputs_1CT022-066_R00_ajb_nf.xlsx?d=w1f5e5cf44ca64e258620c218b584fe03&csf=1&web=1&e=3KqTYd

4.2 Predicted TIA Water Quality (Post Model Calibration)

Attachment 2 presents a comparison between the measured data at TL-1 and the water quality predictions generated by the model. The graphs show several model predictions (Table 9), representing the model calibration evolution described in Section 3.

The graphs include predictions up until the Doris TIA is drained and maintained empty after the North Dam is breached during reclamation, immediately before final closure. For parameters regulated under the Metal and Diamond Mining Effluent Regulations (MDMER), the maximum authorized monthly mean concentrations were included on the plots (MDMER 2022).

After the screening assessment and calibration adjustments, parameters could be reclassified into three groups presented in Table 11.

Table 11: Screening Summary of Water Load Balance Parameters after Calibration

Classification Type	Parameters Included	Comparison to 2020 Model Prediction
Conservative	F, nitrate (NO_3) Dissolved Metals: Al, Sb, As, Ba, Ca, Cd, Cr, Cu, Fe, Pb, Li, Hg, Mn, Mo, Ni, Se, Ag, Tl, V, P, Zn Total Metals: Al, Sb, As, Ba, Ca, Cd, Cr, Fe, Pb, Li, Hg, Mn, Mo, Ni, Se, Ag, Tl, V, P, Zn	2021 model predictions are similar to or lower than 2020 model predictions but remain above measured 2021 values. Both sets of modeled values are reflective of conservative assumptions (parameter predictions typical greater than measured). Modelled peaks in the 2021 model occur more gradually than in the 2020 model. *Note: some values may be at or close to the method detection limit and slightly above the model prediction; these parameters were still considered to be conservative.*
Trending Well	Total dissolved solids (TDS), Cl, ammonia (NH_4), nitrite (NO_2), total cyanide (CN-T), Free cyanide (CN-F), WAD cyanide (CN-WAD), thiocyanate (SCN) Dissolved Metals: Be, B, Co, Mg, Na, U Total Metals: Be, B, Co, Cu, Mg, Na, U	2021 model predictions are similar to or lower than 2020 model predictions and are tracking well with the measured 2021 values. 2021 predictions show improved accuracy in reflecting measured concentrations peaks and troughs.
Underpredicted – TSS driven	Total suspended solids (TSS)	Model predictions are lower than measured values, no model changes as per the 2019 and 2020 evaluation (SRK 2020, SRK 2021).
Underpredicted – cyanate	Cyanate (CNO)	2021 model predictions remain lower than measured values but are otherwise trending similarly. No model changes for the 2021 calibration.

Sources: https://srk.sharepoint.com/:x:/r/sites/NA1CT022.076/Internal/4_2021_AnnualWLB/HopeBay_AnnualWLBReview_1CT022-066_Rev13_nf_sm_ajb.xlsm?d=wee0f6910e7054a19b2e8fc5f6259cb60&csf=1&web=1&e=sy8DkE

5 Comparison to MDMER

5.1 Measured Values

Doris TIA water was discharged to Roberts Bay in 2021 and will continue to be. This discharge is subject to MDMER under the Fisheries Act. Updated water quality projections for the Doris TIA were compared to the MDMER limits (MDMER 2021) in Attachment 2. All measured data were compared to the MDMER maximum authorized monthly mean concentrations and maximum authorized concentrations in a grab sample, presented in Table 12 and Table 13, respectively. During discharge of Doris TIA water to Roberts Bay in 2021, there were no MDMER exceedances.

Average monthly total copper was highest in late winter (March) at 0.127 mg/L, 42% of the MDMER limit, but below the 2020 highest average monthly concentration.

Unionized ammonia peaked on August 17 at 0.377 mg/L, 38% of the MDMER limit.

Total suspended solids was elevated in September and October 2021 after development of an algal bloom in late summer; however, Roberts Bay discharge was proactively shut off in mid-September and remained so until TSS concentrations decreased below the MDMER limit at the end of October.

Table 12: Comparison of Maximum Monthly Mean Measured Concentrations in the Doris TIA to the MDMER

Parameter	Units	MDMER Maximum Authorized Monthly Mean Concentration	Maximum of 2021 Doris TIA Average Monthly Concentrations (TL-1)	Month of Maximum Concentration	Percent of MDMER Limit
TSS	mg/L	15.00	18.75	October	125%
Total Arsenic	mg/L	0.30	0.003	January*	1%
Total Copper	mg/L	0.30	0.13	March*	42%
Cyanide – Total	mg/L	0.50	0.09	July	17%
Total Lead	mg/L	0.10	0.001	July	0.5%
Total Nickel	mg/L	0.50	0.02	January*	3%
Total Zinc	mg/L	0.50	0.03	July	6%
Radium-226	Bq/L	0.37	0.01	January*	3%
Un-ionized Ammonia (as N)	mg/L	0.50	0.19	September	38%

Sources: https://srk.sharepoint.com/:x:/r/sites/NA1CT022.076/Internal/4_2021_AnnualWLB/HopeBay_AnnualWLBReview_1CT022-066_Rev13_nf_sm_ajb.xlsm?d=wee0f6910e7054a19b2e8fc5f6259cb60&csf=1&web=1&e=sy8DkE

Note: * No discharge to Roberts Bay from the Doris TIA occurred in January to March, and December 2021. Limited discharge in September and October 2021.

Table 13: Comparison of Maximum Grab Sample Concentration Measured in the Doris TIA Compared to the MDMER

Parameter	Units	MDMER Maximum Authorized Concentration in a Grab Sample	Maximum Concentration Measured in the Doris TIA in 2021 (TL-1)	Date of Maximum Concentration	Percent of MDMER Limit
TSS	mg/L	30.00	23.40	2021-10-05	78%
Total Arsenic	mg/L	0.60	0.004	2021-02-16	0.6%
Total Copper	mg/L	0.60	0.18	2021-03-03	31%
Cyanide – Total	mg/L	1.00	0.10	2021-07-20	10%
Total Lead	mg/L	0.20	0.001	2021-03-03	0.3%
Total Nickel	mg/L	1.00	0.02	2021-01-05	2%
Total Zinc	mg/L	1.00	0.03	2021-04-07	3%
Radium-226	Bq/L	1.11	0.01	2021-01-13	1%
Un-ionized Ammonia (as N)	mg/L	1.00	0.38	2021-08-17	38%

Sources: https://srk.sharepoint.com/:x:/r/sites/NA1CT022.076/Internal/4_2021_AnnualWLB/HopeBay_AnnualWLBReview_1CT022-066_Rev13_nf_sm_ajb.xlsm?d=wee0f6910e7054a19b2e8fc5f6259cb60&csf=1&web=1&e=sy8DkE

Note: * No discharge to Roberts Bay from the Doris TIA occurred in January to March, and December 2021. Limited discharge in September and October 2021.

5.2 Modeled Values

The updated water quality predictions were also screened against the MDMER limits to evaluate potential exceedances that may occur in the future. A summary of the findings is presented in Table 14 with a discussion included for each parameter. MDMER limits were also presented alongside predictions in Attachment 2.

Arsenic was identified during the FEIS as a parameter requiring treatment once the Madrid ore was processed and this remains unchanged for the updated predictions. Processing of Madrid ore began in October 2019, and the average monthly concentration in the Doris TIA increased by a factor of 2.5 in December 2020 compared to January 2019. The arsenic concentrations observed in 2020 remain below the predictions for arsenic and less than 1% of the MDMER limits for both maximum authorized monthly mean concentrations and maximum authorized concentrations in a grab sample.

The same four parameters identified as parameters to watch in the 2018 and 2019 reviews will still be monitored closely: TSS, total arsenic, total copper, total cyanide, and unionized ammonia.

Table 14: Comparison of Updated Predictions to MDMER Limits

Parameter	Discussion of Results
TSS	The model is not able to accurately predict TSS. A treatment plant to target TSS removal for mine water sent directly to the environment was operational in 2021. TSS will continue to be monitored and the discharge to Roberts Bay managed to prevent discharge of high TSS water linked to a yearly algal bloom.
Arsenic	Concentrations in the Doris TIA in 2020 increased by a factor of 2.5 after commencing Madrid ore processing, however, remain under the model predictions. Concentrations in 2021 have remained under the model predictions and Madrid ore processing has since been suspended. The need for arsenic treatment will be reassessed should Madrid ore processing recommence.
Copper	Updated predictions remain below the proposed MDMER limit. Copper concentrations will continue to be monitored, and if arsenic treatment is required, copper treatment may also be considered.
Total Cyanide	Updated predictions increase above the MDMER limit in Feb 2023. Total cyanide concentrations in the Doris TIA originate from iron cyanide complexes which readily degrade by photolysis. Modelled peaks for total cyanide occur in the spring before longer sunlight days commence photolysis. Measured cyanide concentrations have demonstrated that cyanide readily undergoes degradation in the Doris TIA during the open water season. Agnico Eagle will not discharge water that is above total cyanide limits.
Lead	Updated predictions remain below the MDMER limits and are not of concern.
Nickel	Updated predictions remain below the MDMER limits and are not of concern.
Zinc	Updated predictions remain below the MDMER limits and are not of concern.
Unionized Ammonia	Un-ionized ammonia is both pH and temperature dependent and not included in the model, as these parameters do not act conservatively and are not suitable for mass balancing. Agnico Eagle is sourcing treatment solutions to address un-ionized ammonia if necessary.

6 Final Remarks

Overall, the mechanisms behind the FEIS water and load balance appear to be well calibrated to the measured data for most parameters.

Five parameters (TSS, total arsenic, total copper, total cyanide, and unionized ammonia) have been identified as parameters of concern regarding MDMER limits applied to mine discharges and will continue to be monitored throughout 2022.

Table 15: Summary of the SRK (2021) Model Calibration to the Measured 2021 Data

<table>
<tr><th>Evaluated Model Input</th><th>Changes Made to Model Input</th><th>Conclusions of Calibration</th></tr>
<tr><td>Hydrology Data</td><td>Updated with 2021 measured data and meteorology baseline update (SRK, 2022)</td><td rowspan="4">Predicted elevation considered good fit with measure elevations.</td></tr>
<tr><td>Doris Process Plant process rate</td><td>Updated with 2021 measured data</td></tr>
<tr><td>Doris Mine water flows</td><td>Updated with 2021 measured data</td></tr>
<tr><td>Sedimentation control pond flows</td><td>Updated with 2021 measured data</td></tr>
<tr><td>Cyanate in the Doris TIA</td><td>No changes made</td><td>Calibration evaluation was underpredicted by the model, but measured values exhibit high variability and all other cyanide derivatives trended well.</td></tr>
</table>

Regards,
SRK Consulting (Canada) Inc.

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Nina Feng, EIT
Consultant, Water Management

And,

This signature was scanned with the author's approval for exclusive use in this document; any other use is not authorized.

Christina James
Principal Consultant

Attachments:

Attachment 1 Annual WLB Assessment – 2021 – TABLES
Attachment 2 Annual WLB Assessment – 2021 – PLOTS

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The opinions expressed in this document have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. While SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

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Attachment 1 Annual WLB Assessment – 2021 – TABLES

Project: **Hope Bay**
Number: **1CT022.076**
Task: **Summary of the FEIS Model Inputs**
Source: *HopeBay_FEISWLBalance_TypeA_Rev34_AJB_NF.gsm*

Table A1.1: Processing Rates for the Doris, Madrid and Boston Processing Plants

Model Date	Processing Rates (tonnes/day)						
	Total Doris Process Plant	Doris Ore to Doris Process Plant	Madrid North Ore to Doris Process Plant	Madrid North Ore to Madrid Process Plant	Madrid South to Doris Process Plant	Boston Ore to Doris Process Plant	Boston Ore to Boston Process Plant
1900-01-01	0	0	0	0	0	0	0
2011-01-01	0	0	0	0	0	0	0
2016-01-01	0	0	0	0	0	0	0
2017-01-01	0	0	0	0	0	0	0
2017-02-01	212	212	0	0	0	0	0
2017-03-01	351	351	0	0	0	0	0
2017-04-01	635	635	0	0	0	0	0
2017-05-01	659	659	0	0	0	0	0
2017-06-01	662	662	0	0	0	0	0
2017-07-01	569	569	0	0	0	0	0
2017-08-01	741	741	0	0	0	0	0
2017-09-01	555	555	0	0	0	0	0
2017-10-01	733	733	0	0	0	0	0
2017-11-01	634	634	0	0	0	0	0
2017-12-01	841	841	0	0	0	0	0
2018-01-01	814	814	0	0	0	0	0
2018-02-01	966	966	0	0	0	0	0
2018-03-01	1,012	1,012	0	0	0	0	0
2018-04-01	1,073	1,073	0	0	0	0	0
2018-05-01	893	893	0	0	0	0	0
2018-06-01	818	818	0	0	0	0	0
2018-07-01	1,027	1,027	0	0	0	0	0
2018-08-01	1,386	1,386	0	0	0	0	0
2018-09-01	1,614	1,614	0	0	0	0	0
2018-10-01	1,851	1,851	0	0	0	0	0
2018-11-01	1,842	1,842	0	0	0	0	0
2018-12-01	1,555	1,555	0	0	0	0	0
2019-01-01	1,464	1,464	0	0	0	0	0
2019-02-01	1,696	1,696	0	0	0	0	0
2019-03-01	1,680	1,680	0	0	0	0	0
2019-04-01	1,335	1,335	0	0	0	0	0
2019-05-01	1,999	1,999	0	0	0	0	0
2019-06-01	1,877	1,877	0	0	0	0	0
2019-07-01	1,416	1,416	0	0	0	0	0
2019-08-01	1,835	1,835	0	0	0	0	0
2019-09-01	1,893	1,893	0	0	0	0	0
2019-10-01	1,966	1,792	174	0	0	0	0
2019-11-01	1,794	1,369	425	0	0	0	0
2019-12-01	1,888	1,143	745	0	0	0	0
2020-01-01	963	963	0	0	0	0	0
2020-02-01	1,007	1,007	0	0	0	0	0
2020-03-01	1,374	1,339	35	0	0	0	0
2020-04-01	1,835	1,286	549	0	0	0	0
2020-05-01	1,192	1,072	121	0	0	0	0
2020-06-01	1,781	1,643	138	0	0	0	0
2020-07-01	1,196	990	205	0	0	0	0
2020-08-01	930	770	161	0	0	0	0
2020-09-01	435	404	32	0	0	0	0
2020-10-01	1,233	1,092	141	0	0	0	0
2020-11-01	917	917	0	0	0	0	0
2020-12-01	1,289	1,069	220	0	0	0	0
2020-01-01	1,121	1,121	0	0	0	0	0
2020-02-01	787	787	0	0	0	0	0
2020-03-01	549	549	0	0	0	0	0
2020-04-01	1,285	1,285	0	0	0	0	0
2020-05-01	1,341	1,341	0	0	0	0	0
2020-06-01	502	502	0	0	0	0	0
2020-07-01	786	786	0	0	0	0	0
2020-08-01	1,071	1,071	0	0	0	0	0
2020-09-01	961	961	0	0	0	0	0
2020-10-01	228	228	0	0	0	0	0
2020-11-01	0	0	0	0	0	0	0

2020-12-01	0	0	0	0	0	0	0
2022-01-01	2,000	0	1,800	1,200	0	200	200
2023-01-01	2,400	0	2,000	1,200	0	400	800
2024-01-01	2,400	0	2,000	1,200	0	400	2,200
2025-01-01	2,400	0	2,000	1,200	0	400	2,400
2026-01-01	2,400	0	2,000	1,200	0	400	2,400
2027-01-01	2,400	0	2,000	1,200	0	400	2,400
2028-01-01	2,400	0	2,000	1,200	0	400	2,400
2029-01-01	2,400	0	1,932	1,200	68	400	1,184
2030-01-01	2,400	0	1,452	1,200	548	400	0
2031-01-01	2,400	0	1,147	1,200	685	569	0
2032-01-01	2,400	0	0	0	1,414	184	0
2033-01-01	2,400	0	0	0	0	0	0
2300-01-01	2,400	0	0	0	0	0	0

Note; Model interprets the values as constant over the next time period

Project: **Hope Bay**
Number: **1CT022.076**
Task: **Summary of the FEIS Model Inputs**
Source: *HopeBay_FEISWLBalance_TypeA_Rev34_AJB_NF.gsm*

Table A1.2: Mine Water Flows By Source

Model Date	Mine Water Flows (m^3/day)								
	Doris Mine		Madrid North Mine				Madrid South Mine		
	Flows from Doris Lake	Flows from Bedrock	Flows from Patch Lake	Flows from Imniagut Lake	Flows from Windy Lake	Flows from Bedrock	Flows from Wolverine Lake	Flows from Patch Lake	Flows from Bedrock
1900-01-01	0	0	0	0	0	0	0	0	0
2017-10-01	0	0	0	0	0	0	0	0	0
2017-11-01	0	0	0	0	0	0	0	0	0
2017-12-01	0	0	0	0	0	0	0	0	0
2018-01-01	0	0	0	0	0	0	0	0	0
2018-02-01	13	85	0	0	0	0	0	0	0
2018-03-01	95	204	0	0	0	0	0	0	0
2018-04-01	101	150	0	0	0	0	0	0	0
2018-05-01	119	109	0	0	0	0	0	0	0
2018-06-01	188	137	0	0	0	0	0	0	0
2018-07-01	191	170	0	0	0	0	0	0	0
2018-08-01	188	128	0	0	0	0	0	0	0
2018-09-01	142	83	0	0	0	0	0	0	0
2018-10-01	396	215	0	0	0	0	0	0	0
2018-11-01	467	268	0	0	0	0	0	0	0
2018-12-01	419	234	0	0	0	0	0	0	0
2019-01-01	402	247	0	0	0	0	0	0	0
2019-02-01	385	293	0	0	0	0	0	0	0
2019-03-01	645	446	0	0	0	0	0	0	0
2019-04-01	485	296	0	0	0	0	0	0	0
2019-05-01	522	306	0	0	0	0	0	0	0
2019-06-01	523	389	0	0	0	0	0	0	0
2019-07-01	569	345	0	0	0	0	0	0	0
2019-08-01	604	344	0	0	0	0	0	0	0
2019-09-01	653	361	0	0	0	0	0	0	0
2019-10-01	643	373	0	0	0	0	0	0	0
2019-11-01	831	507	0	0	0	0	0	0	0
2019-12-01	1,477	875	0	0	0	0	0	0	0
2020-01-01	1,752	1,014	0	0	0	0	0	0	0
2020-02-01	651	258	0	0	0	0	0	0	0
2020-03-01	462	239	0	0	0	0	0	0	0
2020-04-01	215	114	0	0	0	0	0	0	0
2020-05-01	256	138	0	0	0	0	0	0	0
2020-06-01	188	49	0	0	0	0	0	0	0
2020-07-01	659	303	0	0	0	0	0	0	0
2020-08-01	605	33	0	0	0	0	0	0	0
2020-09-01	1,064	449	0	0	0	0	0	0	0
2020-10-01	1,093	560	0	0	0	0	0	0	0
2020-11-01	1,292	690	0	0	0	0	0	0	0
2020-12-01	892	478	0	0	0	0	0	0	0
2021-01-01	834	446	0	0	0	0	0	0	0
2021-02-01	1,003	537	0	0	0	0	0	0	0
2021-03-01	1,026	544	0	0	0	0	0	0	0
2021-04-01	1,191	631	0	0	0	0	0	0	0
2021-05-01	966	511	0	0	0	0	0	0	0
2021-06-01	1,265	669	0	0	0	0	0	0	0
2021-07-01	705	377	0	0	0	0	0	0	0
2021-08-01	720	385	0	0	0	0	0	0	0
2021-09-01	475	254	0	0	0	0	0	0	0
2021-10-01	762	408	0	0	0	0	0	0	0
2021-11-01	521	279	0	0	0	0	0	0	0
2021-12-01	1,027	550	0	0	0	0	0	0	0
2022-01-01	0	0	531	52	5	77	0	0	0
2022-02-01	0	0	547	52	5	71	0	0	0
2022-03-01	0	0	559	53	5	70	0	0	0
2022-04-01	0	0	569	53	6	63	0	0	0
2022-05-01	0	0	576	54	6	59	0	0	0
2022-06-01	0	0	601	54	6	196	0	0	0
2022-07-01	0	0	701	54	7	163	0	0	0
2022-08-01	0	0	773	55	7	139	0	0	0
2022-09-01	0	0	826	55	7	129	0	0	0
2022-10-01	0	0	868	55	7	125	0	0	0
2022-11-01	0	0	905	55	7	118	0	0	0
2022-12-01	0	0	935	55	8	109	0	0	0
2023-01-01	0	0	959	55	8	104	0	0	0
2023-02-01	0	0	977	56	8	97	0	0	0
2023-03-01	0	0	990	56	8	92	0	0	0
2023-04-01	0	0	1,001	56	8	91	0	0	0
2023-05-01	0	0	1,010	56	9	87	0	0	0
2023-06-01	0	0	1,017	56	9	84	0	0	0
2023-07-01	0	0	1,023	56	9	80	0	0	0
2023-08-01	0	0	1,028	56	9	80	0	0	0
2023-09-01	0	0	1,032	56	9	77	0	0	0
2023-10-01	0	0	1,035	56	9	76	0	0	0
2023-11-01	0	0	1,038	56	9	74	0	0	0
2023-12-01	0	0	1,041	56	9	73	0	0	0
2024-01-01	0	0	1,042	56	10	69	0	0	0
2024-02-01	0	0	1,044	56	10	69	0	0	0
2024-03-01	0	0	1,045	56	10	67	0	0	0
2024-04-01	0	0	1,046	56	10	66	0	0	0
2024-05-01	0	0	1,047	56	10	65	0	0	0

Project: **Hope Bay**
Number: **1CT022.076**
Task: **Summary of the FEIS Model Inputs**
Source: *HopeBay_FEISWLBalance_TypeA_Rev34_AJB_NF.gsm*

Table A1.2: Mine Water Flows By Source

Model Date	Mine Water Flows (m^3/day)								
	Doris Mine		Madrid North Mine				Madrid South Mine		
	Flows from Doris Lake	Flows from Bedrock	Flows from Patch Lake	Flows from Imniagut Lake	Flows from Windy Lake	Flows from Bedrock	Flows from Wolverine Lake	Flows from Patch Lake	Flows from Bedrock
2024-06-01	0	0	1,048	56	10	64	0	0	0
2024-07-01	0	0	1,049	56	10	63	0	0	0
2024-08-01	0	0	1,049	57	10	63	0	0	0
2024-09-01	0	0	1,050	57	10	62	0	0	0
2024-10-01	0	0	1,051	57	10	60	0	0	0
2024-11-01	0	0	1,051	57	10	59	0	0	0
2024-12-01	0	0	1,051	57	11	56	0	0	0
2025-01-01	0	0	1,052	57	11	55	0	0	0
2025-02-01	0	0	1,052	57	11	54	0	0	0
2025-03-01	0	0	1,052	57	11	53	0	0	0
2025-04-01	0	0	1,053	57	11	52	0	0	0
2025-05-01	0	0	1,053	57	11	51	0	0	0
2025-06-01	0	0	1,053	57	11	51	0	0	0
2025-07-01	0	0	1,053	57	11	51	0	0	0
2025-08-01	0	0	1,053	57	11	51	0	0	0
2025-09-01	0	0	1,053	57	11	48	0	0	0
2025-10-01	0	0	1,054	57	11	49	0	0	0
2025-11-01	0	0	1,054	57	11	49	0	0	0
2025-12-01	0	0	1,054	57	11	49	0	0	0
2026-01-01	0	0	1,054	57	11	48	0	0	0
2026-02-01	0	0	1,054	57	11	48	0	0	0
2026-03-01	0	0	1,054	57	11	48	0	0	0
2026-04-01	0	0	1,054	57	11	48	0	0	0
2026-05-01	0	0	1,054	57	11	48	0	0	0
2026-06-01	0	0	1,054	57	11	48	0	0	0
2026-07-01	0	0	1,054	57	11	48	0	0	0
2026-08-01	0	0	1,054	57	11	48	0	0	0
2026-09-01	0	0	1,055	57	12	45	0	0	0
2026-10-01	0	0	1,055	57	12	45	0	0	0
2026-11-01	0	0	1,055	57	12	45	0	0	0
2026-12-01	0	0	1,055	57	12	45	0	0	0
2027-01-01	0	0	1,055	57	12	45	0	0	0
2027-02-01	0	0	1,055	57	12	45	0	0	0
2027-03-01	0	0	1,055	57	12	45	0	0	0
2027-04-01	0	0	1,055	57	12	45	0	0	0
2027-05-01	0	0	1,055	57	12	45	0	0	0
2027-06-01	0	0	1,055	57	12	45	0	0	0
2027-07-01	0	0	1,055	57	12	45	0	0	0
2027-08-01	0	0	1,055	57	12	45	0	0	0
2027-09-01	0	0	1,055	57	12	45	0	0	0
2027-10-01	0	0	1,055	57	12	45	0	0	0
2027-11-01	0	0	1,055	57	12	45	0	0	0
2027-12-01	0	0	1,055	57	12	45	0	0	0
2028-01-01	0	0	1,055	57	12	45	0	0	0
2028-02-01	0	0	1,055	57	12	45	0	0	0
2028-03-01	0	0	1,055	57	12	45	0	0	0
2028-04-01	0	0	1,055	57	12	45	0	0	0
2028-05-01	0	0	1,055	57	12	45	0	0	0
2028-06-01	0	0	1,055	57	12	45	0	0	0
2028-07-01	0	0	1,055	57	12	45	0	0	0
2028-08-01	0	0	1,055	57	12	45	0	0	0
2028-09-01	0	0	1,056	57	12	41	0	0	0
2028-10-01	0	0	1,056	57	12	41	0	0	0
2028-11-01	0	0	1,056	57	12	41	0	0	0
2028-12-01	0	0	1,056	57	12	41	0	0	0
2029-01-01	0	0	1,056	57	12	41	0	2	2
2029-02-01	0	0	1,056	57	12	41	0	2	2
2029-03-01	0	0	1,056	57	12	41	0	2	2
2029-04-01	0	0	1,056	57	12	41	0	2	2
2029-05-01	0	0	1,056	57	12	41	0	2	2
2029-06-01	0	0	1,056	57	12	41	0	2	31
2029-07-01	0	0	1,056	57	12	41	18	111	151
2029-08-01	0	0	1,056	57	12	41	35	166	115
2029-09-01	0	0	1,056	57	12	41	49	198	97
2029-10-01	0	0	1,056	57	12	41	62	219	90
2029-11-01	0	0	1,056	57	12	41	72	234	86
2029-12-01	0	0	1,056	57	12	41	82	246	85
2030-01-01	0	0	1,056	57	12	41	91	257	85
2030-02-01	0	0	1,056	57	12	41	99	265	90
2030-03-01	0	0	1,056	57	12	41	109	272	106
2030-04-01	0	0	1,056	57	12	41	122	277	109
2030-05-01	0	0	1,056	57	12	41	135	283	105
2030-06-01	0	0	1,056	57	12	41	146	287	98
2030-07-01	0	0	1,056	57	12	41	153	291	93
2030-08-01	0	0	1,056	57	12	41	160	294	87
2030-09-01	0	0	1,056	57	12	41	164	297	84
2030-10-01	0	0	1,056	57	12	41	168	299	78
2030-11-01	0	0	1,056	57	12	41	171	300	75
2030-12-01	0	0	1,056	57	12	41	173	302	73
2031-01-01	0	0	1,056	57	12	41	175	303	70
2031-02-01	0	0	1,056	57	13	38	177	304	69

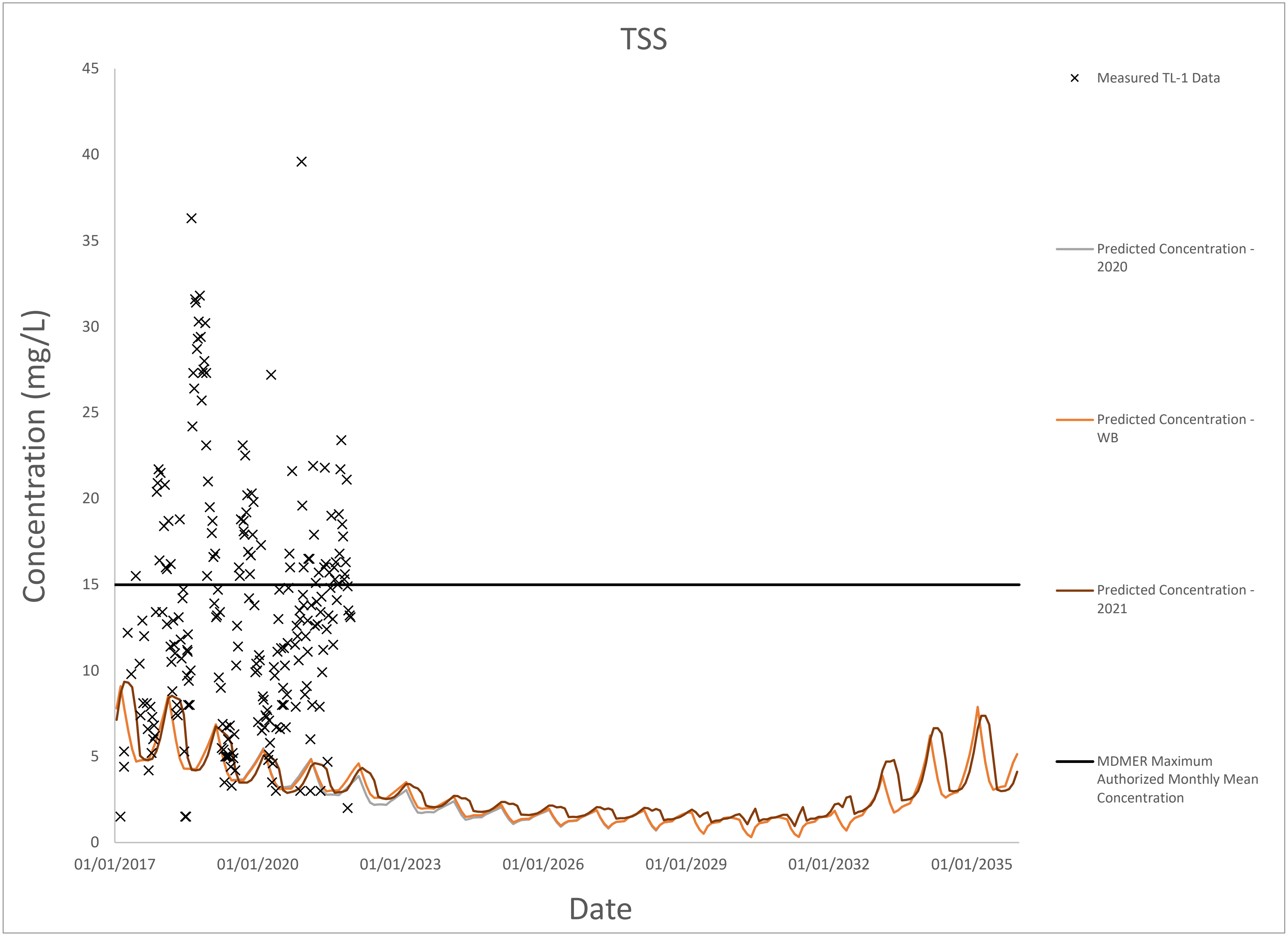
Project: **Hope Bay**
Number: **1CT022.076**
Task: **Summary of the FEIS Model Inputs**
Source: *HopeBay_FEISWLBalance_TypeA_Rev34_AJB_NF.gsm*

Table A1.2: Mine Water Flows By Source

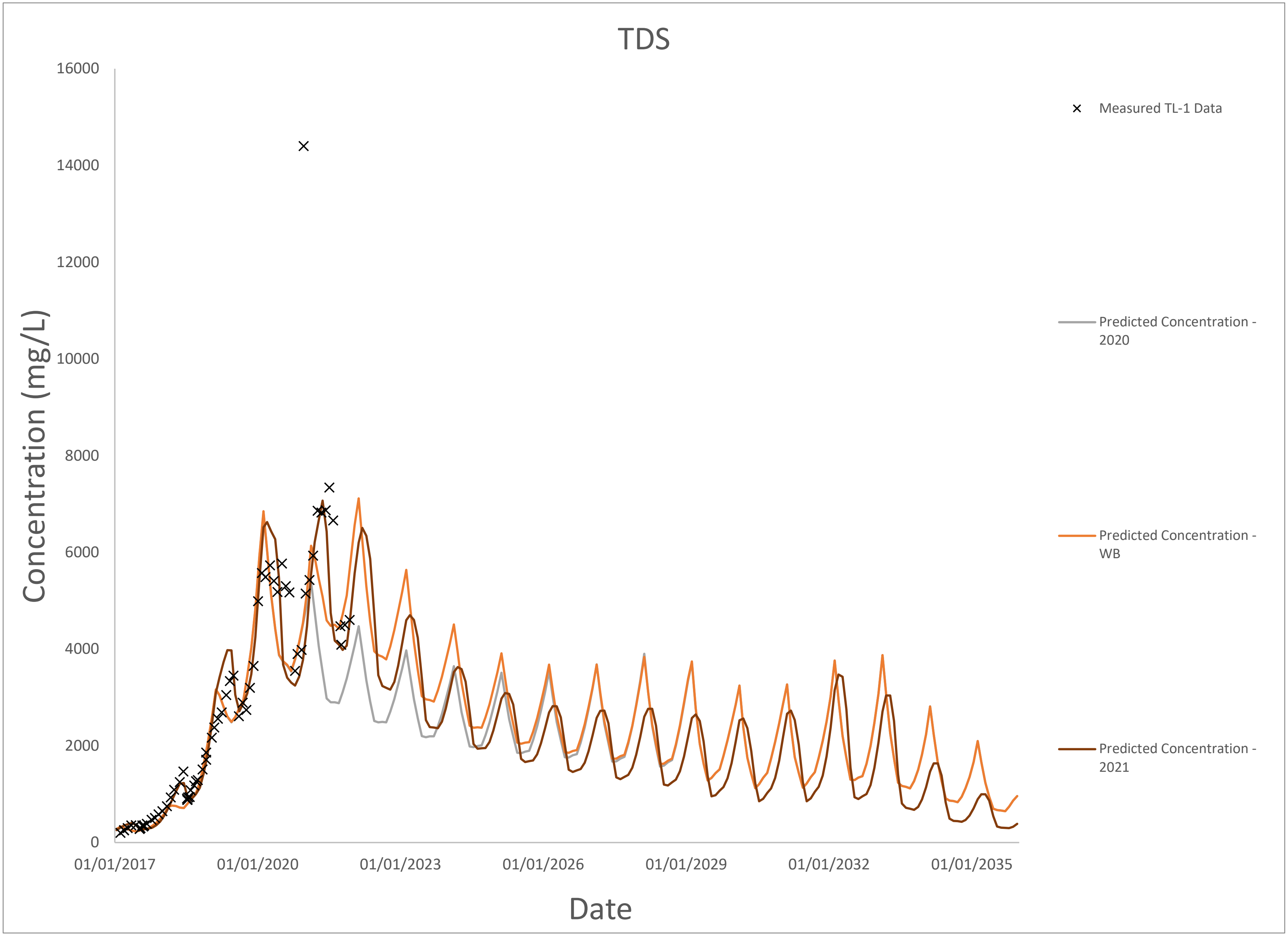
Model Date	Mine Water Flows (m^3/day)								
	Doris Mine		Madrid North Mine				Madrid South Mine		
	Flows from Doris Lake	Flows from Bedrock	Flows from Patch Lake	Flows from Imniagut Lake	Flows from Windy Lake	Flows from Bedrock	Flows from Wolverine Lake	Flows from Patch Lake	Flows from Bedrock
2031-03-01	0	0	1,056	57	13	38	178	305	65
2031-04-01	0	0	1,056	57	13	38	179	305	64
2031-05-01	0	0	1,056	57	13	38	179	306	60
2031-06-01	0	0	1,056	57	13	38	180	306	59
2031-07-01	0	0	1,056	57	13	38	180	307	58
2031-08-01	0	0	1,056	57	13	38	181	307	58
2031-09-01	0	0	1,056	57	13	38	181	308	57
2031-10-01	0	0	1,056	57	13	38	181	308	55
2031-11-01	0	0	1,056	57	13	38	182	308	55
2031-12-01	0	0	1,056	57	13	38	182	308	53
2032-01-01	0	0	0	0	0	0	182	308	53
2032-02-01	0	0	0	0	0	0	182	309	54
2032-03-01	0	0	0	0	0	0	182	309	52
2032-04-01	0	0	0	0	0	0	182	309	51
2032-05-01	0	0	0	0	0	0	182	309	50
2032-06-01	0	0	0	0	0	0	183	309	49
2032-07-01	0	0	0	0	0	0	183	309	48
2032-08-01	0	0	0	0	0	0	183	309	47
2032-09-01	0	0	0	0	0	0	183	309	47
2032-10-01	0	0	0	0	0	0	183	309	47
2032-11-01	0	0	0	0	0	0	183	309	47
2032-12-01	0	0	0	0	0	0	183	310	46
2033-01-01	0	0	0	0	0	0	0	0	0
2100-01-01	0	0	0	0	0	0	0	0	0

Note; Model interprets the values as constant over the next time period

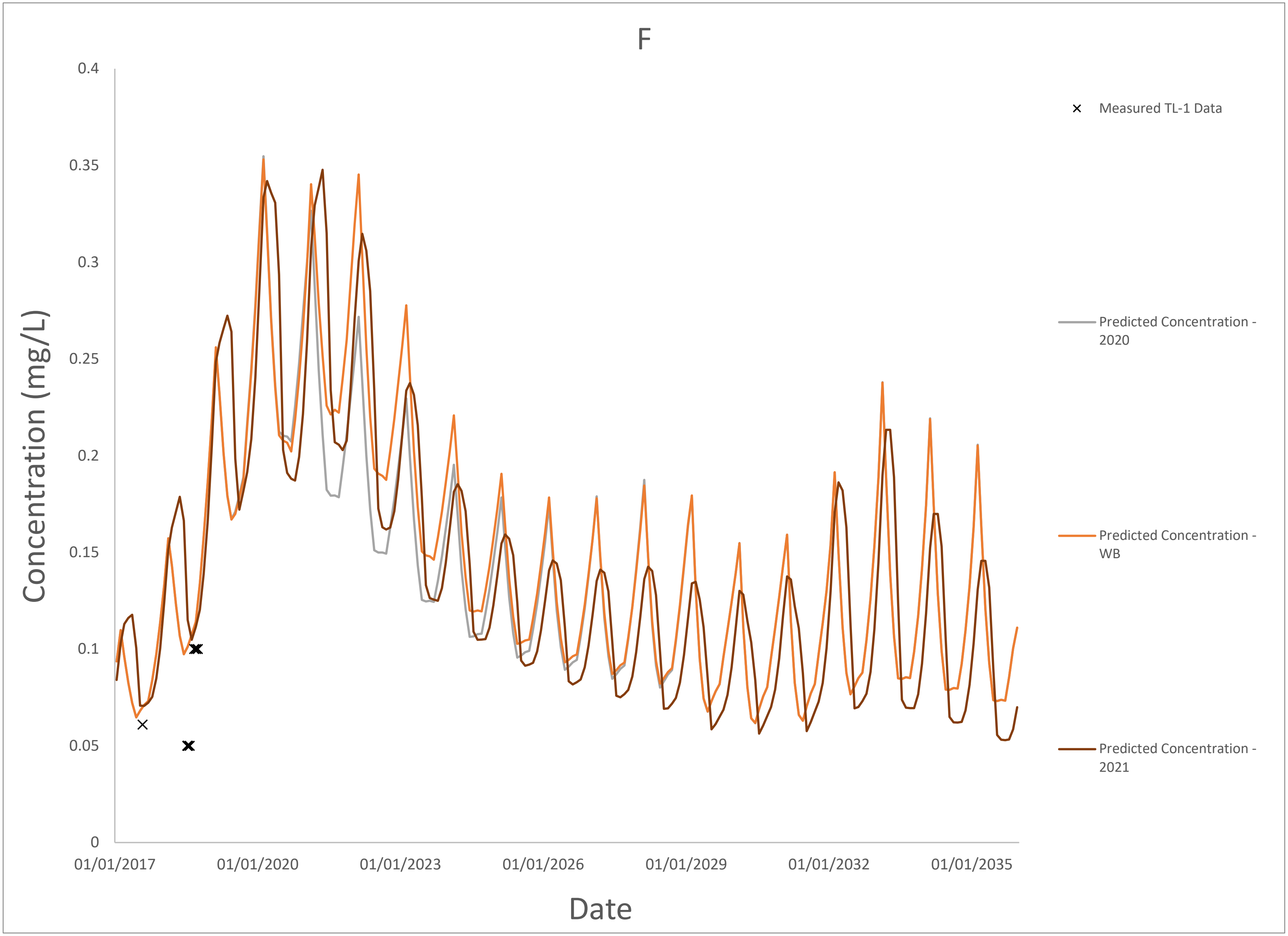
Attachment 2 Annual WLB Assessment – 2021 – PLOTS

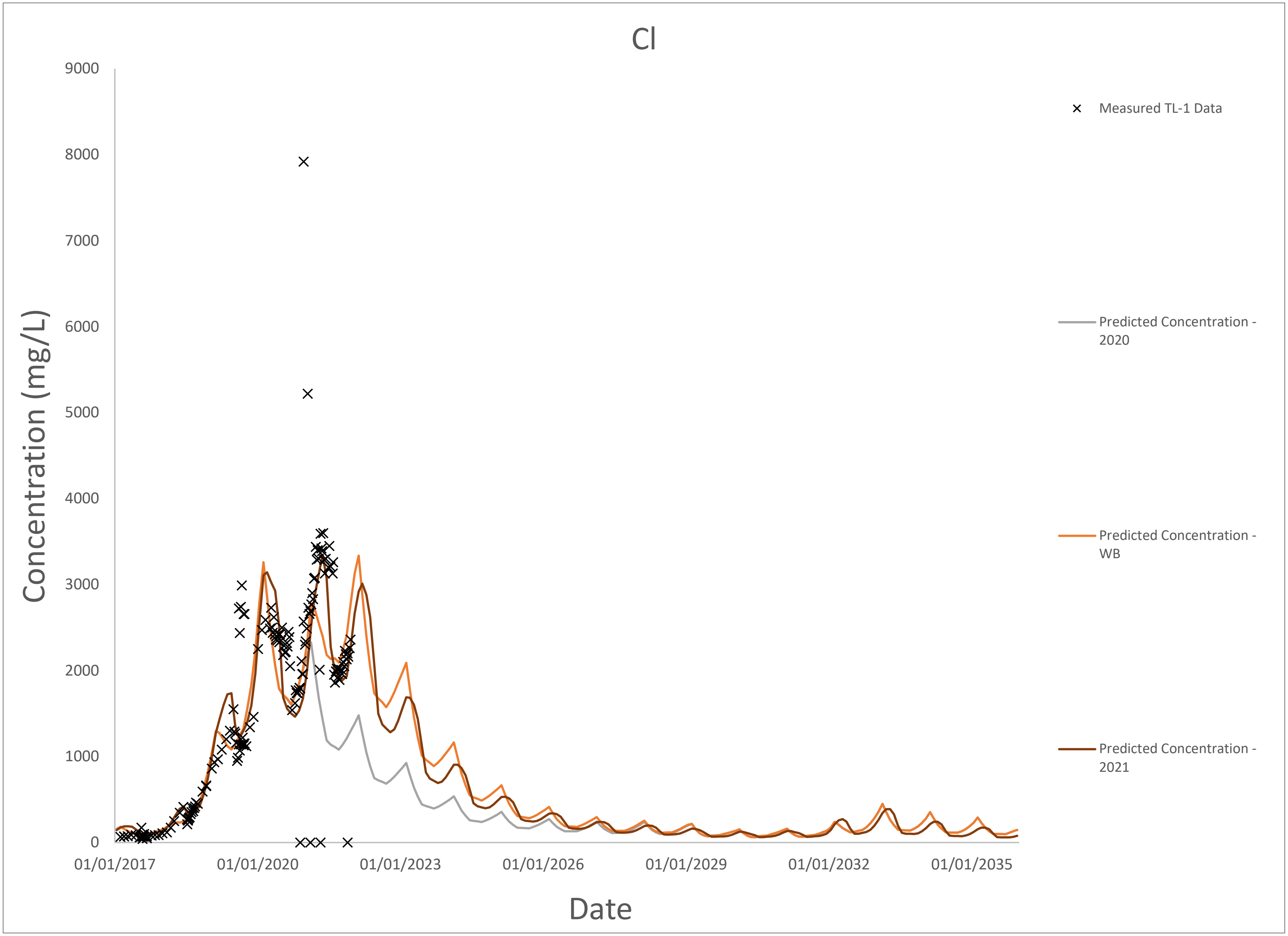


TSS
Concentration (mg/L)
45
40
35
30
25
20
15
10
5
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021
MDMER Maximum Authorized Monthly Mean Concentration

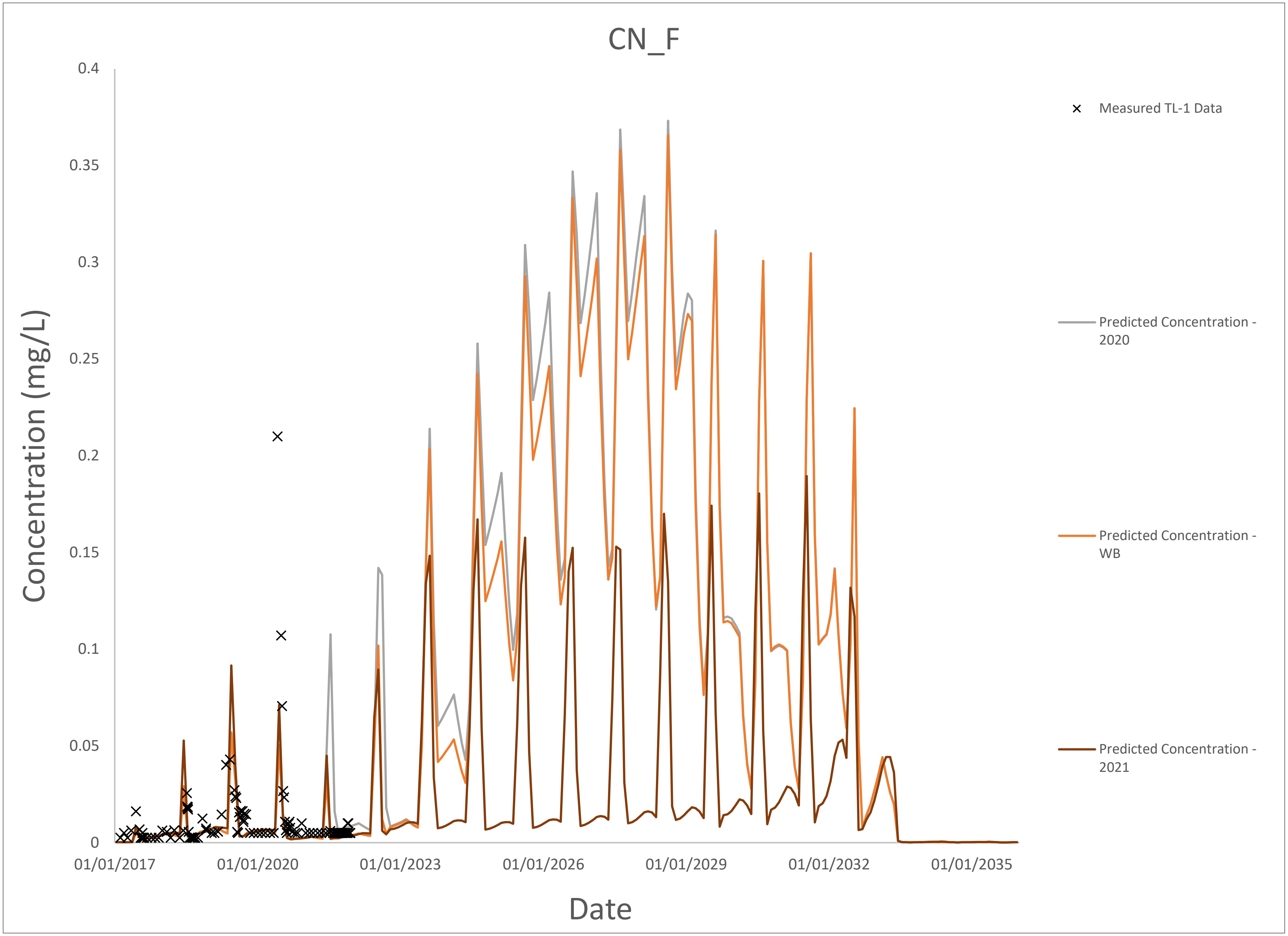


TDS
Concentration (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

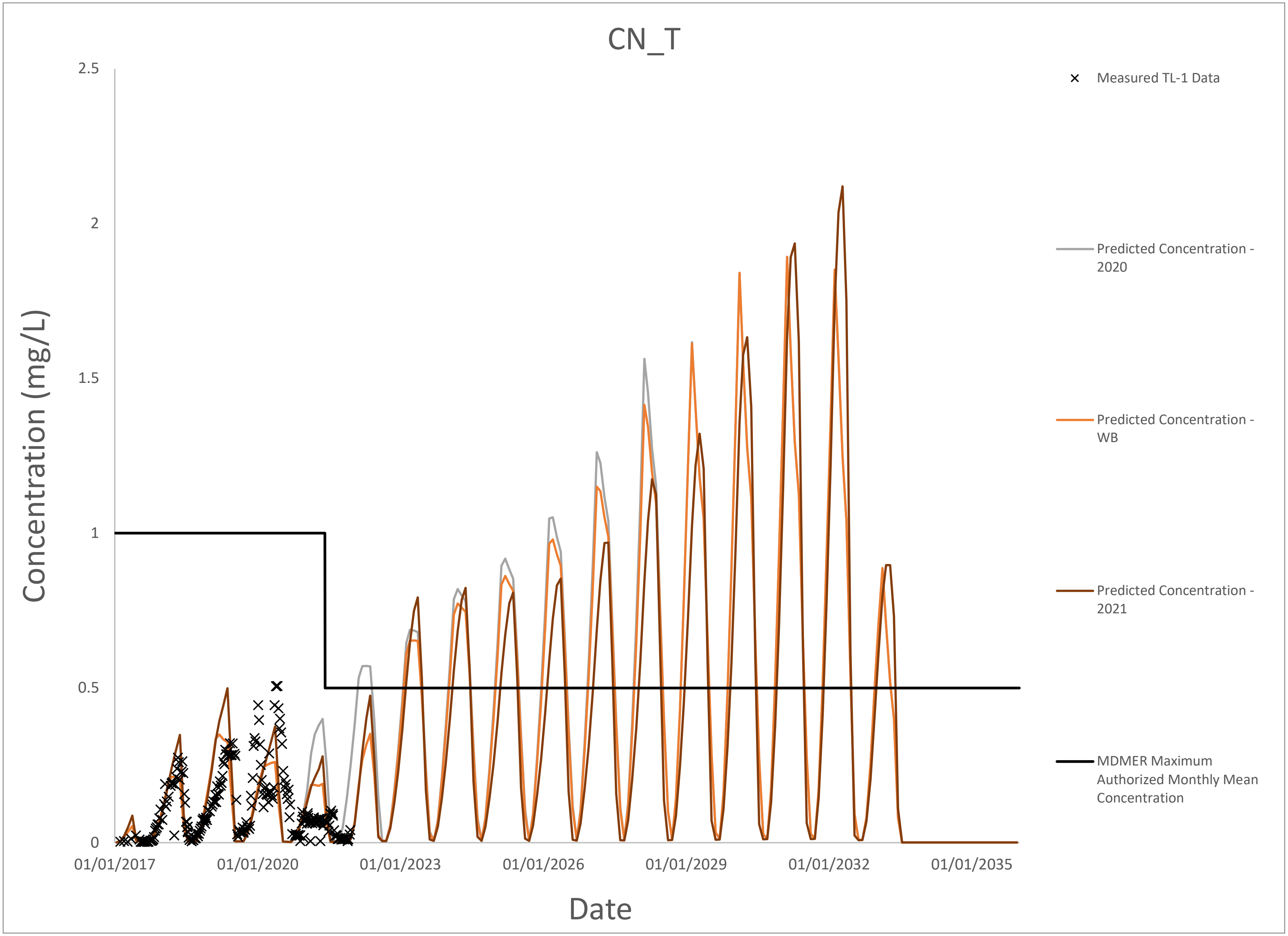

F
Concentration (mg/L)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



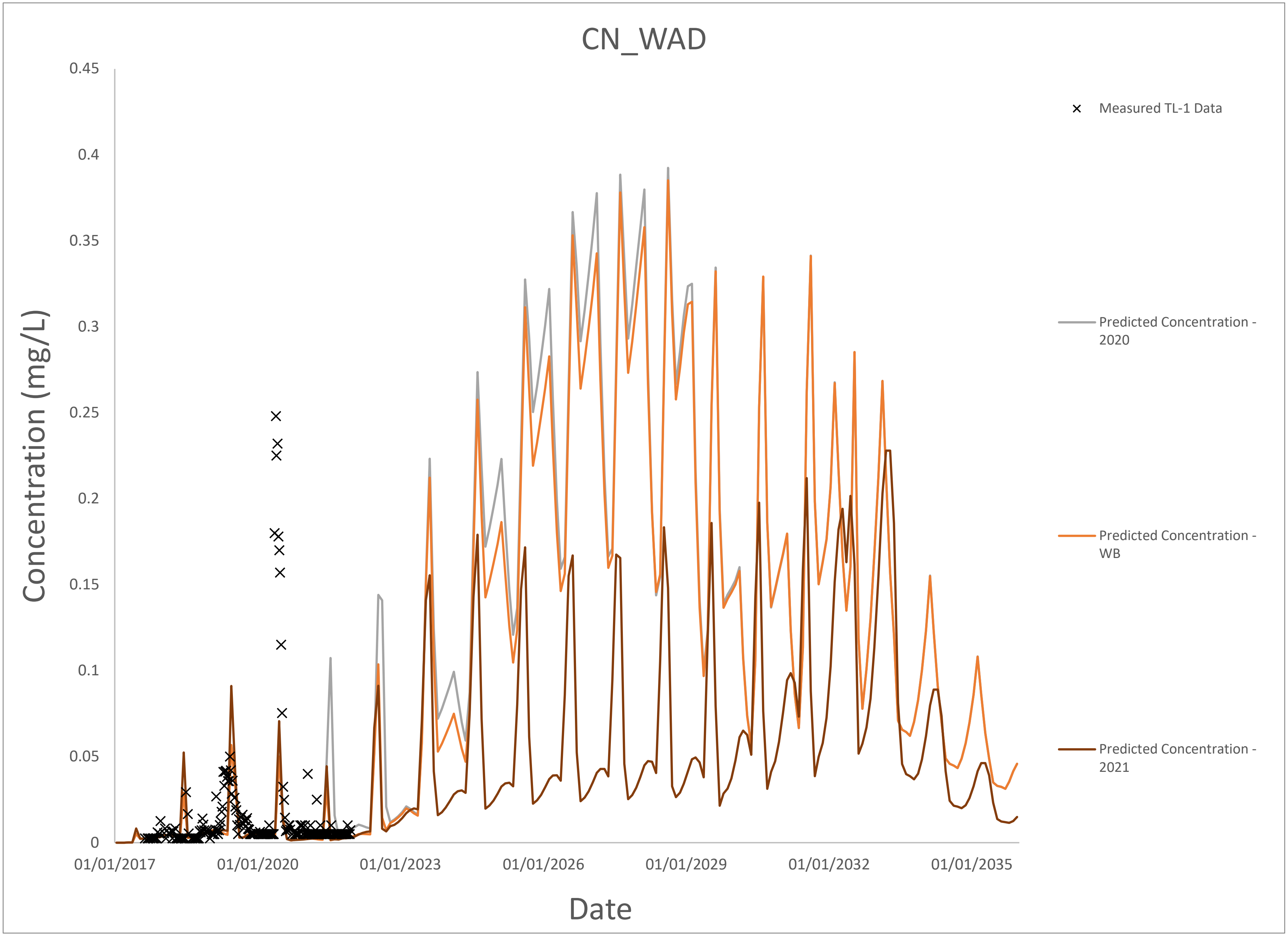
Cl
Concentration (mg/L)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



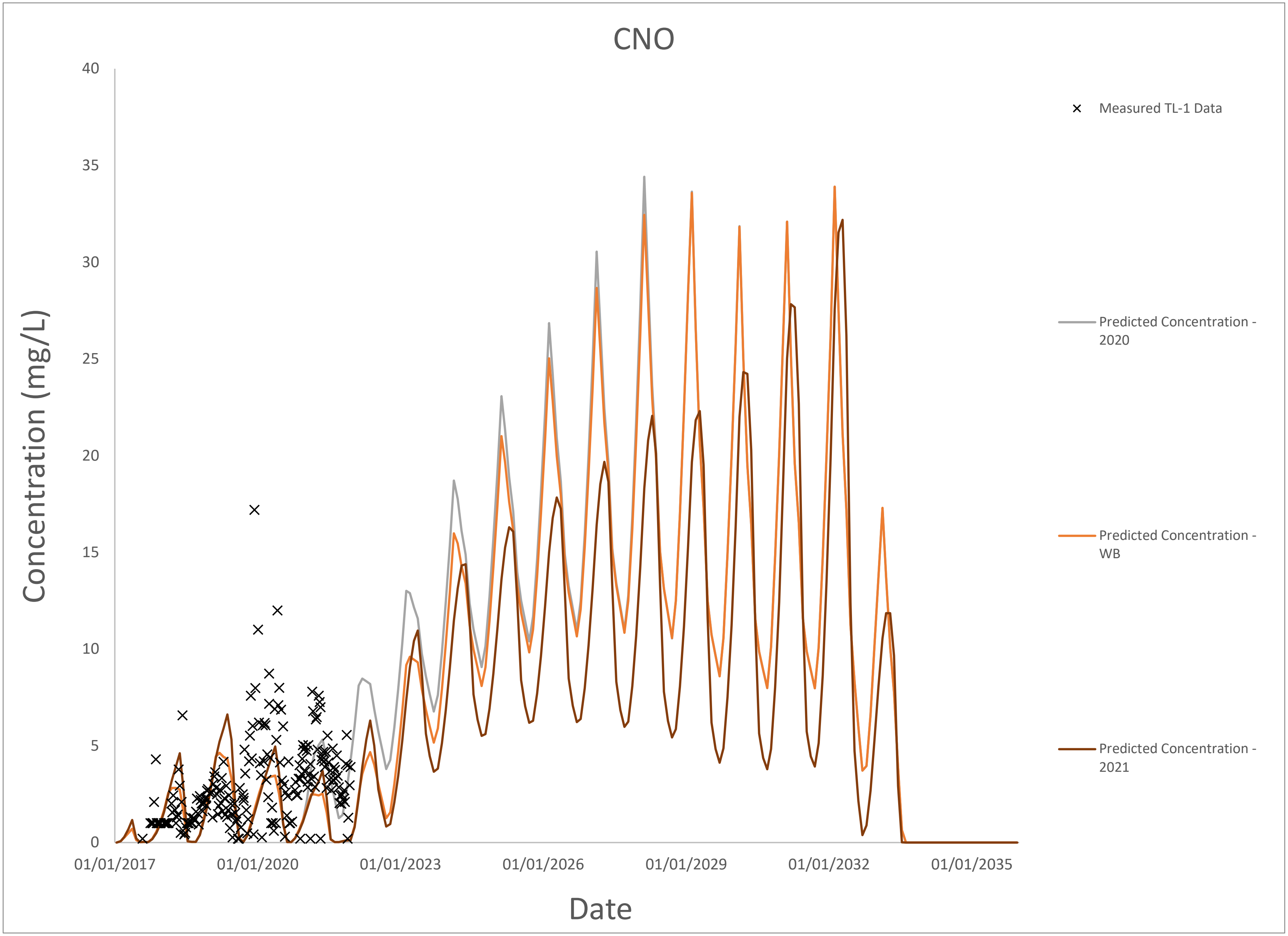
CN_F
Concentration (mg/L)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



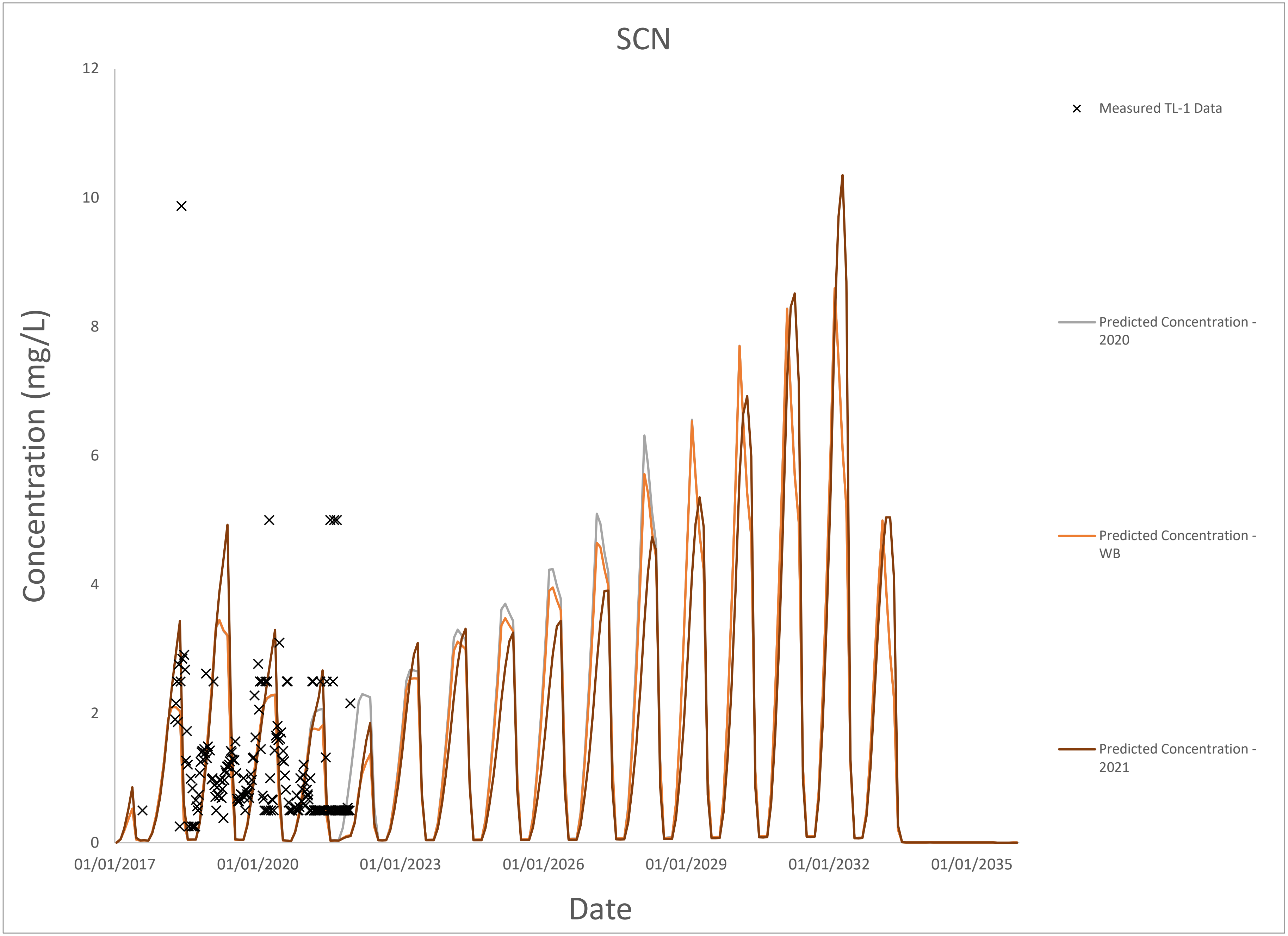
CN_T
Concentration (mg/L)
2.5
2
1.5
1
0.5
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021
MDMER Maximum Authorized Monthly Mean Concentration

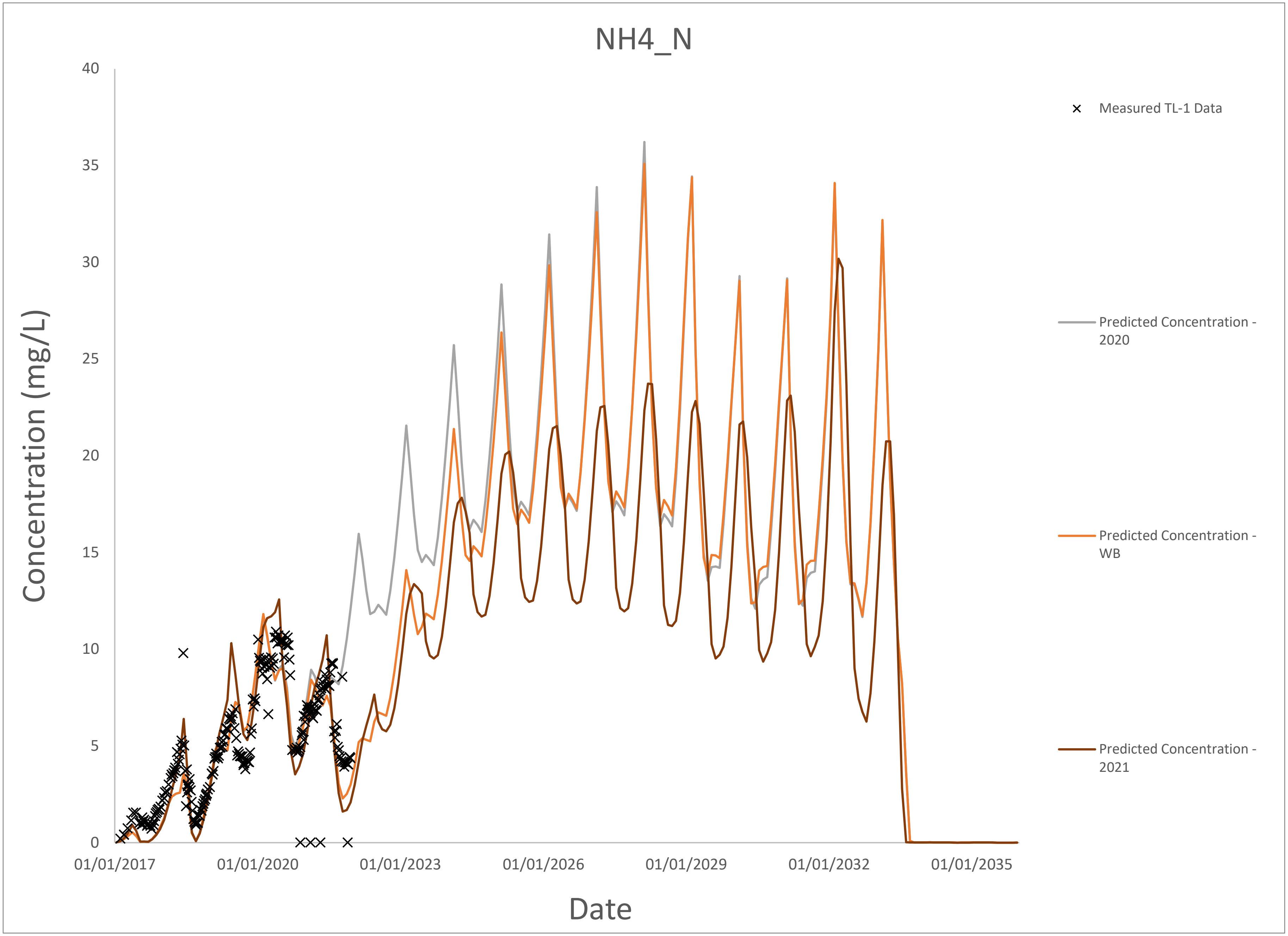


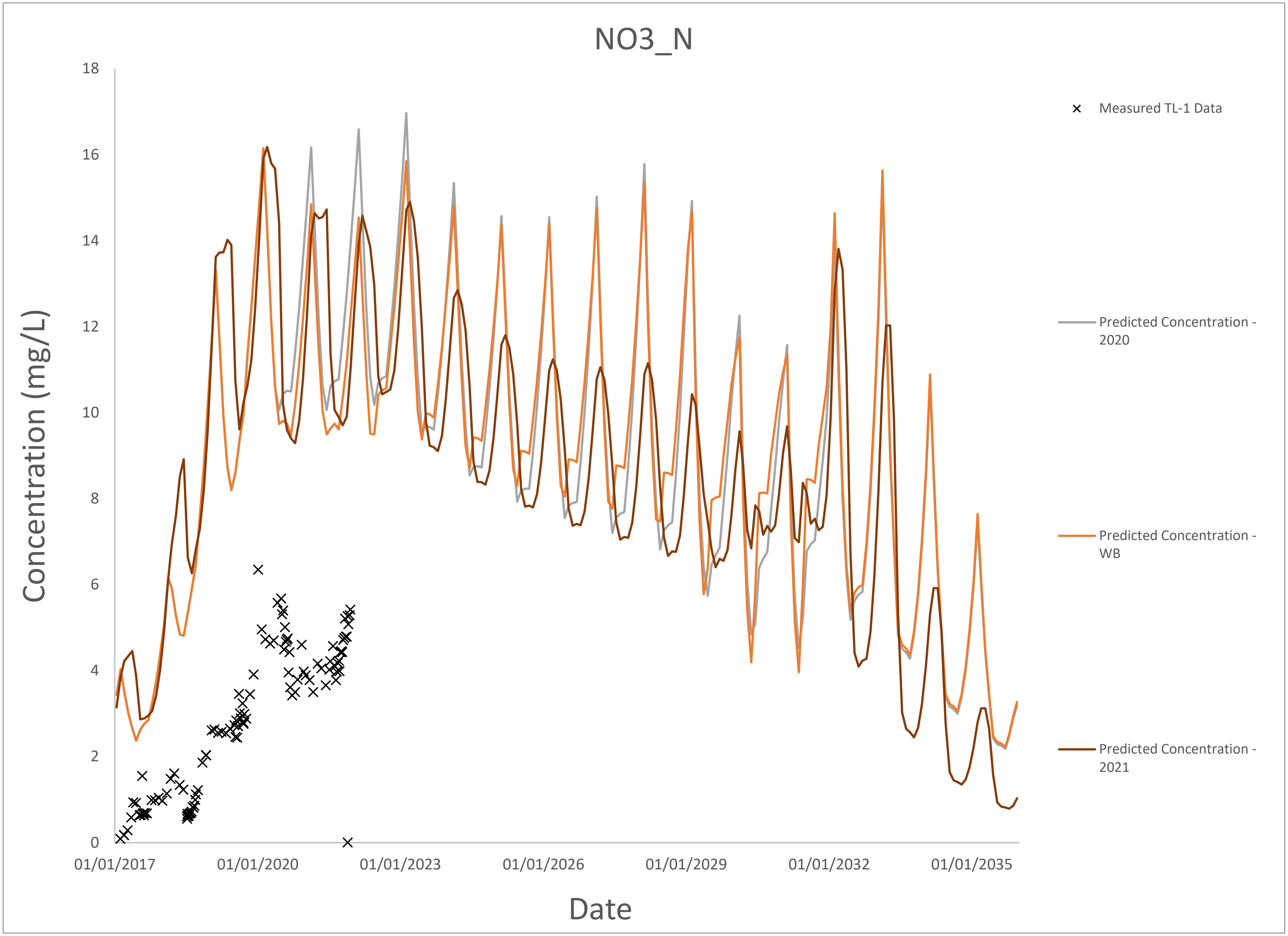
CN_WAD
Concentration (mg/L)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



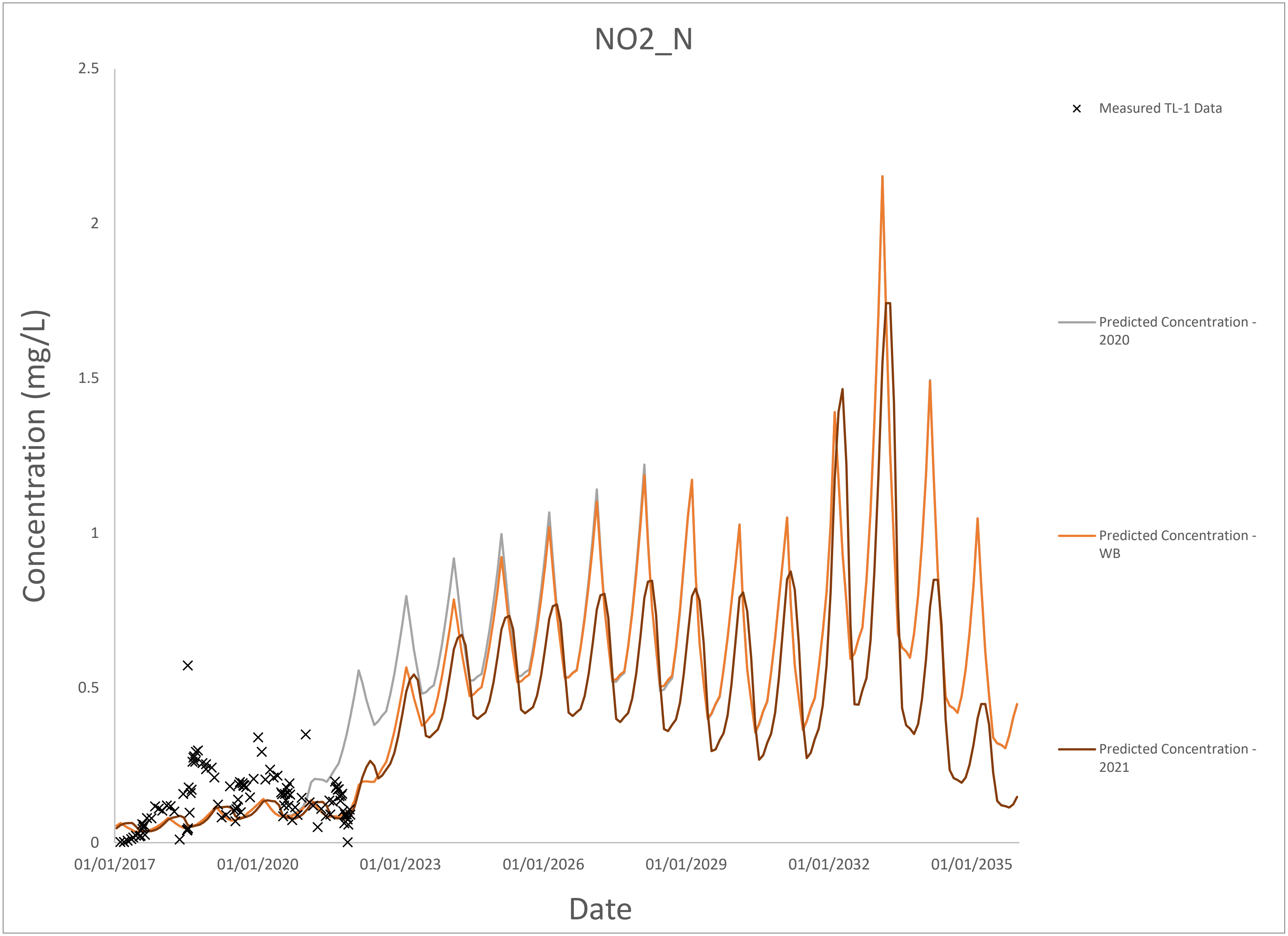
CNO
Concentration (mg/L)
40
35
30
25
20
15
10
5
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

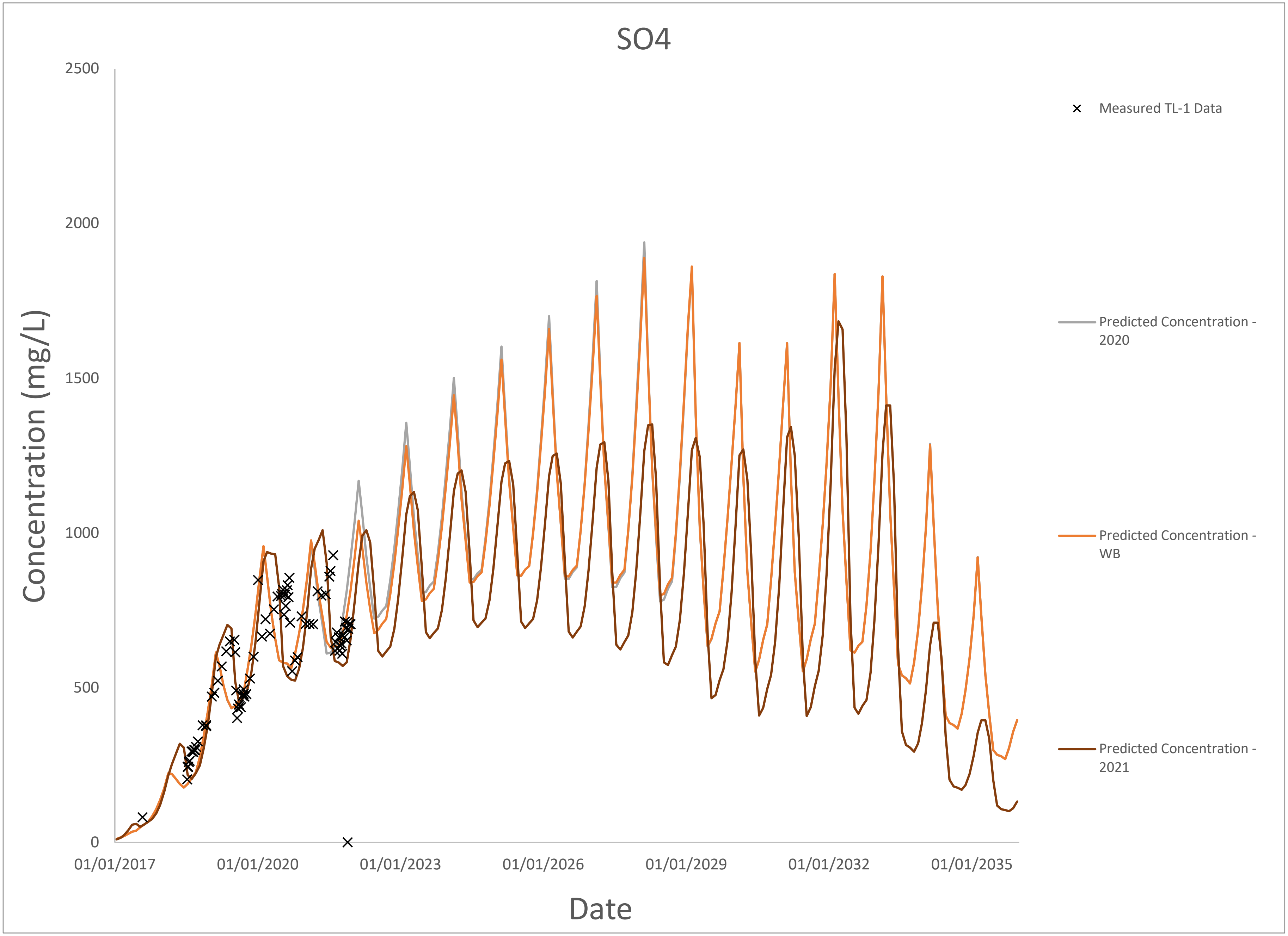

SCN
Concentration (mg/L)
0
2
4
6
8
10
12
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021


NH4_N
Concentration (mg/L)
40
35
30
25
20
15
10
5
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

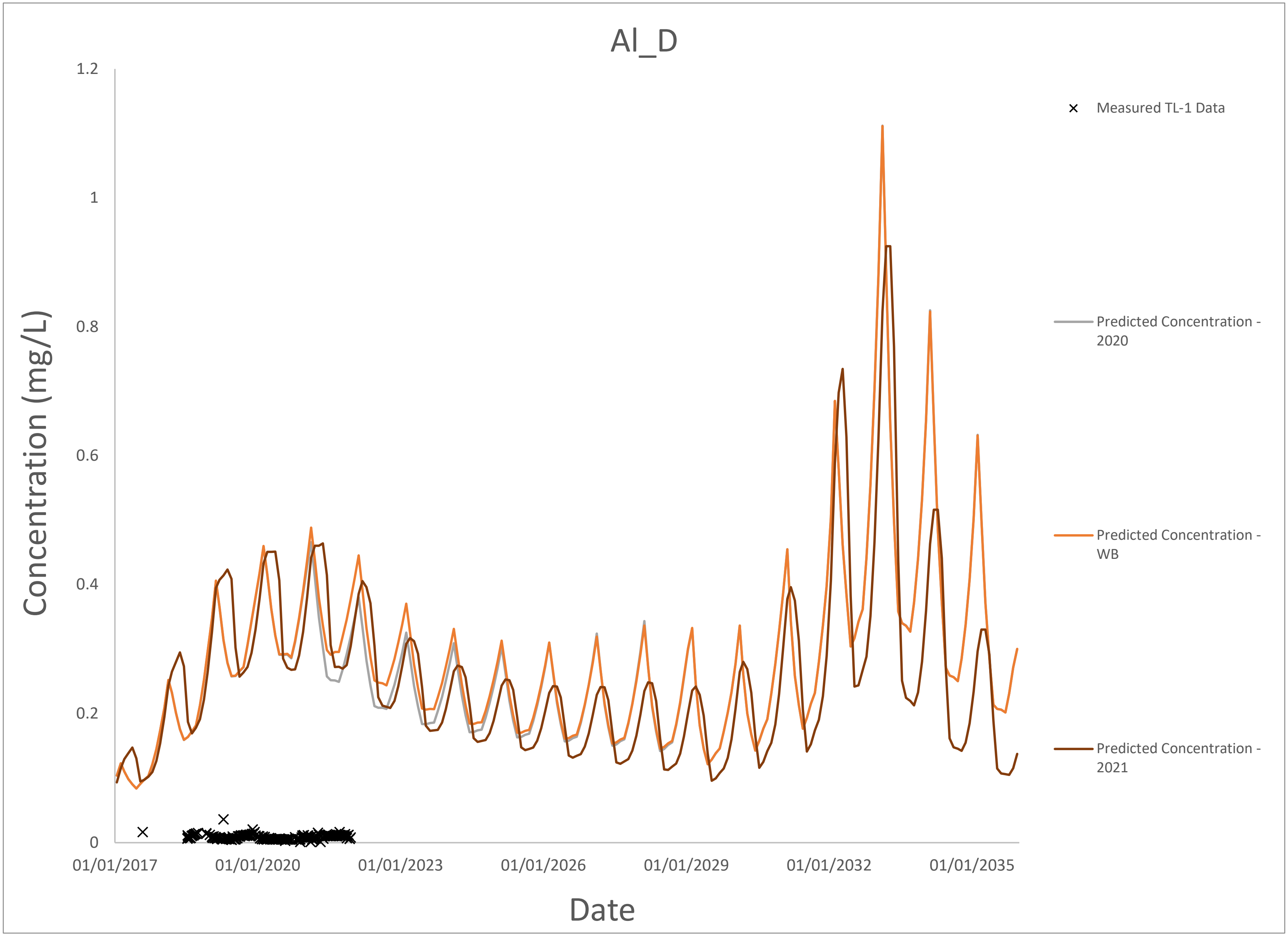


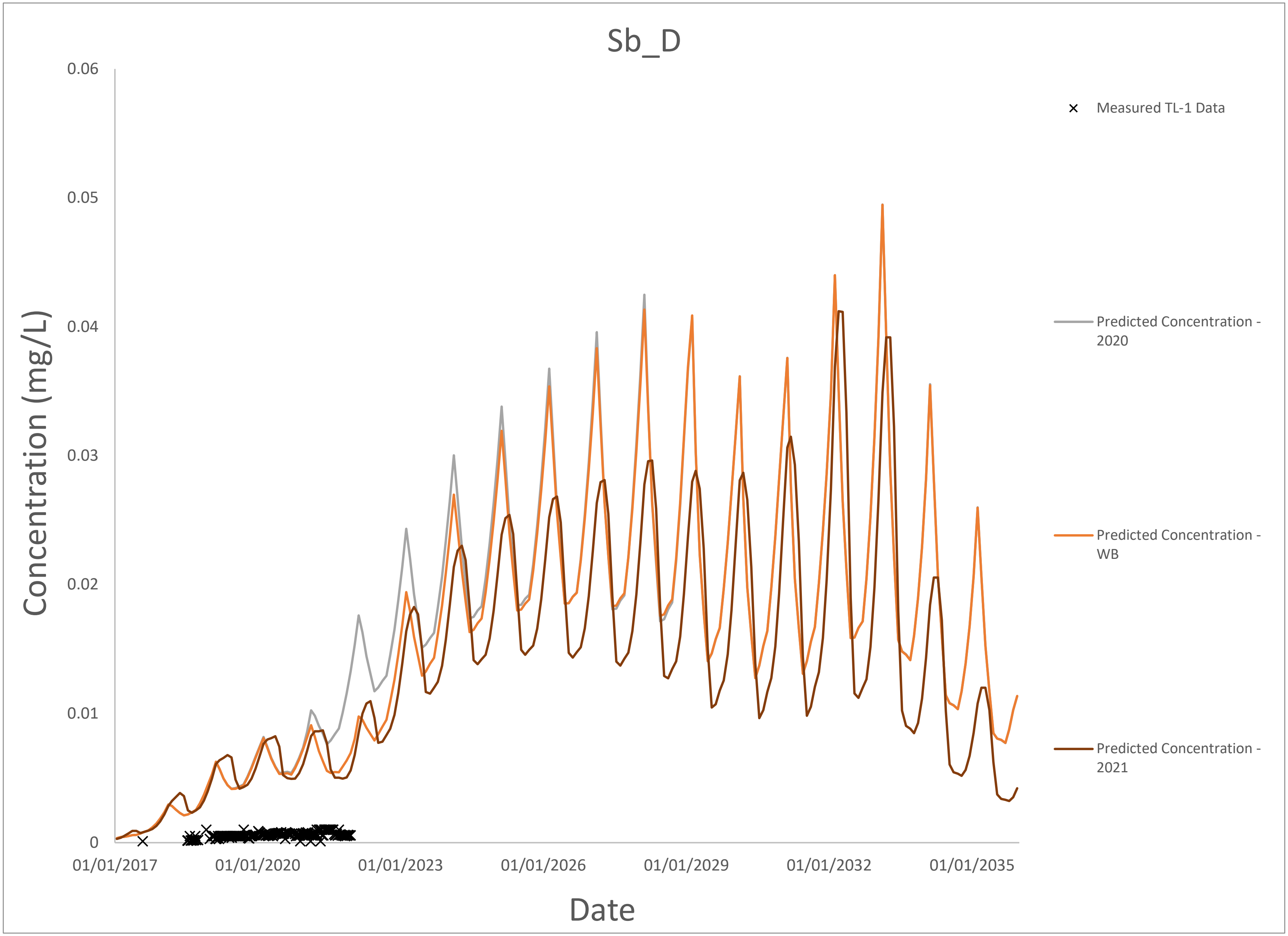
NO3_N
Concentration (mg/L)
0
2
4
6
8
10
12
14
16
18
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

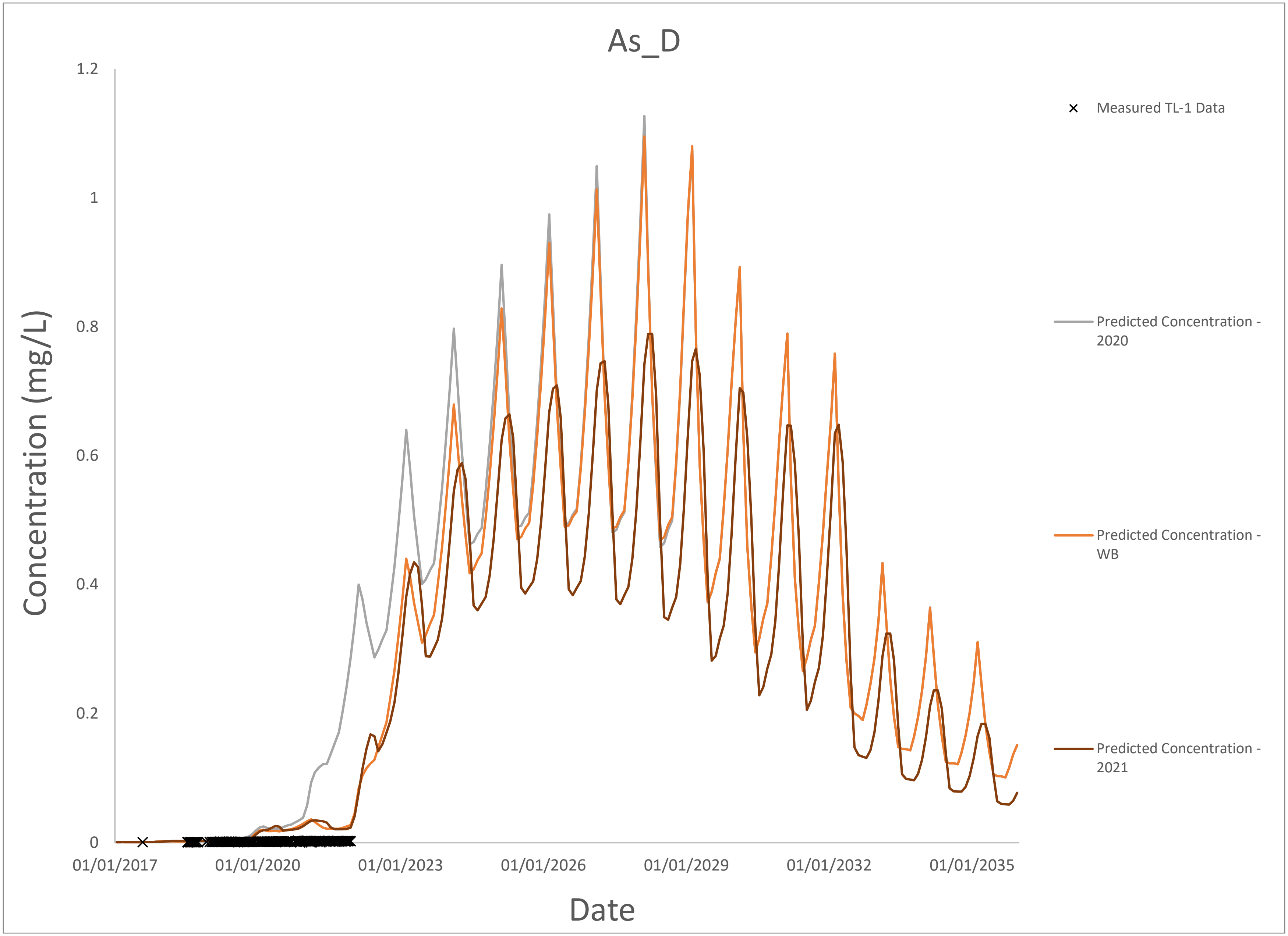

NO2_N
Concentration (mg/L)
2.5
2
1.5
1
0.5
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



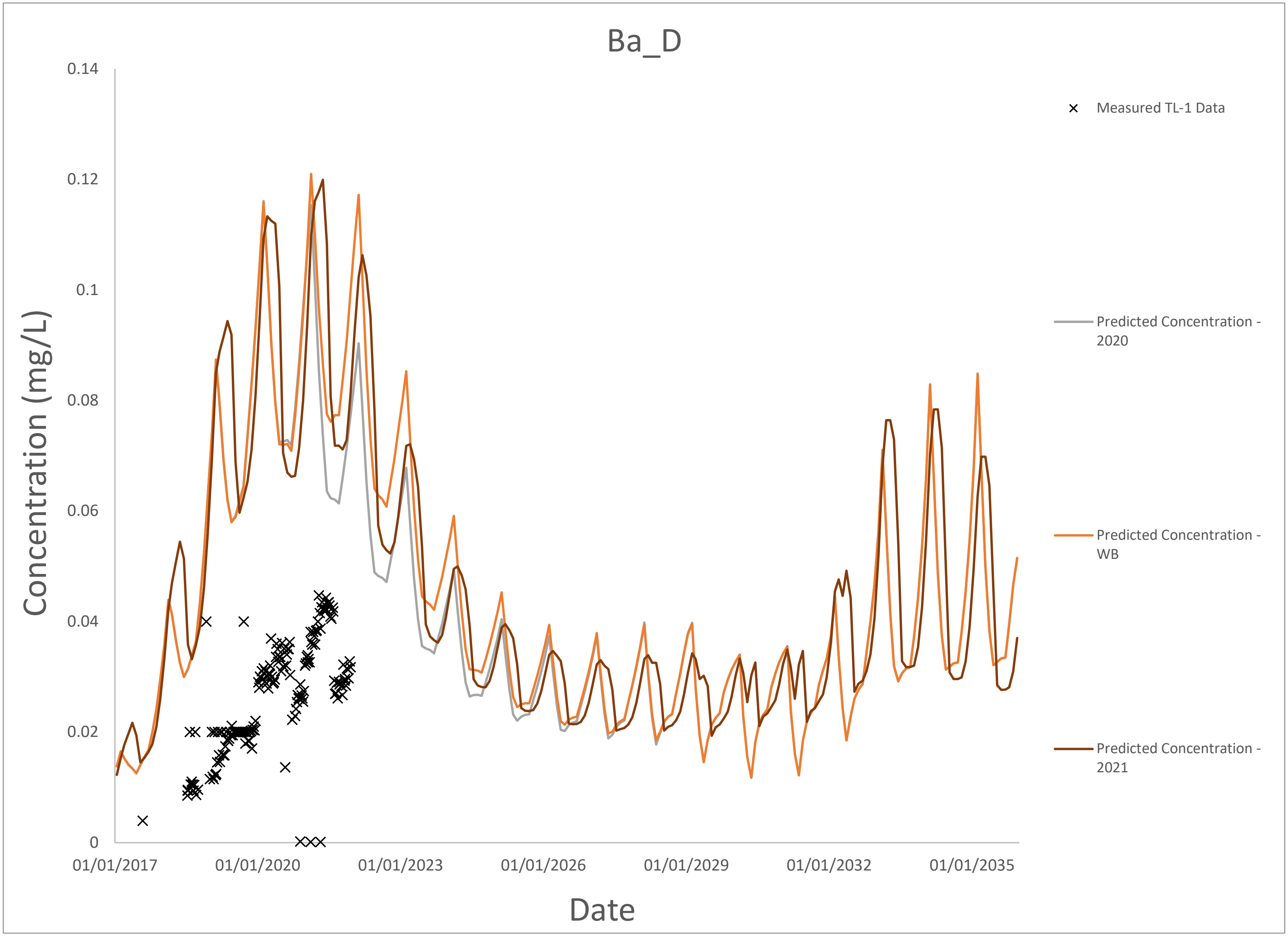
SO4
Concentration (mg/L)
2500
2000
1500
1000
500
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021


Al_D
Concentration (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

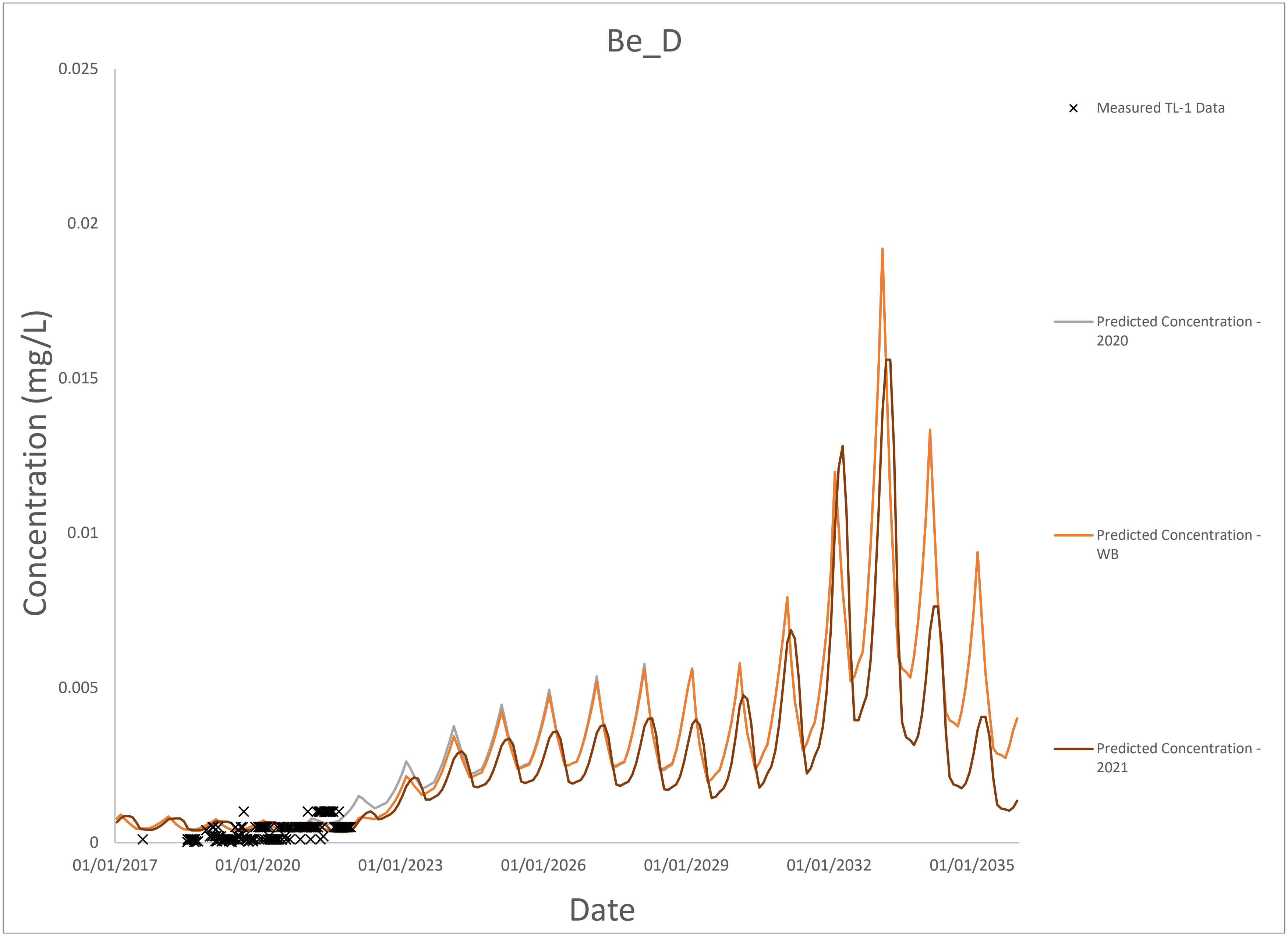

Sb_D
0.06
0.05
0.04
0.03
0.02
0.01
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



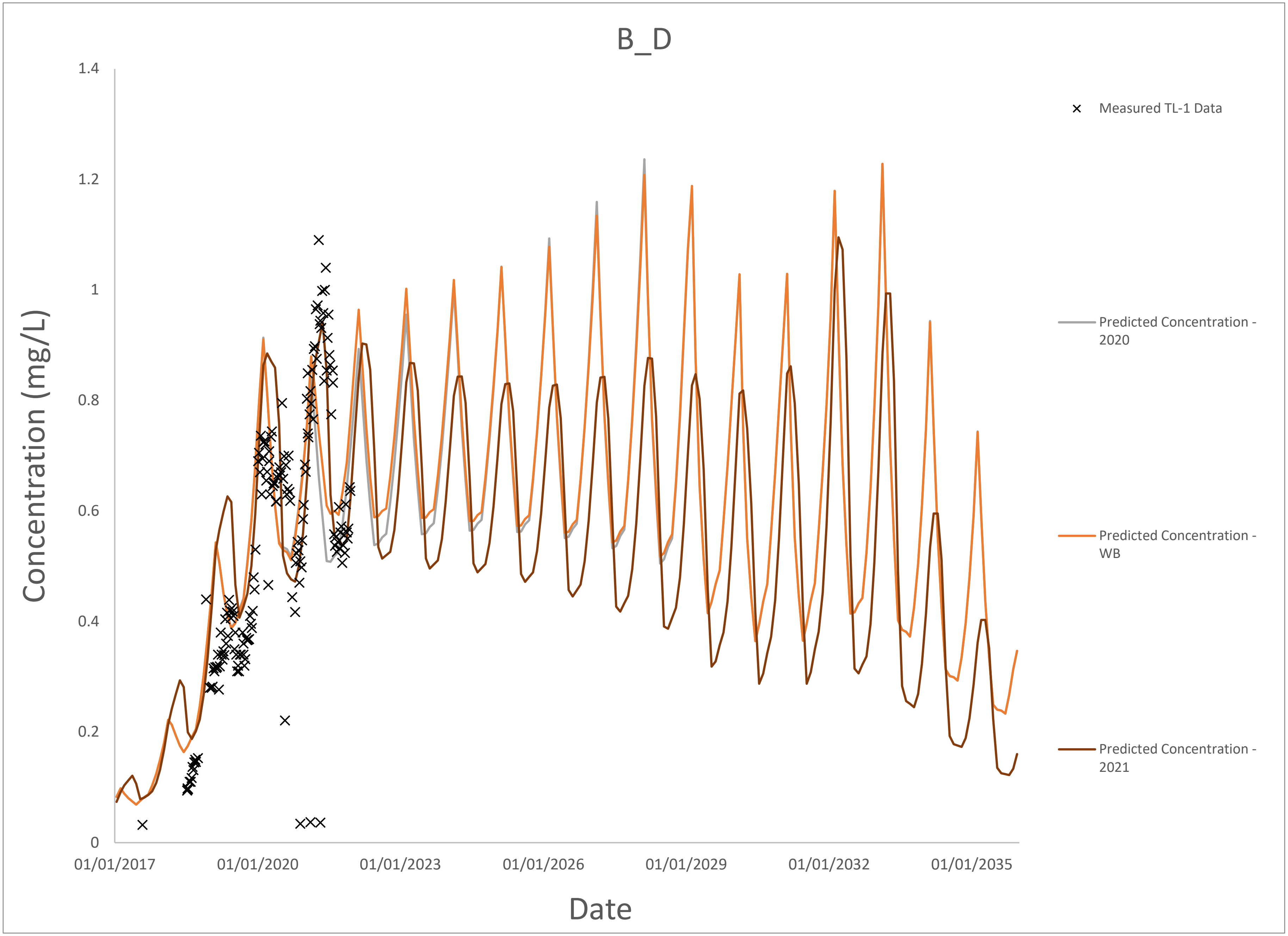
As_D
Concentration (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

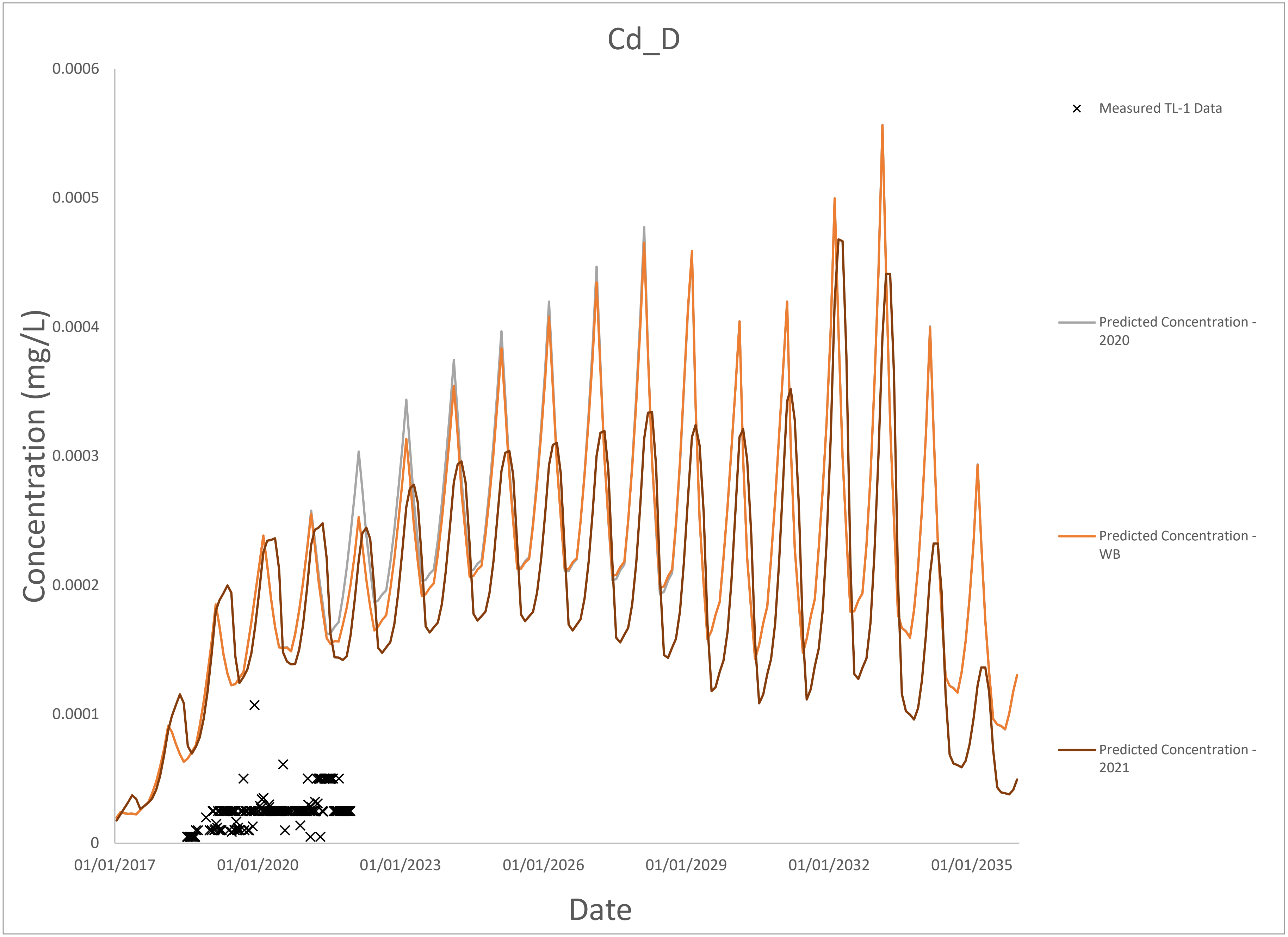


Ba_D
Concentration (mg/L)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

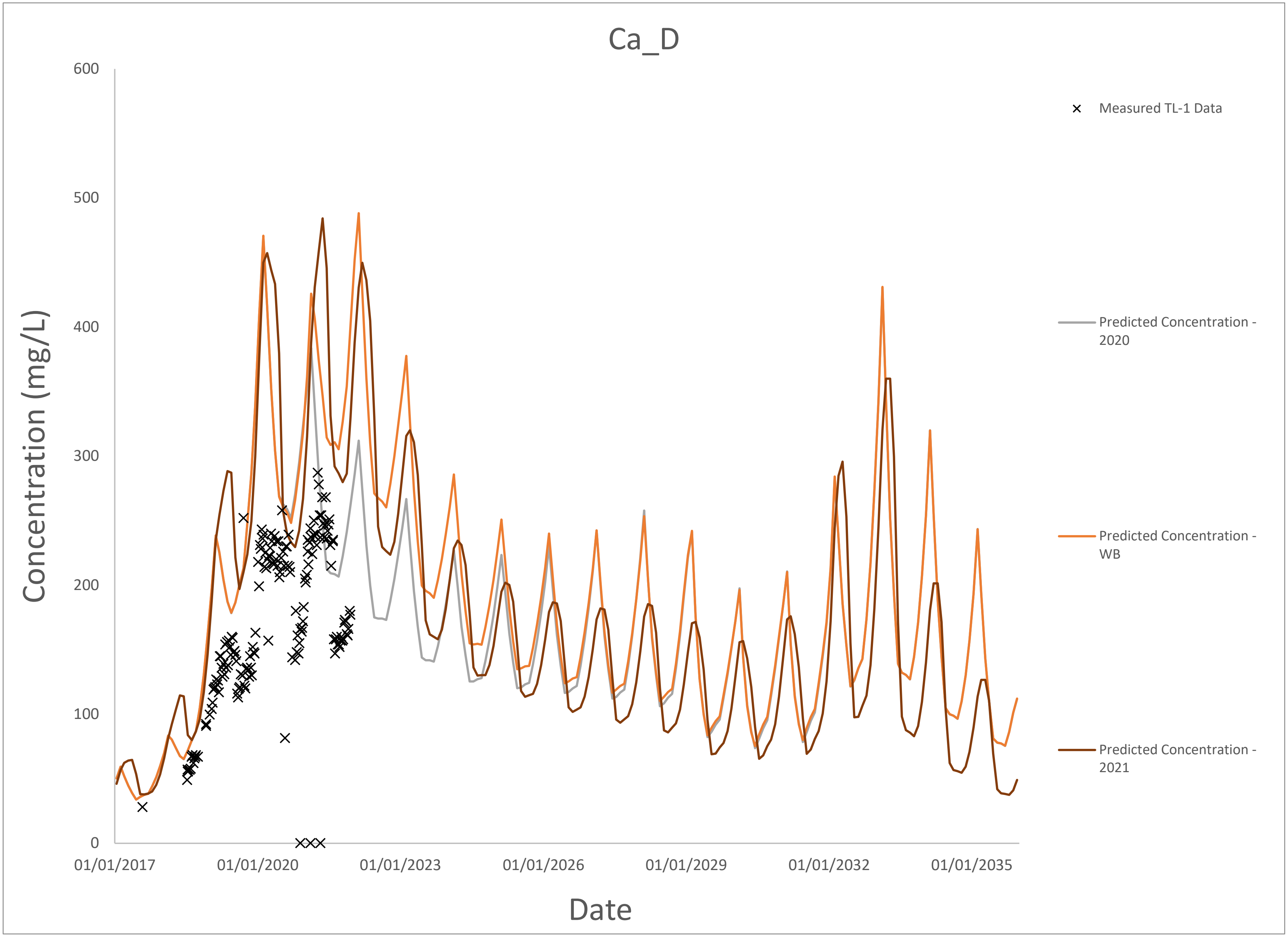


Be_D
Concentration (mg/L)
0.025
0.02
0.015
0.01
0.005
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

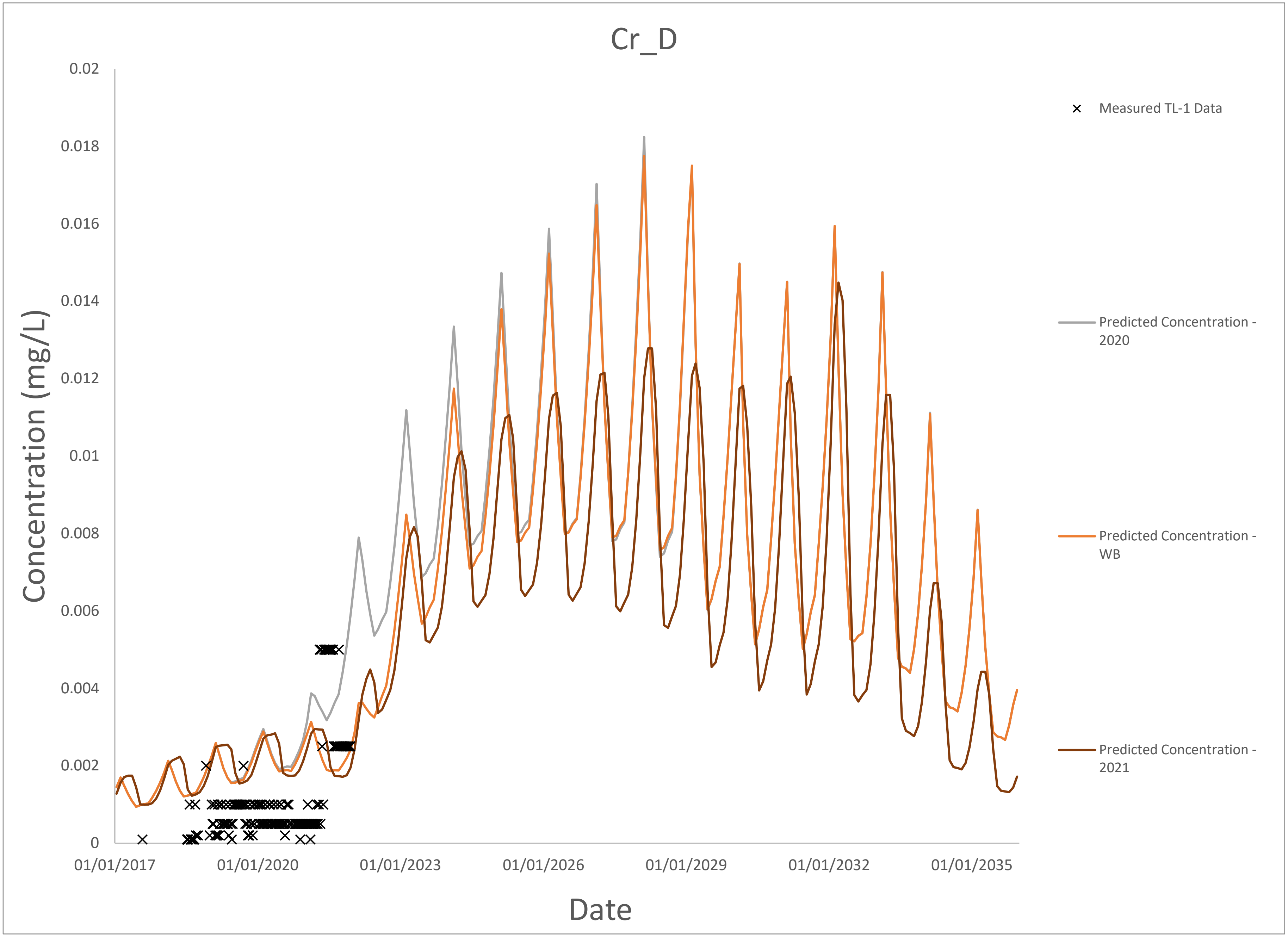

B_D
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021
Concentration (mg/L)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date



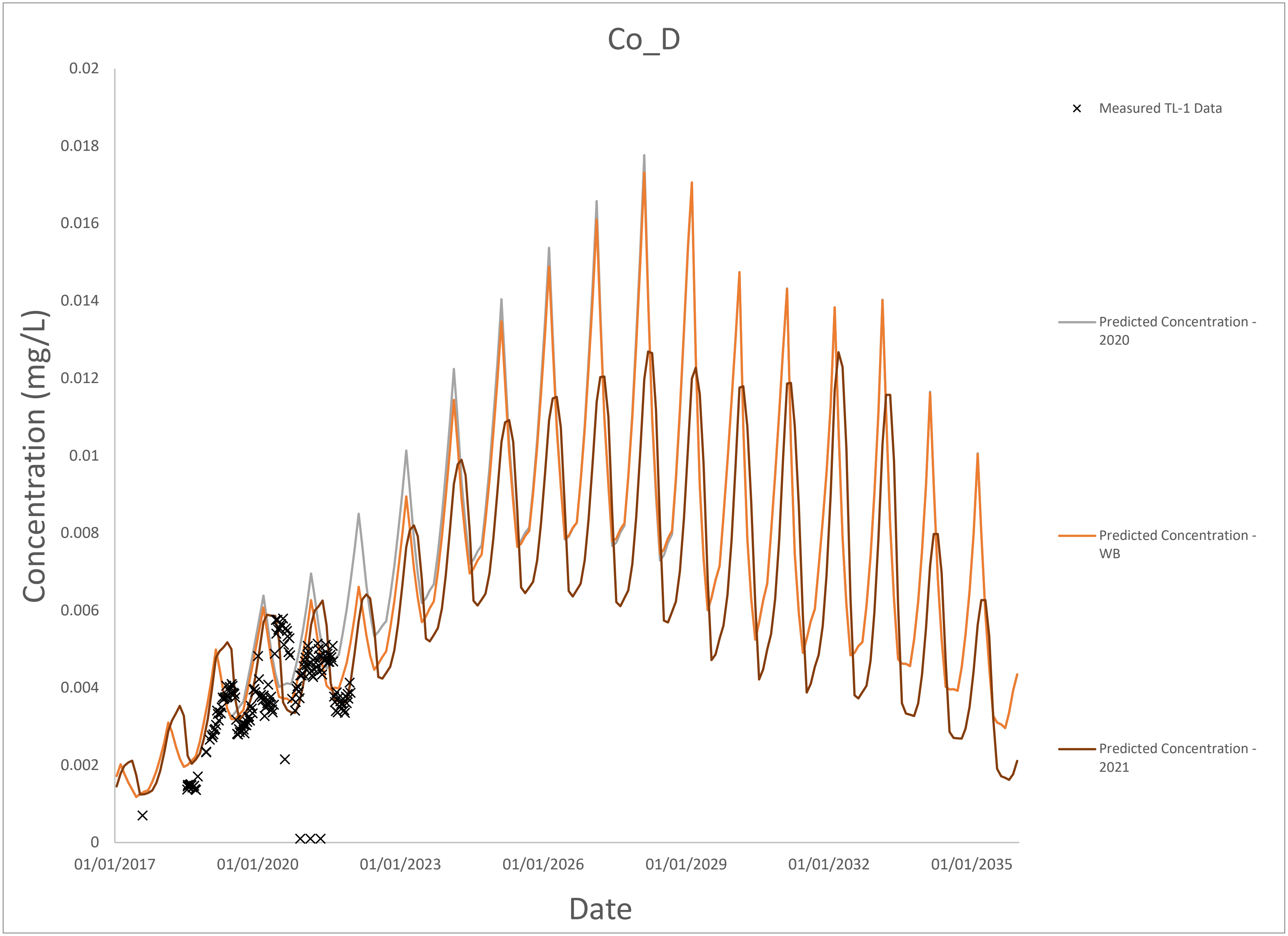
Cd_D
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

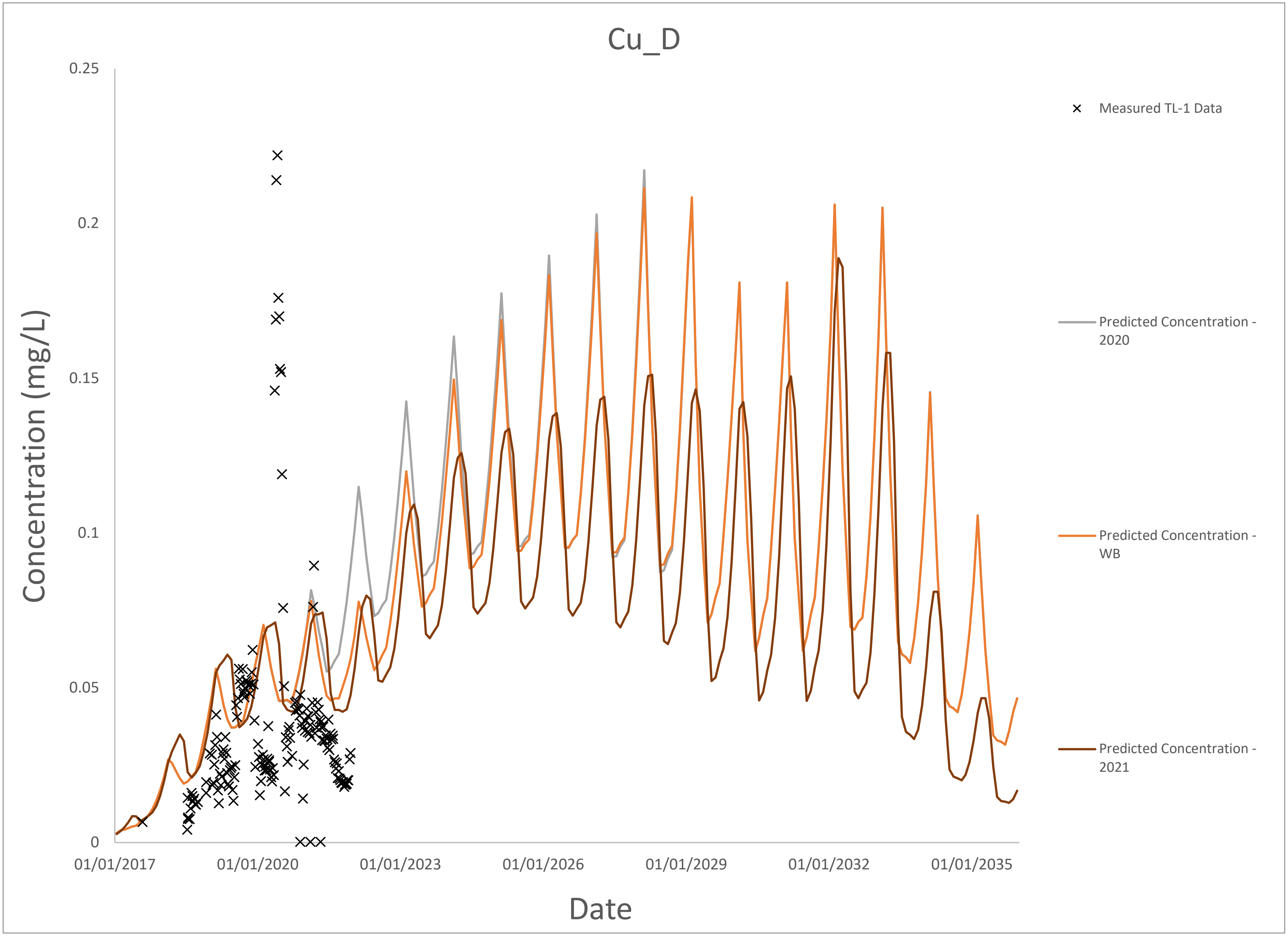


Ca_D
600
500
400
300
200
100
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

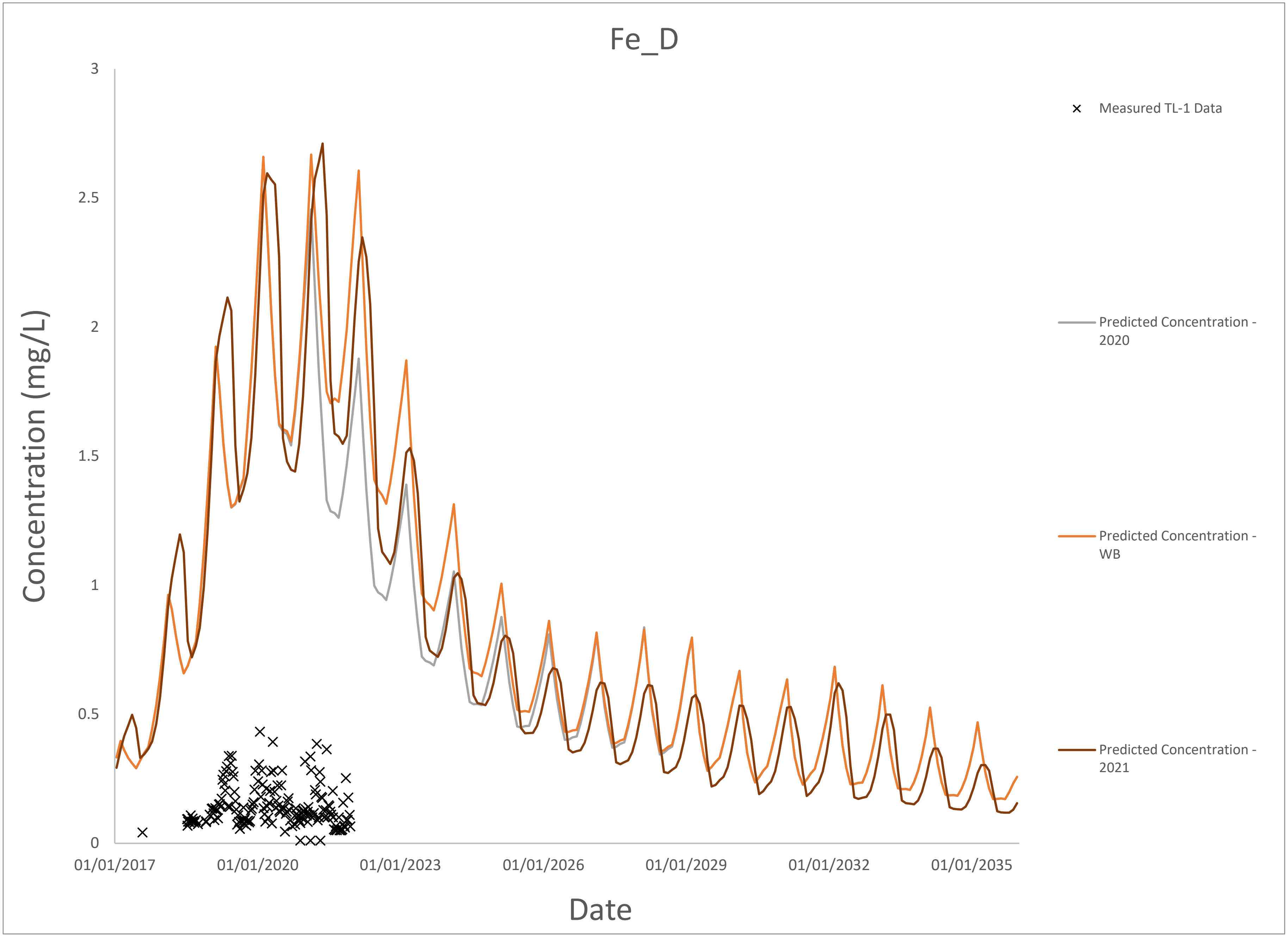


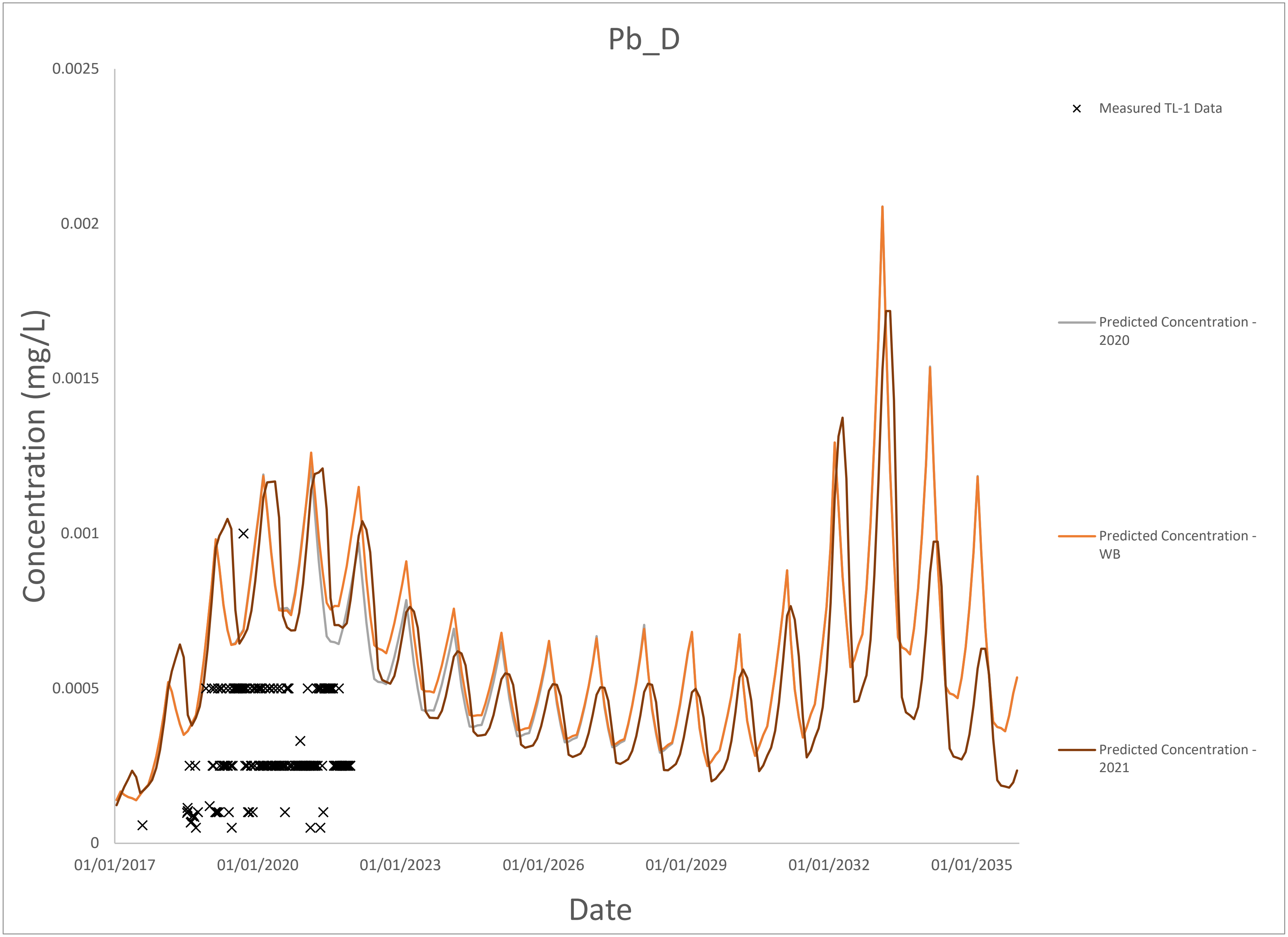
Cr_D
Concentration (mg/L)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021


Co_D
Concentration (mg/L)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

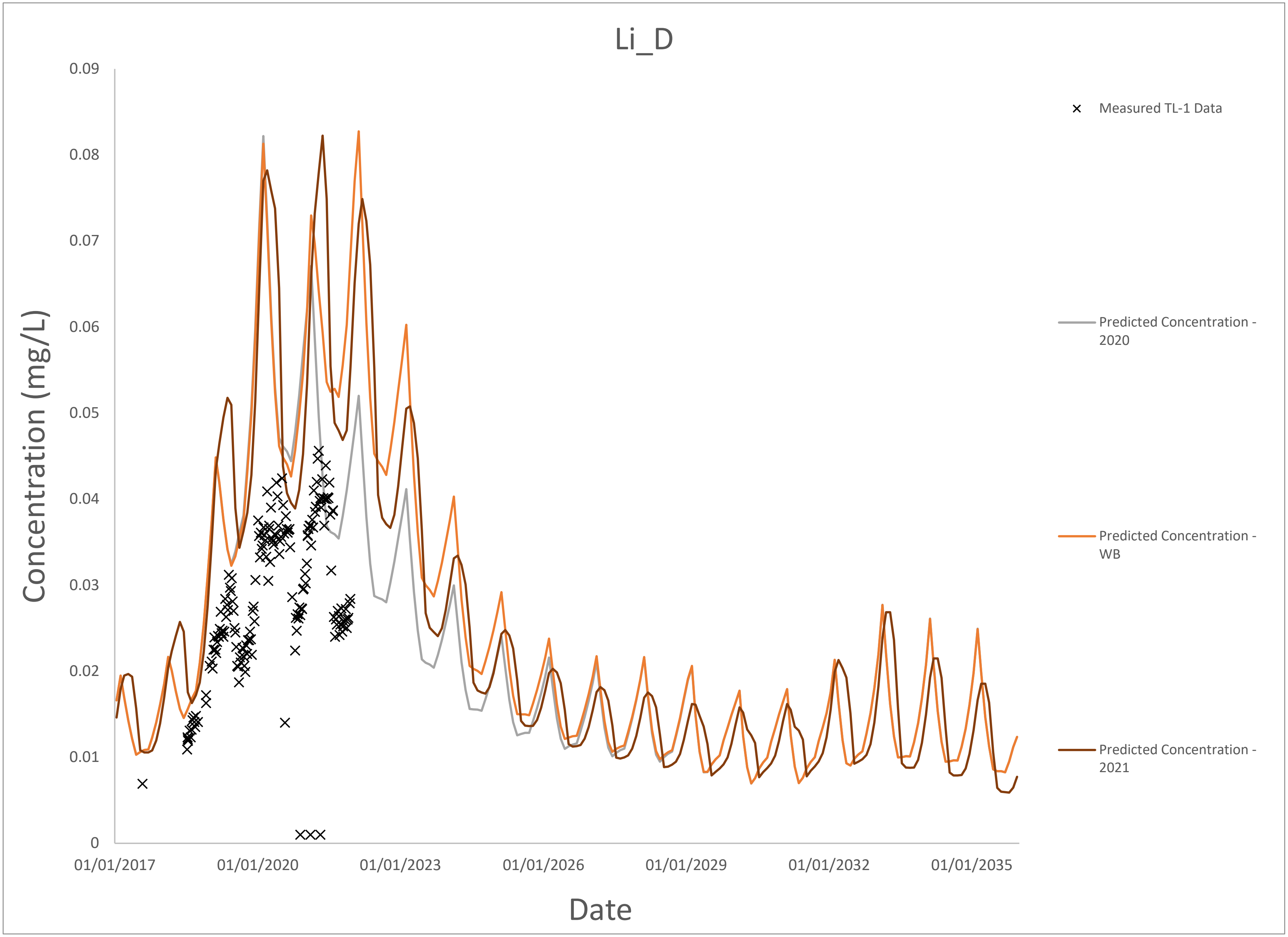


Cu_D
0.25
0.2
0.15
0.1
0.05
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

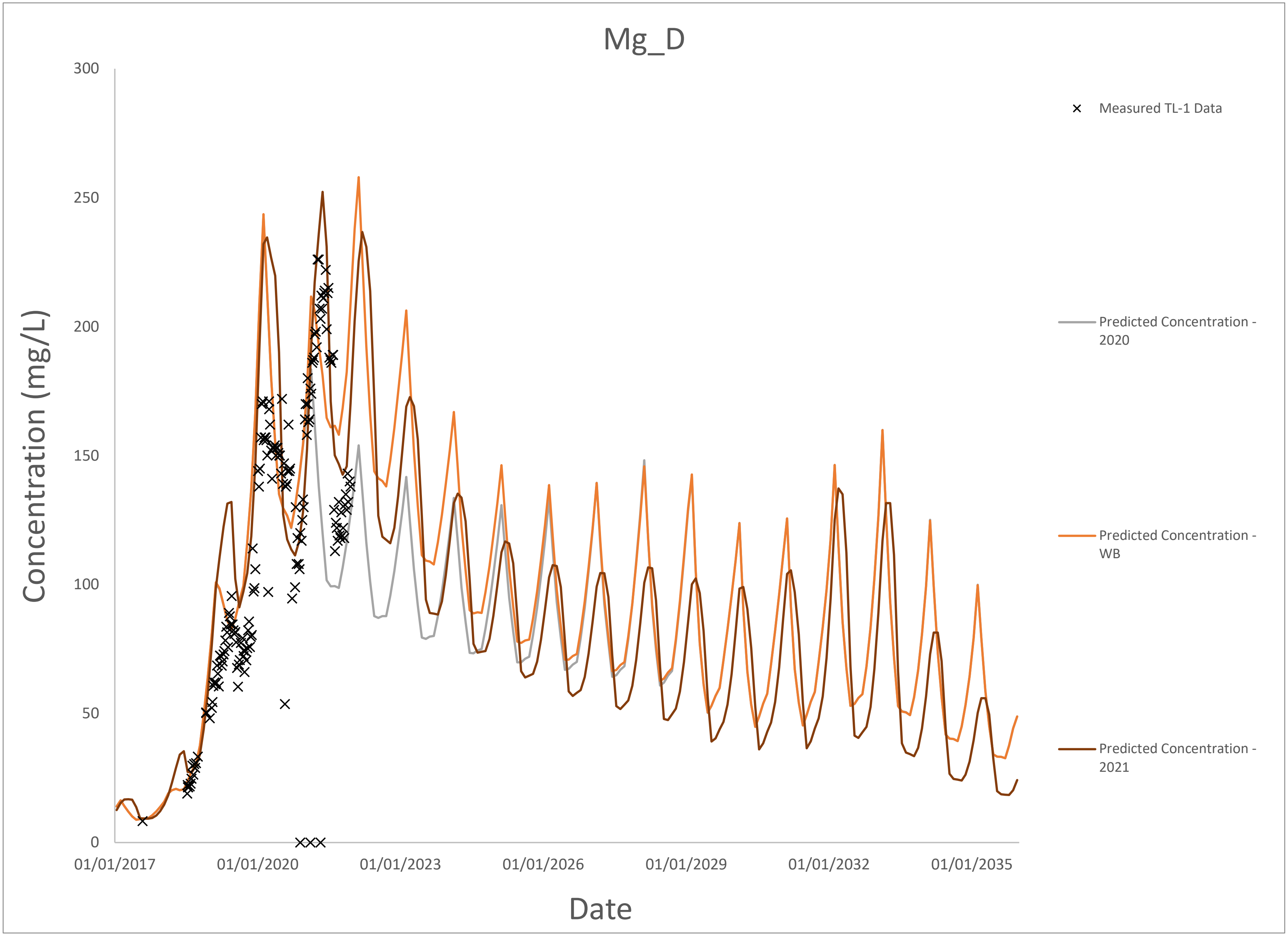

Fe_D
Concentration (mg/L)
3
2.5
2
1.5
1
0.5
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

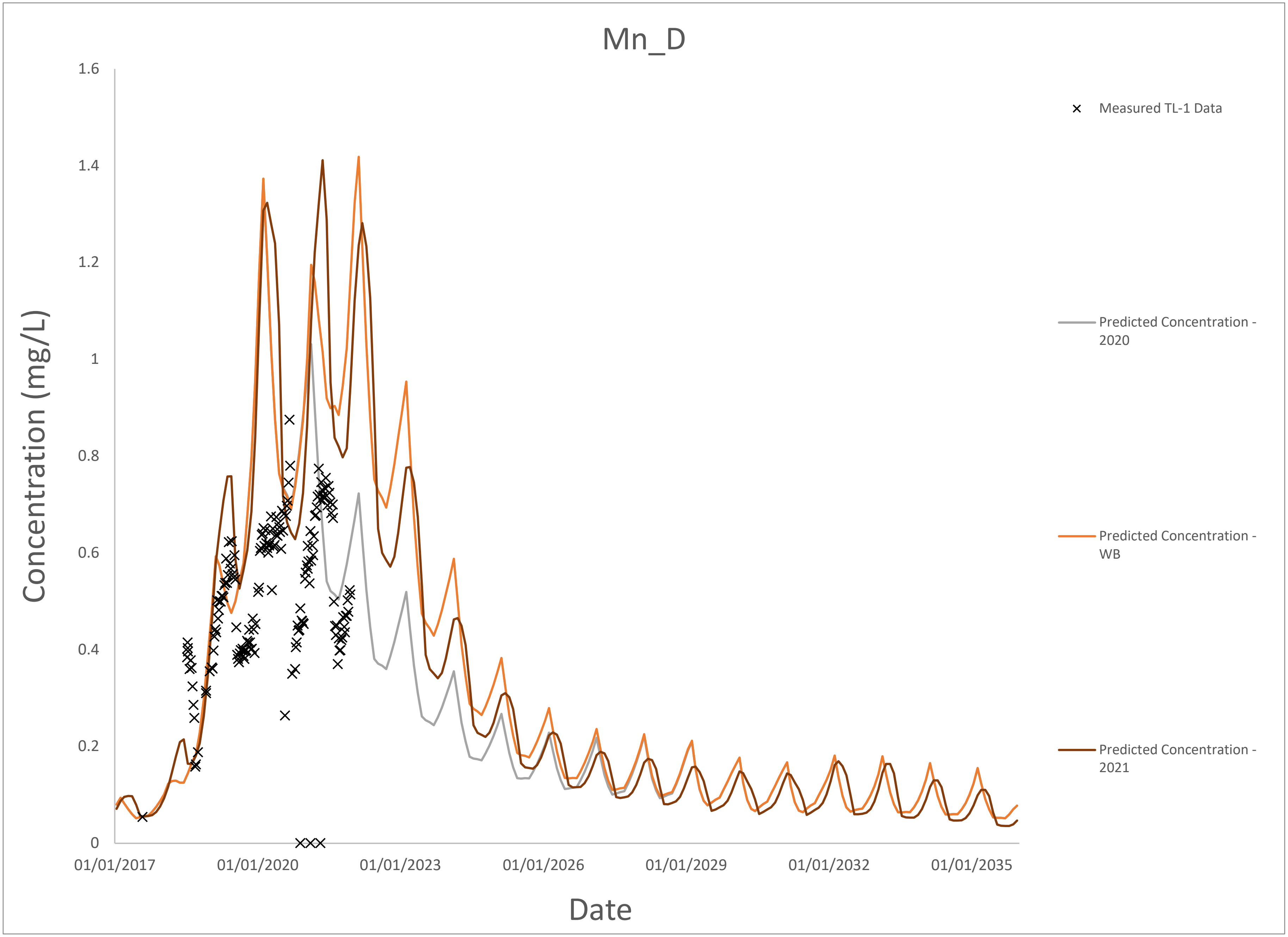


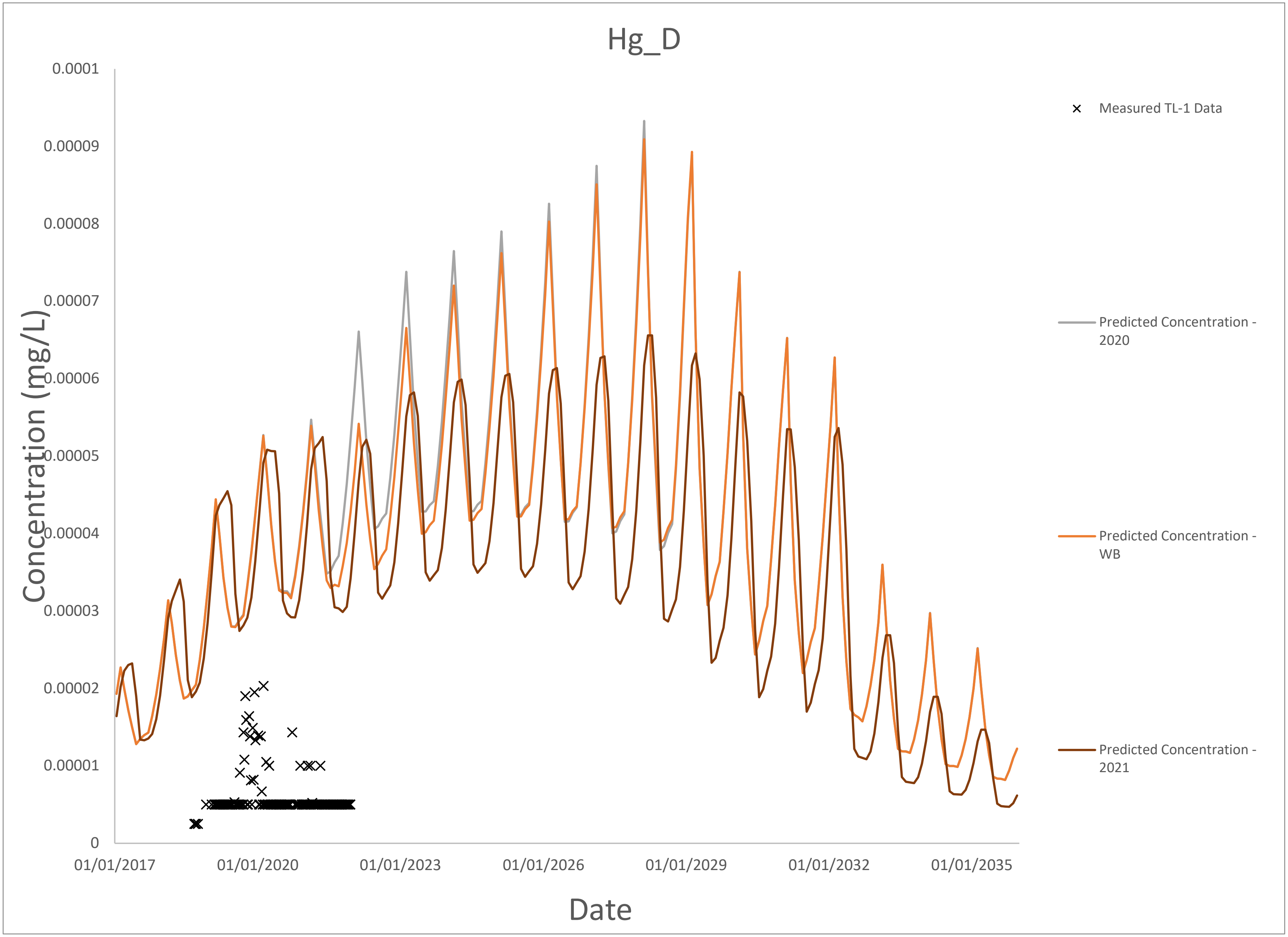
Pb_D
Concentration (mg/L)
0.0025
0.002
0.0015
0.001
0.0005
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



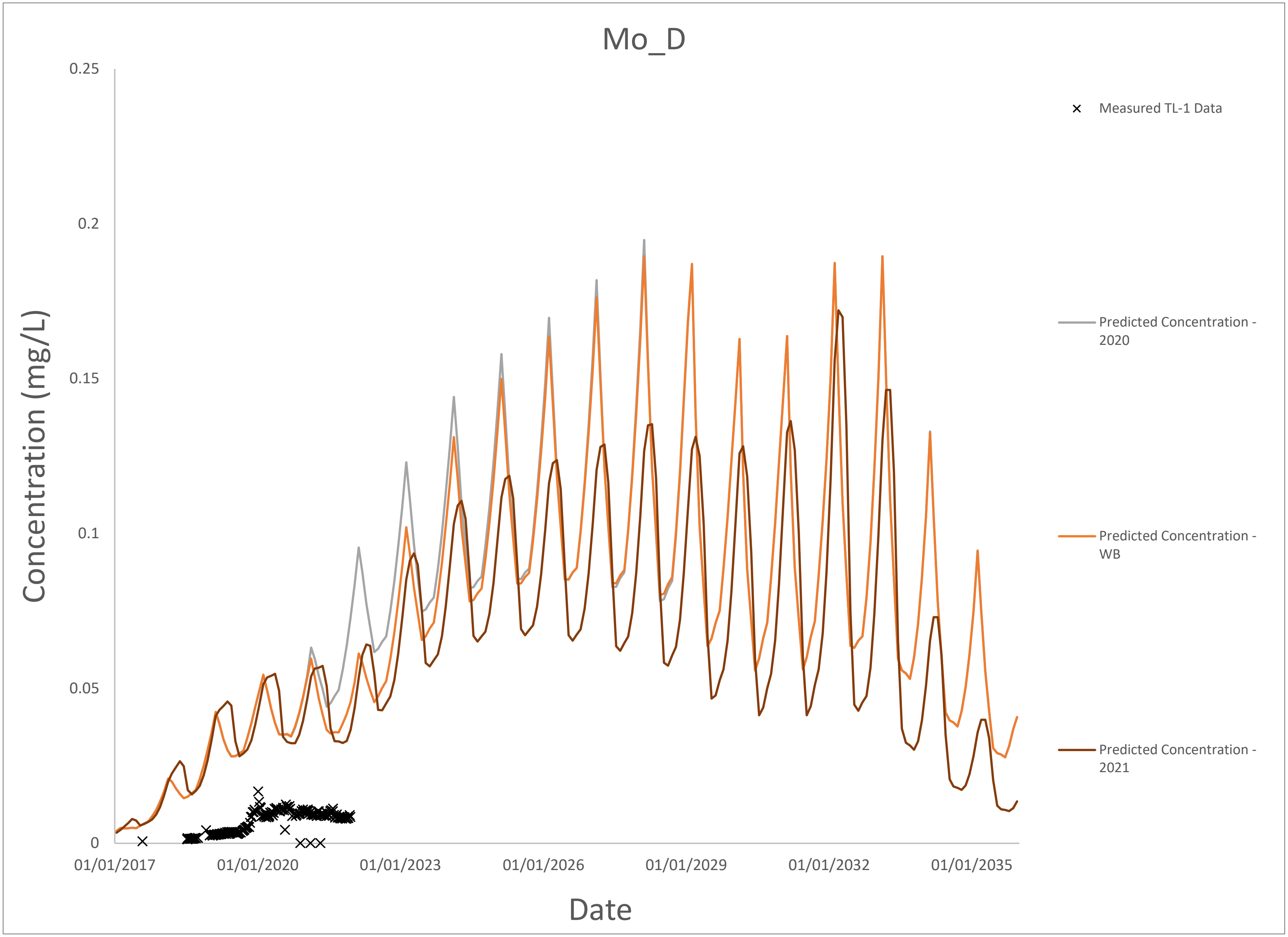
Li_D
Concentration (mg/L)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021


Mg_D
Concentration (mg/L)
300
250
200
150
100
50
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

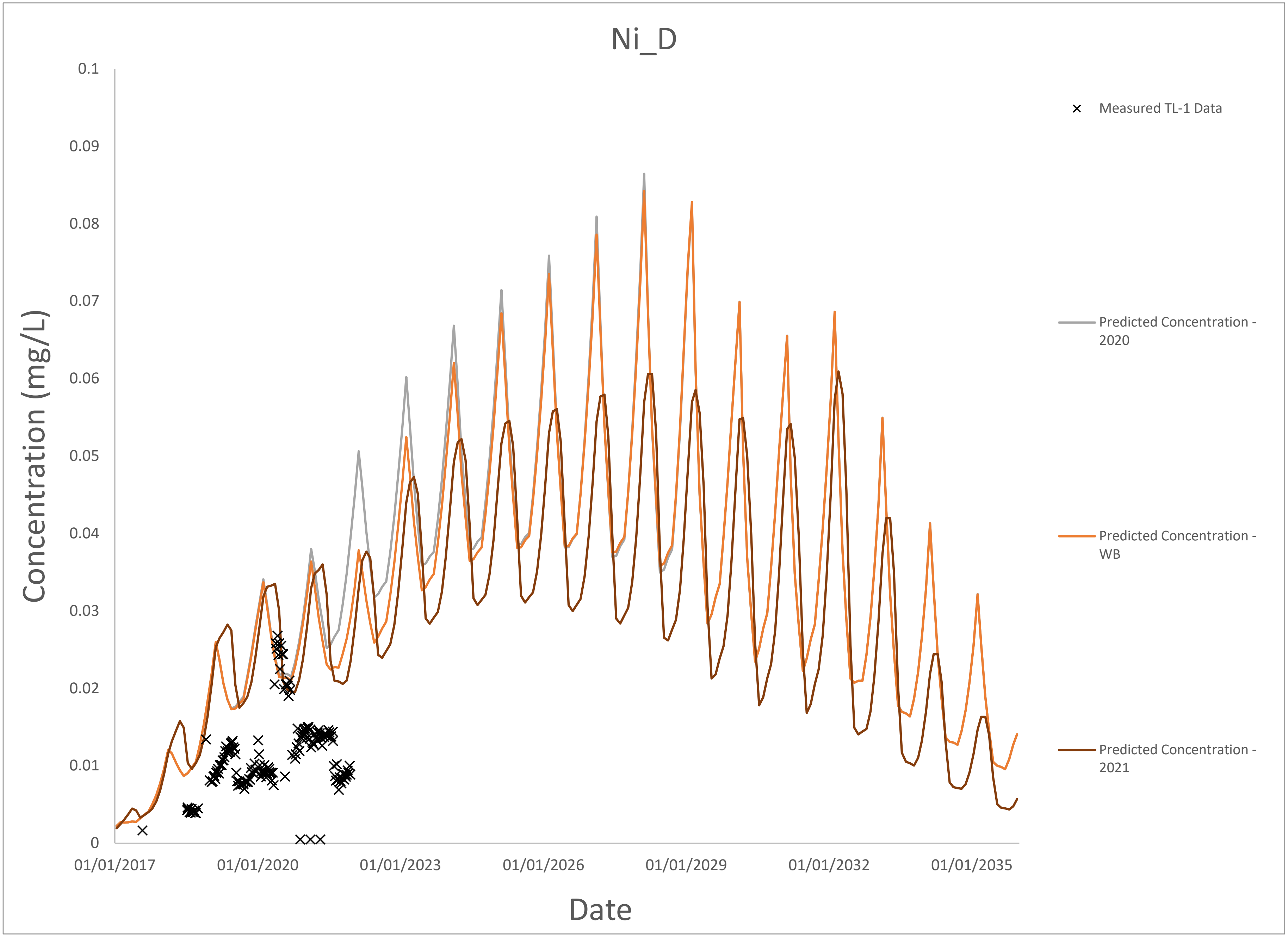

Mn_D
Concentration (mg/L)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



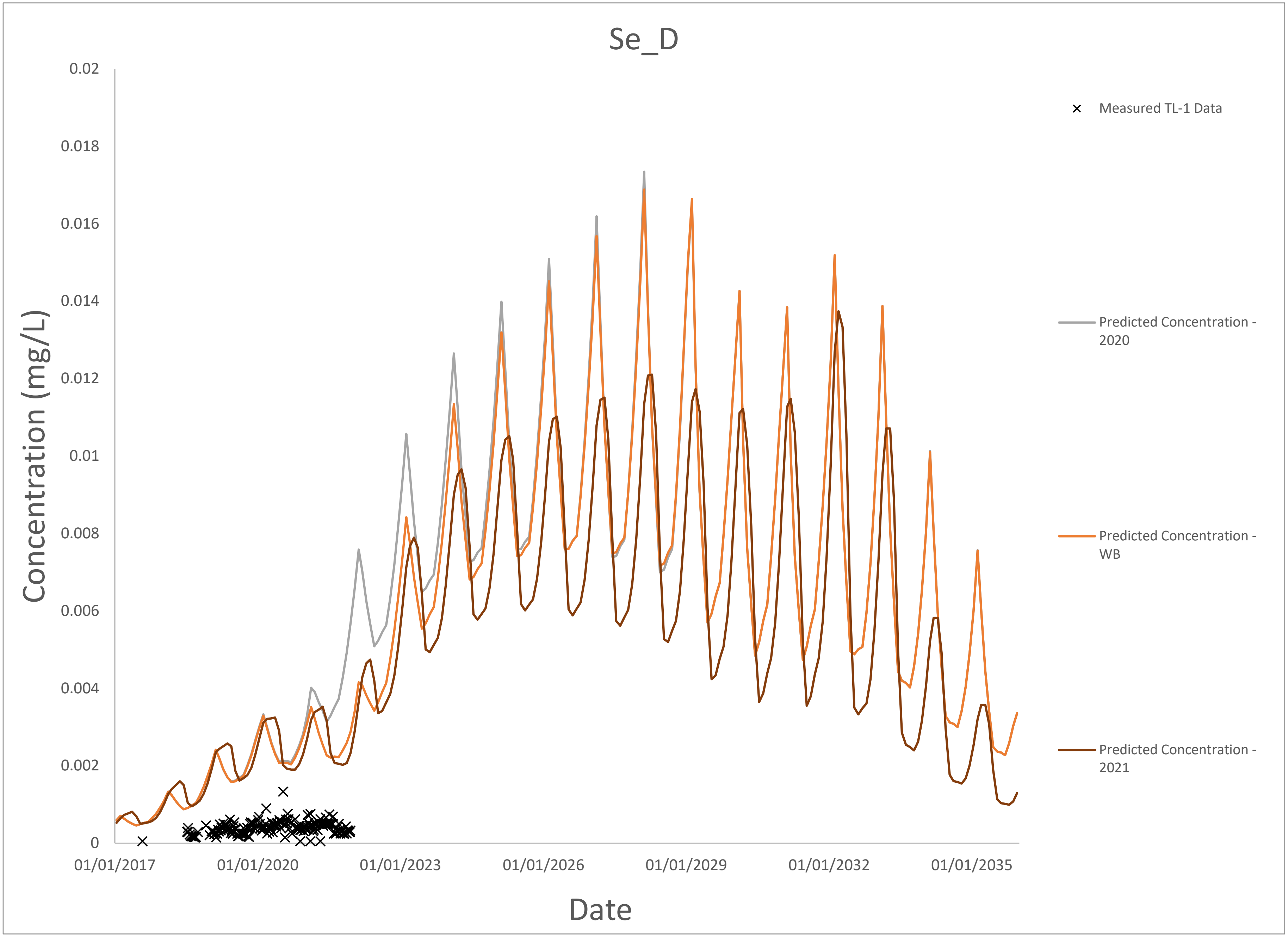
Hg_D
0.0001
0.00009
0.00008
0.00007
0.00006
0.00005
0.00004
0.00003
0.00002
0.00001
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

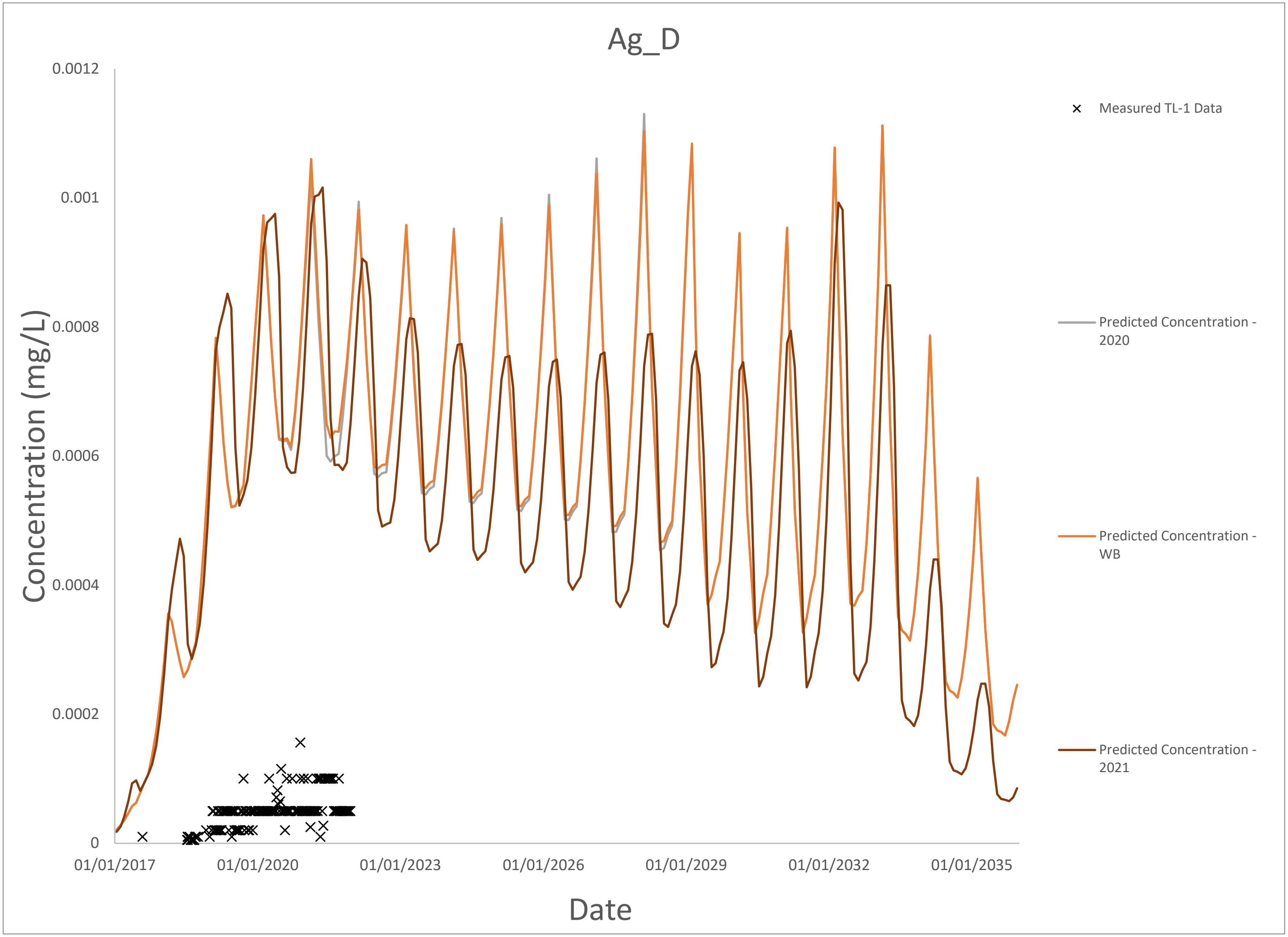


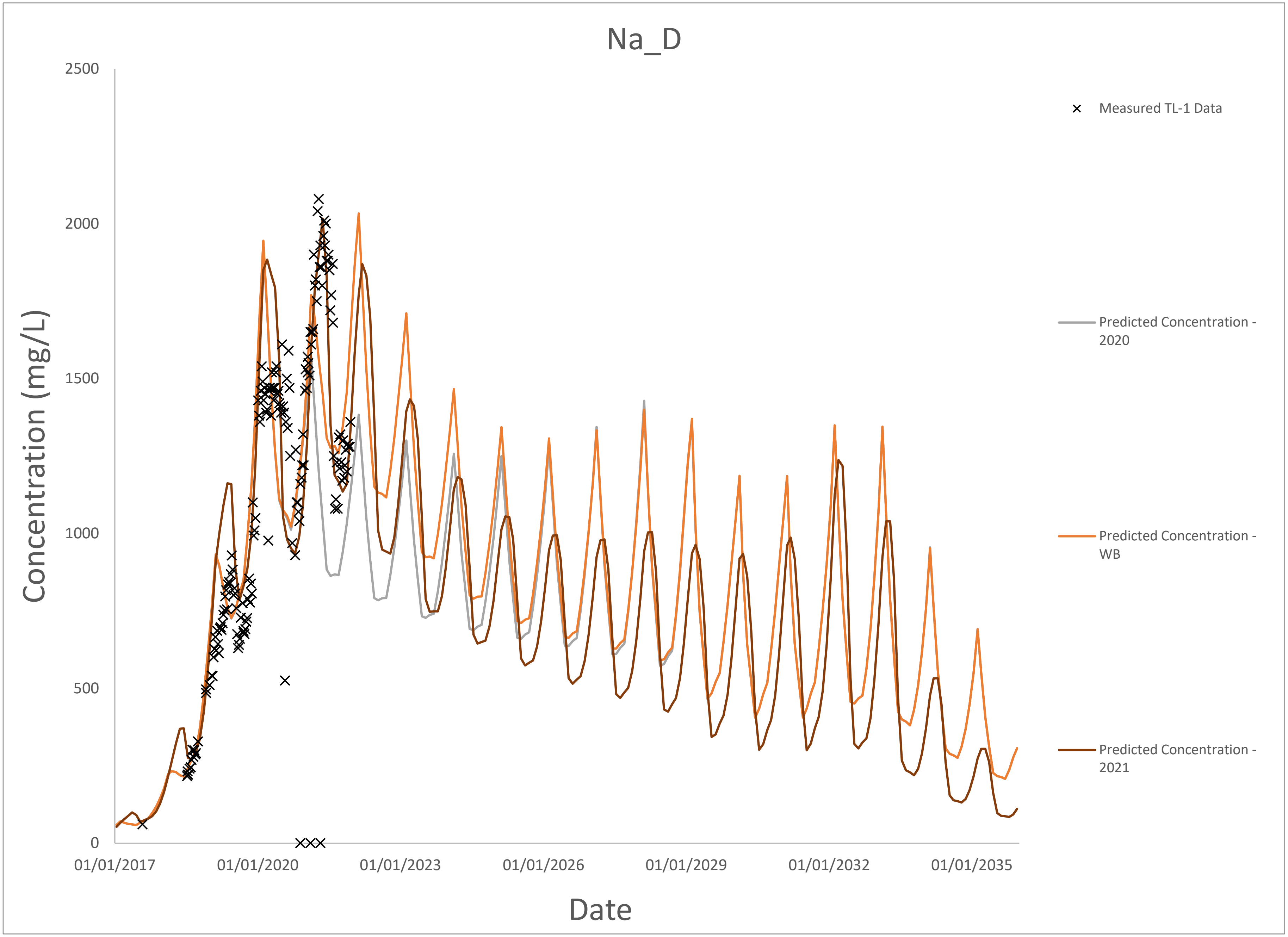
Mo_D
0.25
0.2
0.15
0.1
0.05
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



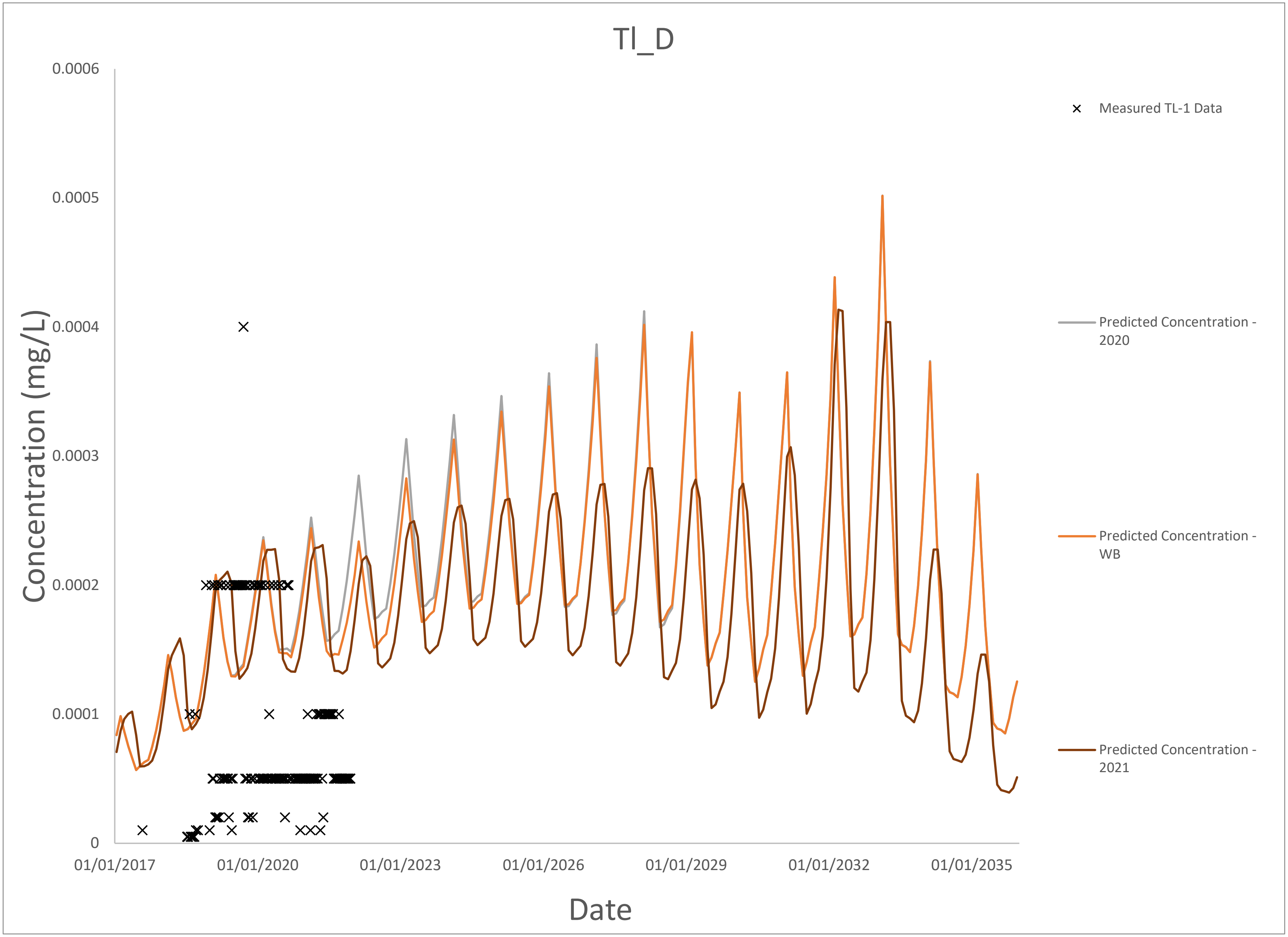
Ni_D
Concentration (mg/L)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021


Se_D
Concentration (mg/L)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

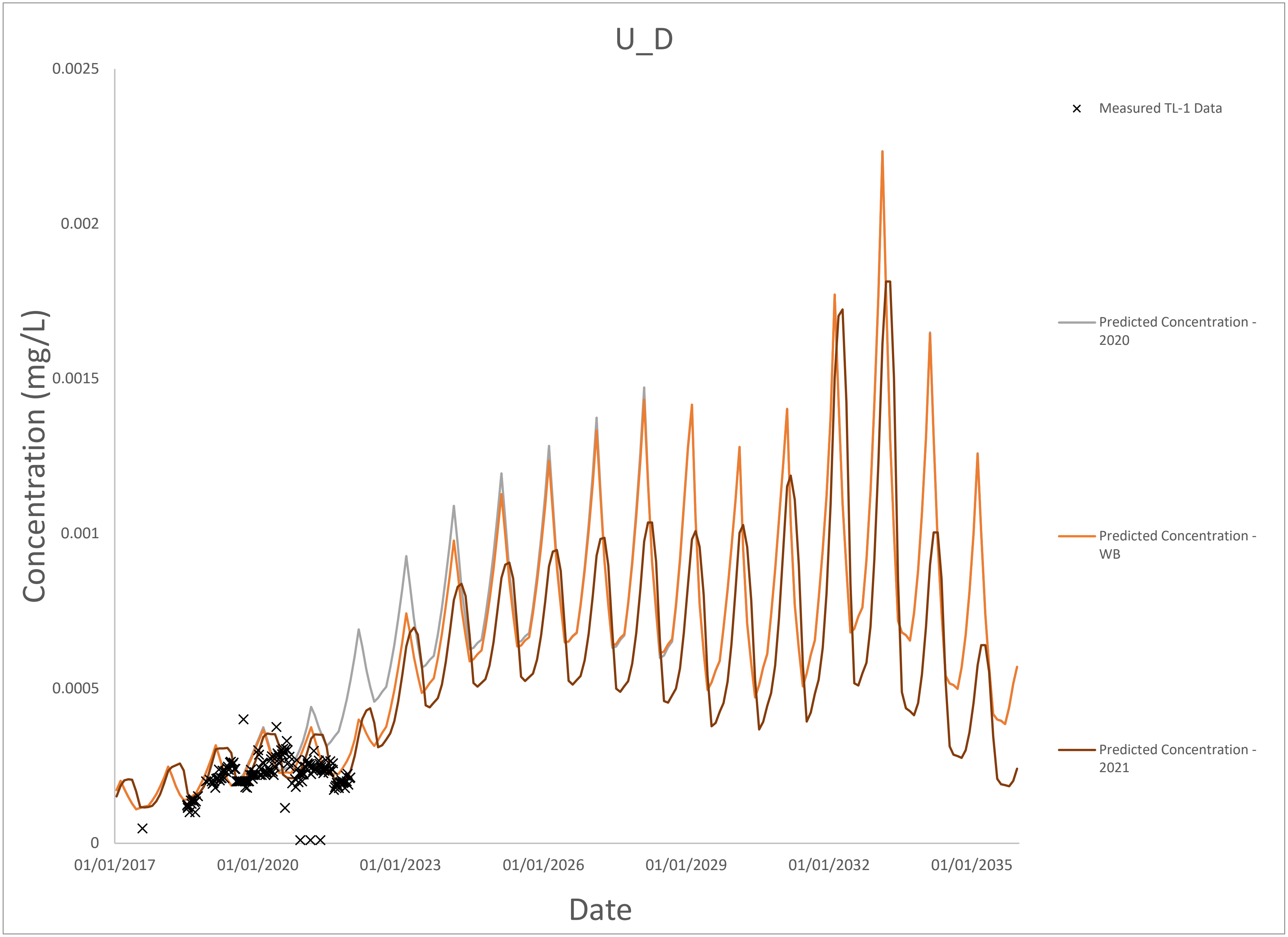

Ag_D
Concentration (mg/L)
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

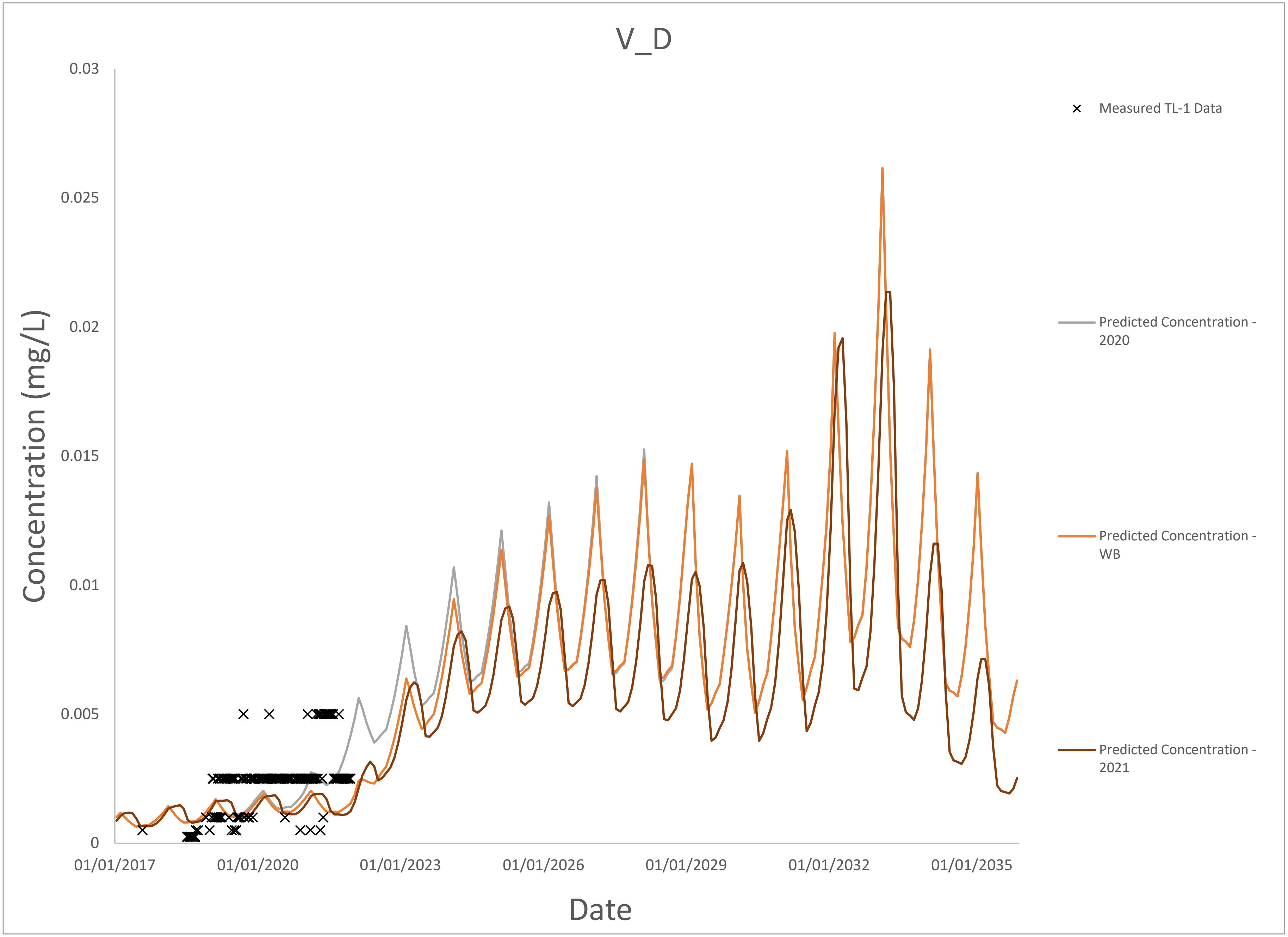


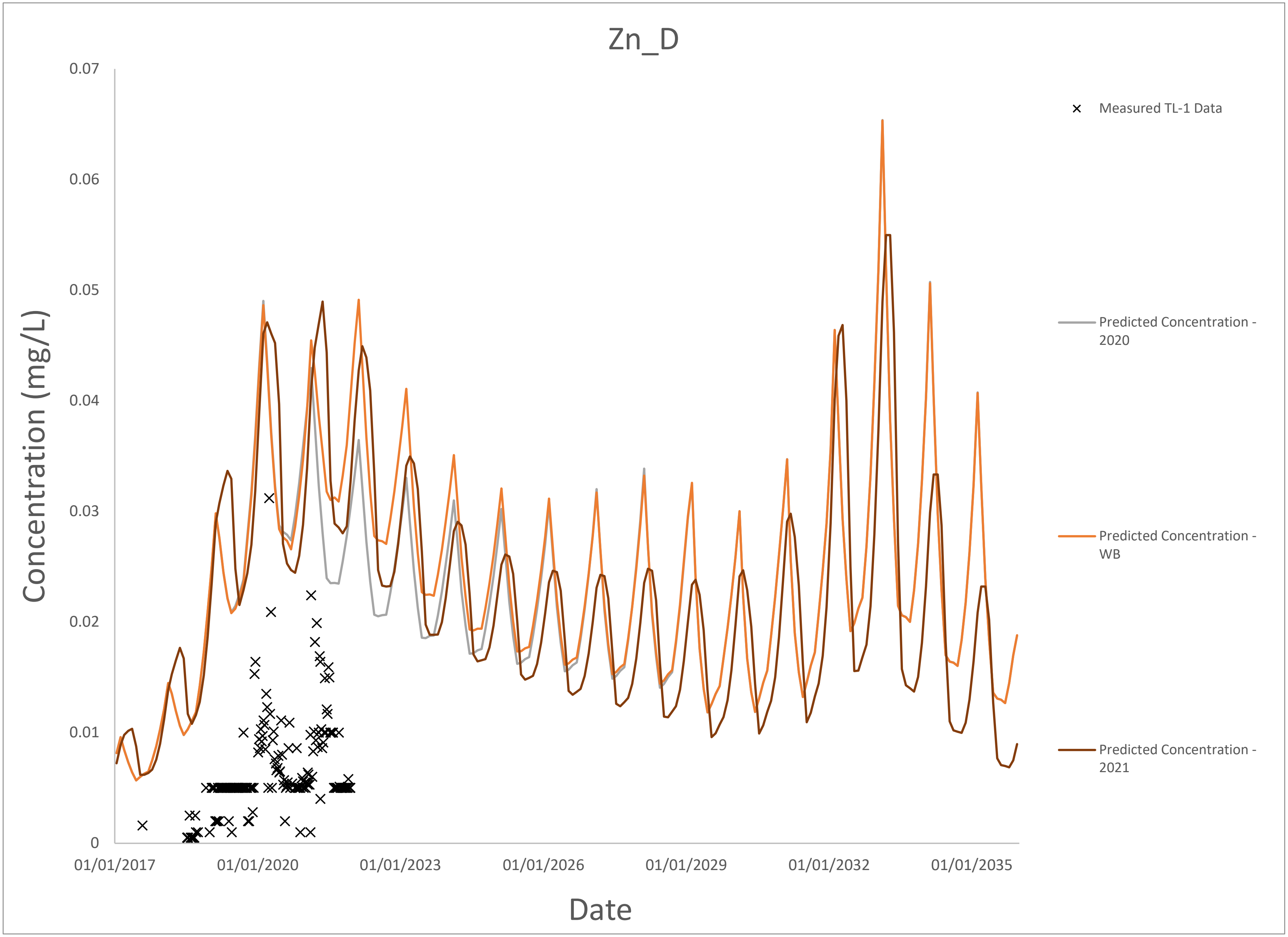
Na_D
Concentration (mg/L)
2500
2000
1500
1000
500
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

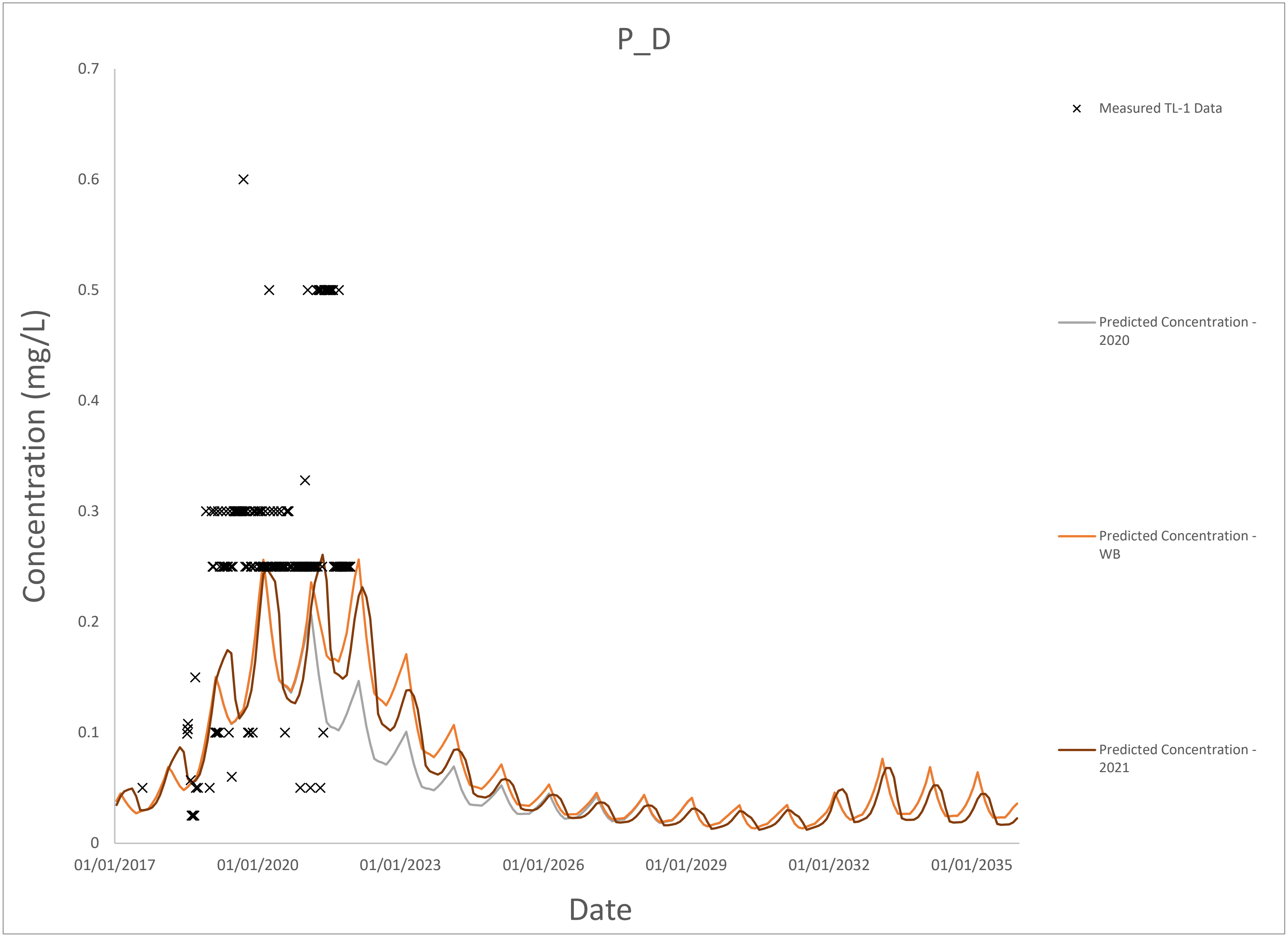


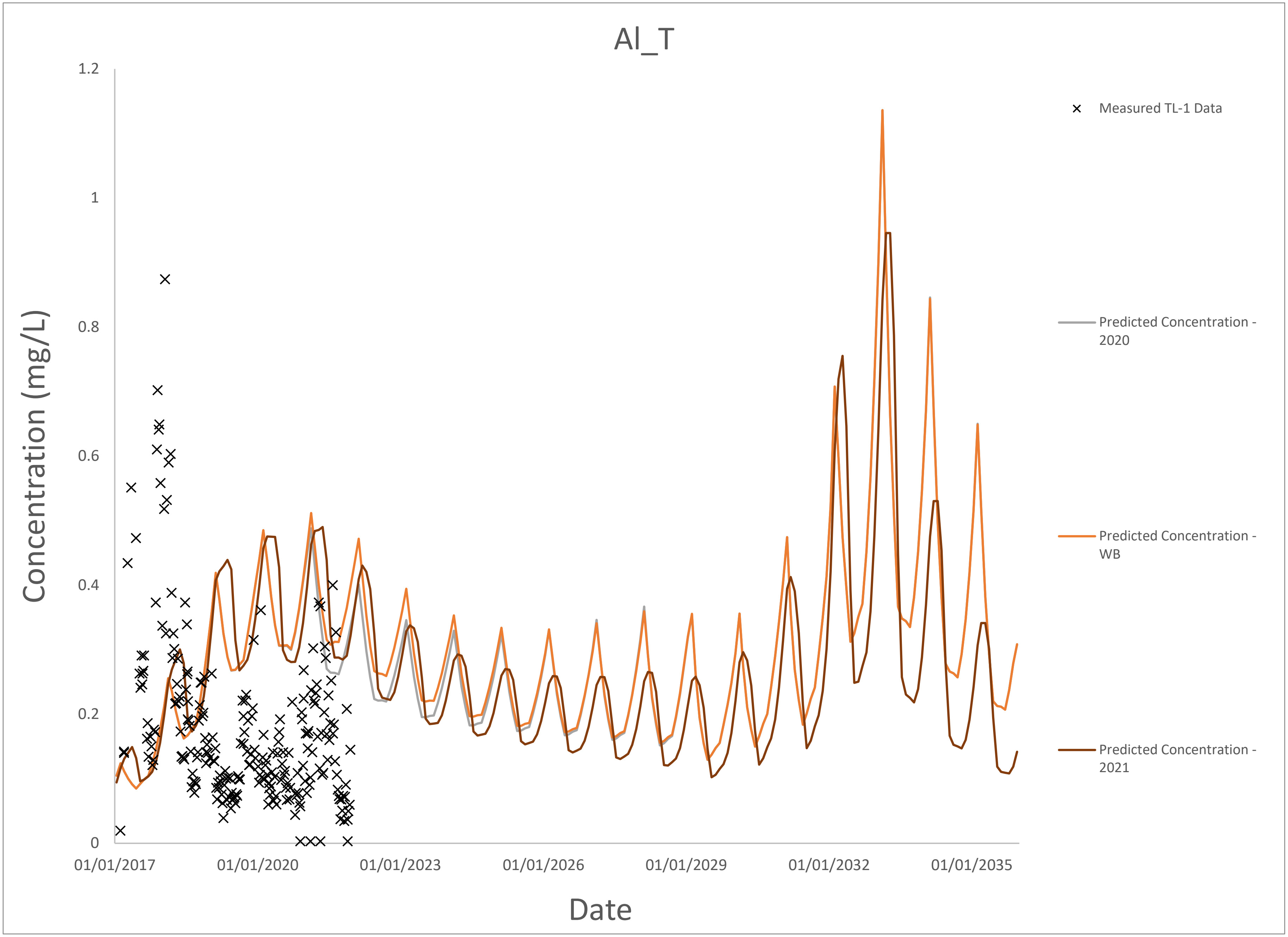
Tl_D
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021


U_D
Concentration (mg/L)
0.0025
0.002
0.0015
0.001
0.0005
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

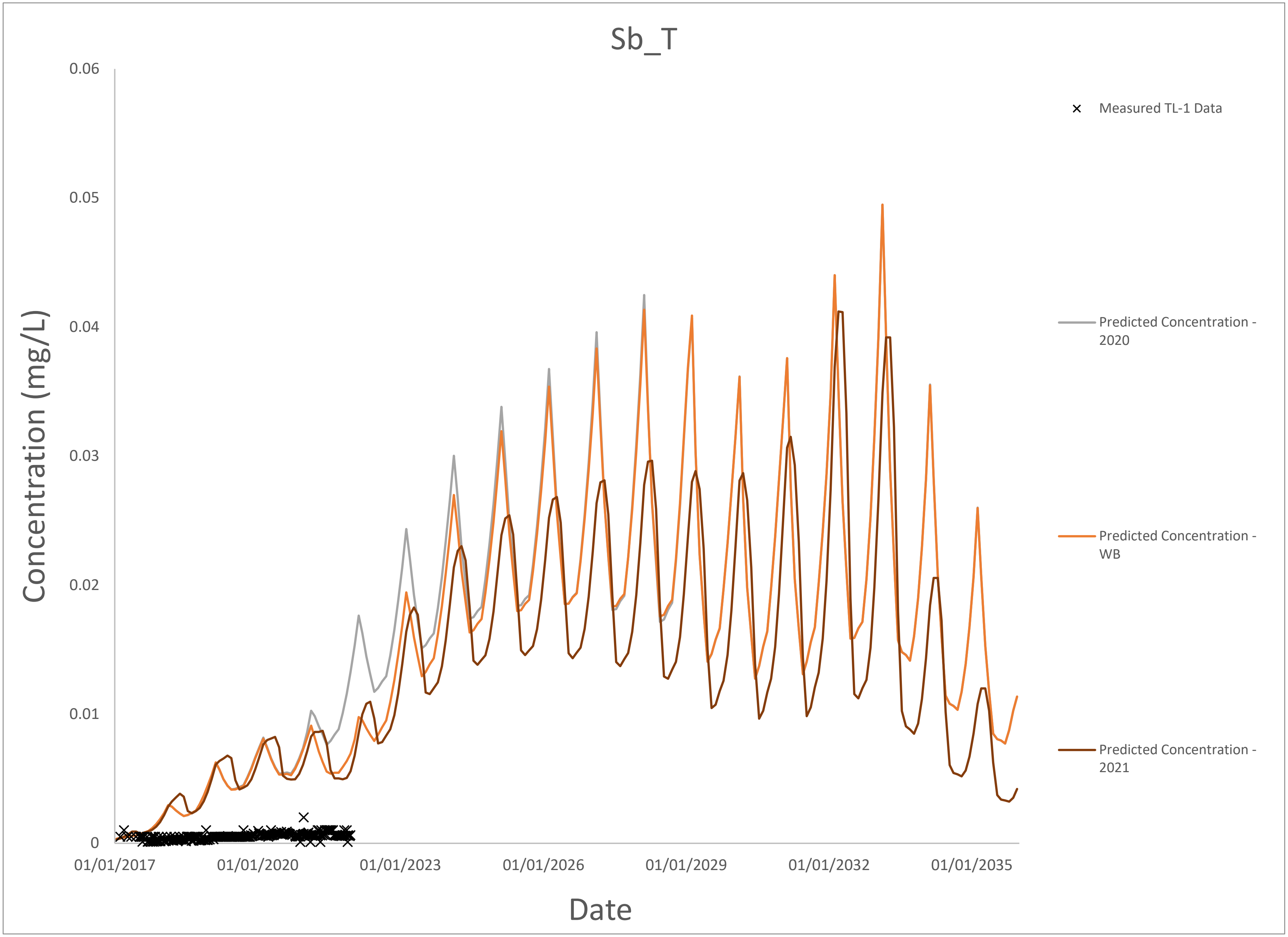

V_D
Concentration (mg/L)
0.03
0.025
0.02
0.015
0.01
0.005
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021


Zn_D
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

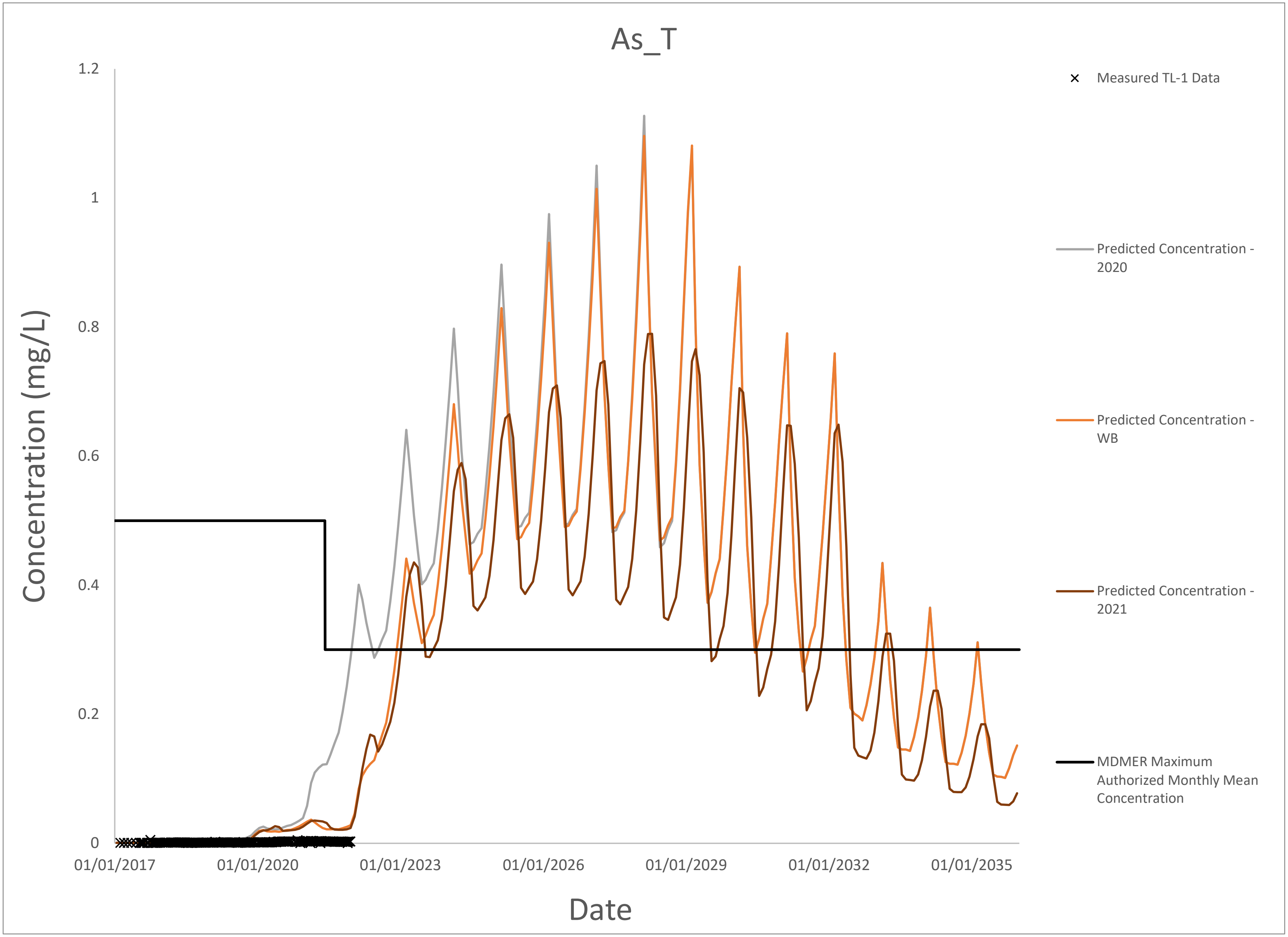

P_D
Concentration (mg/L)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



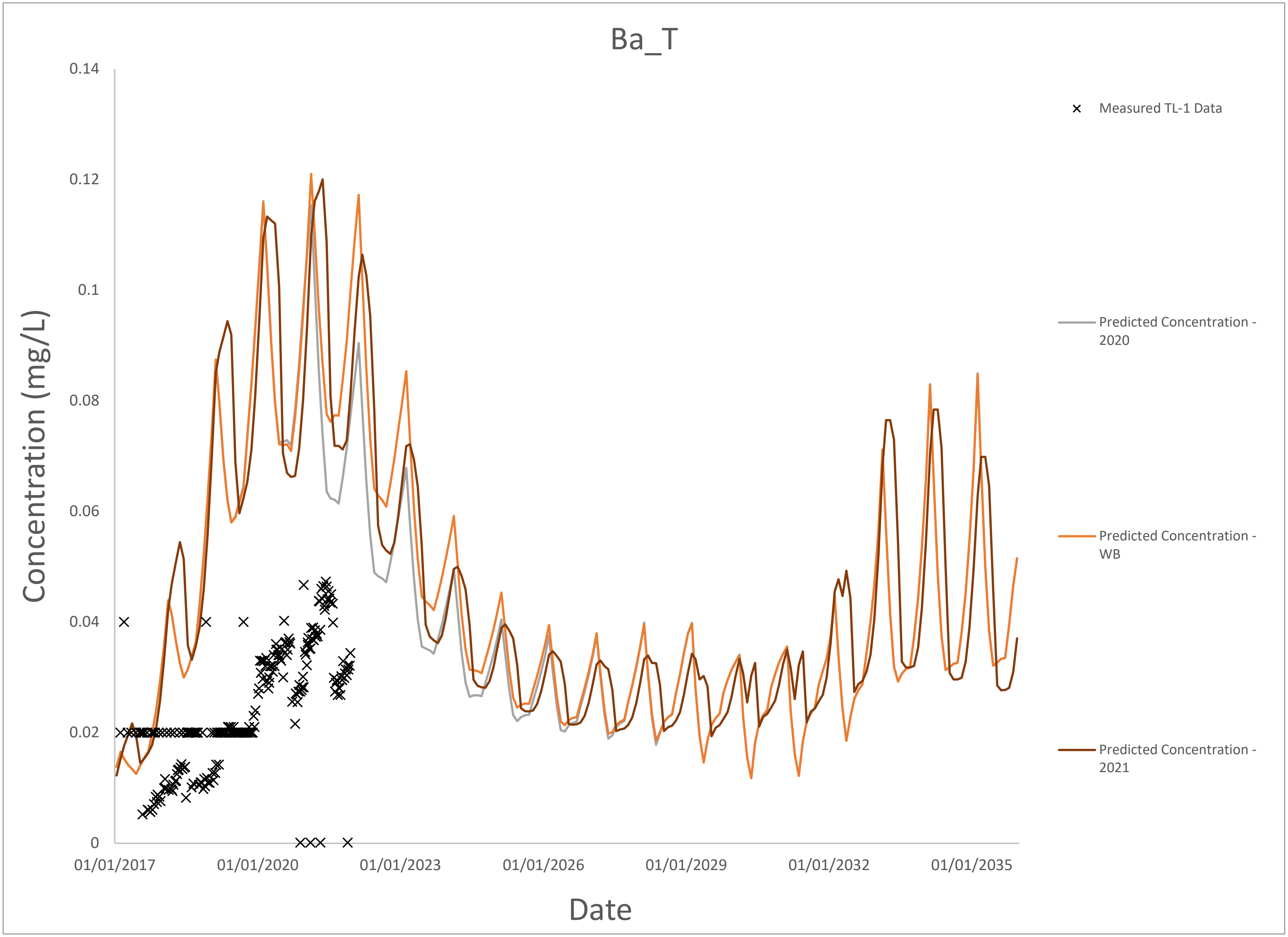
Al_T
Concentration (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



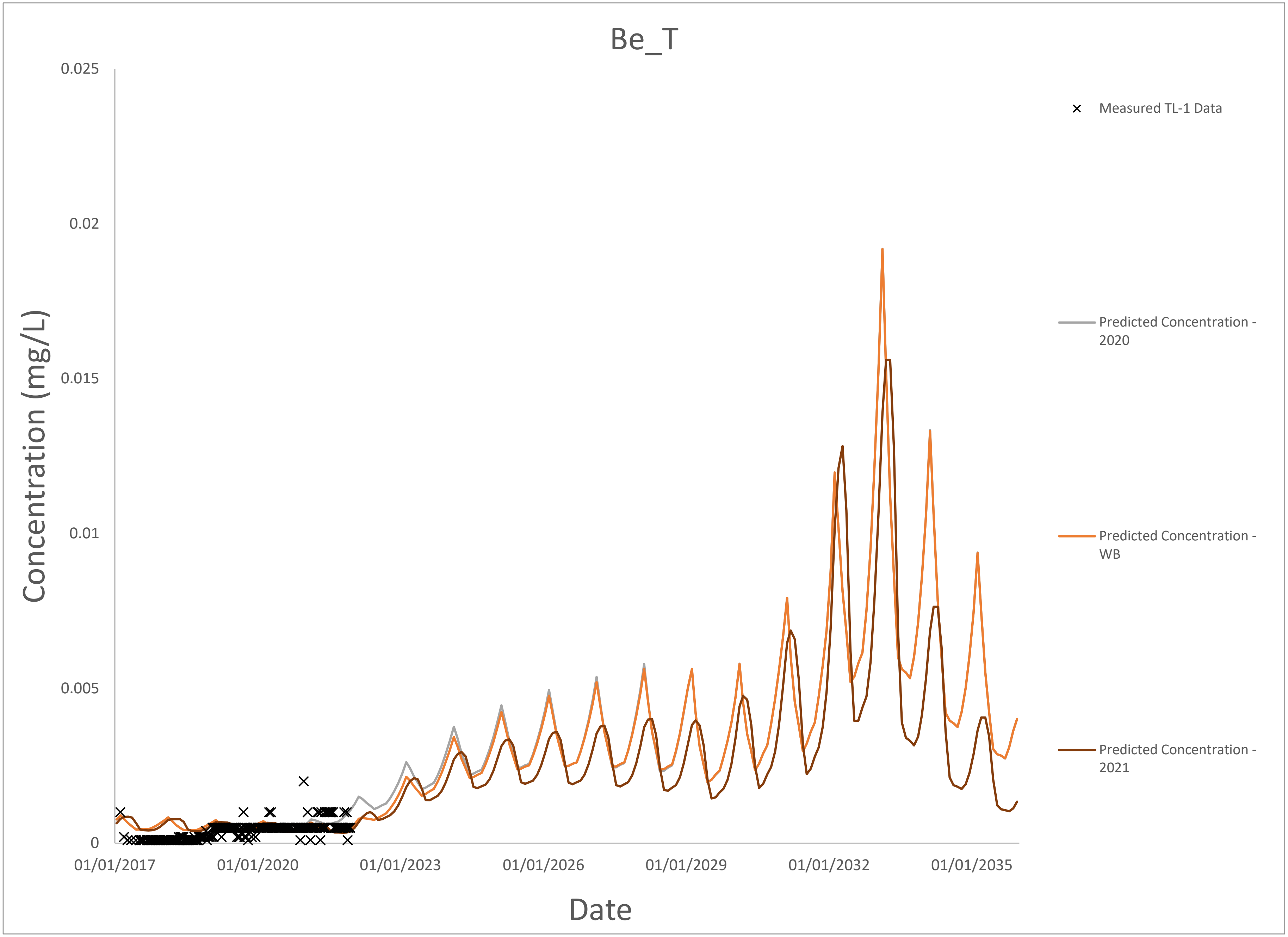
Sb_T
0.06
0.05
0.04
0.03
0.02
0.01
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



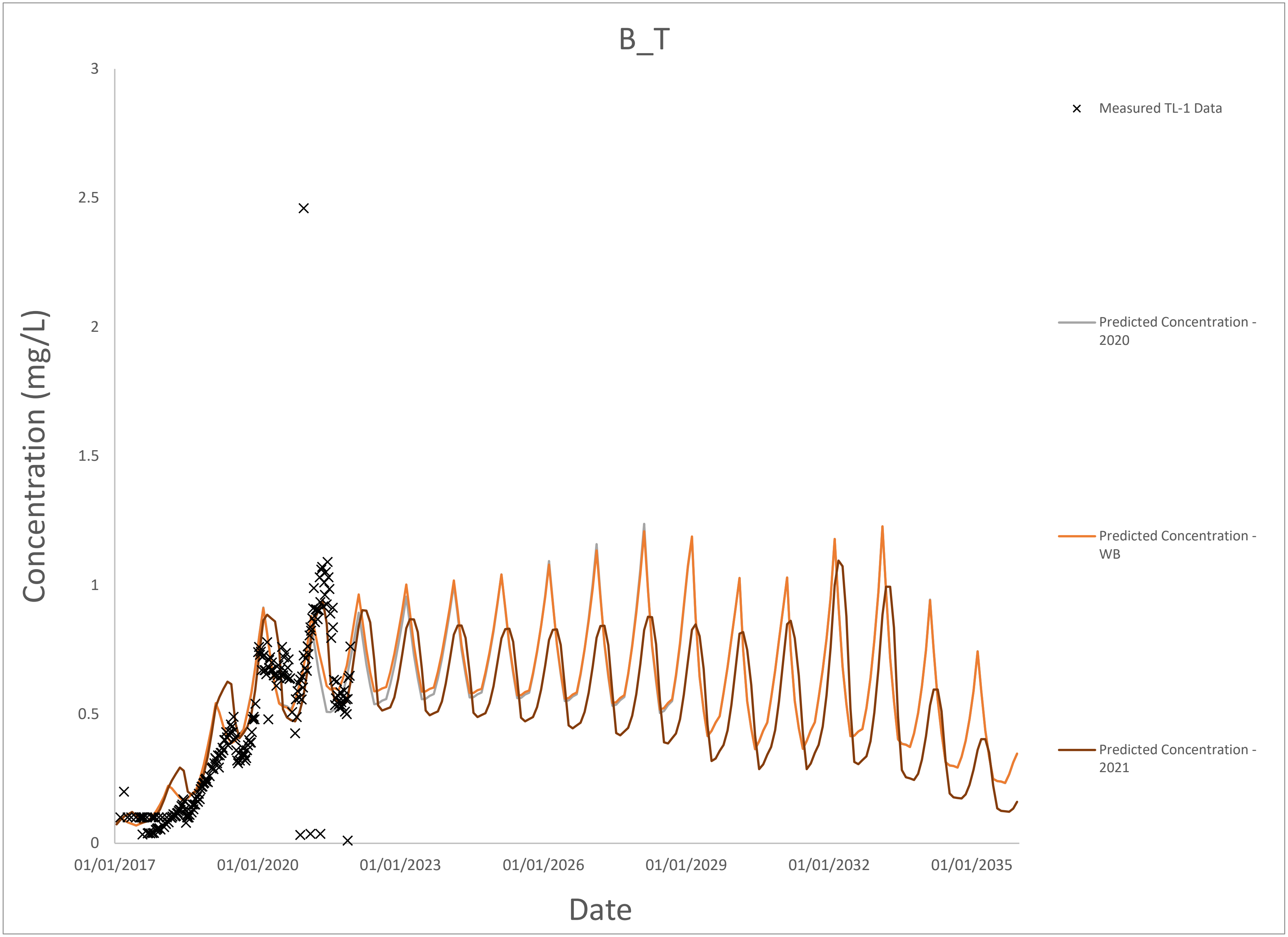
As_T
Concentration (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021
MDMER Maximum Authorized Monthly Mean Concentration



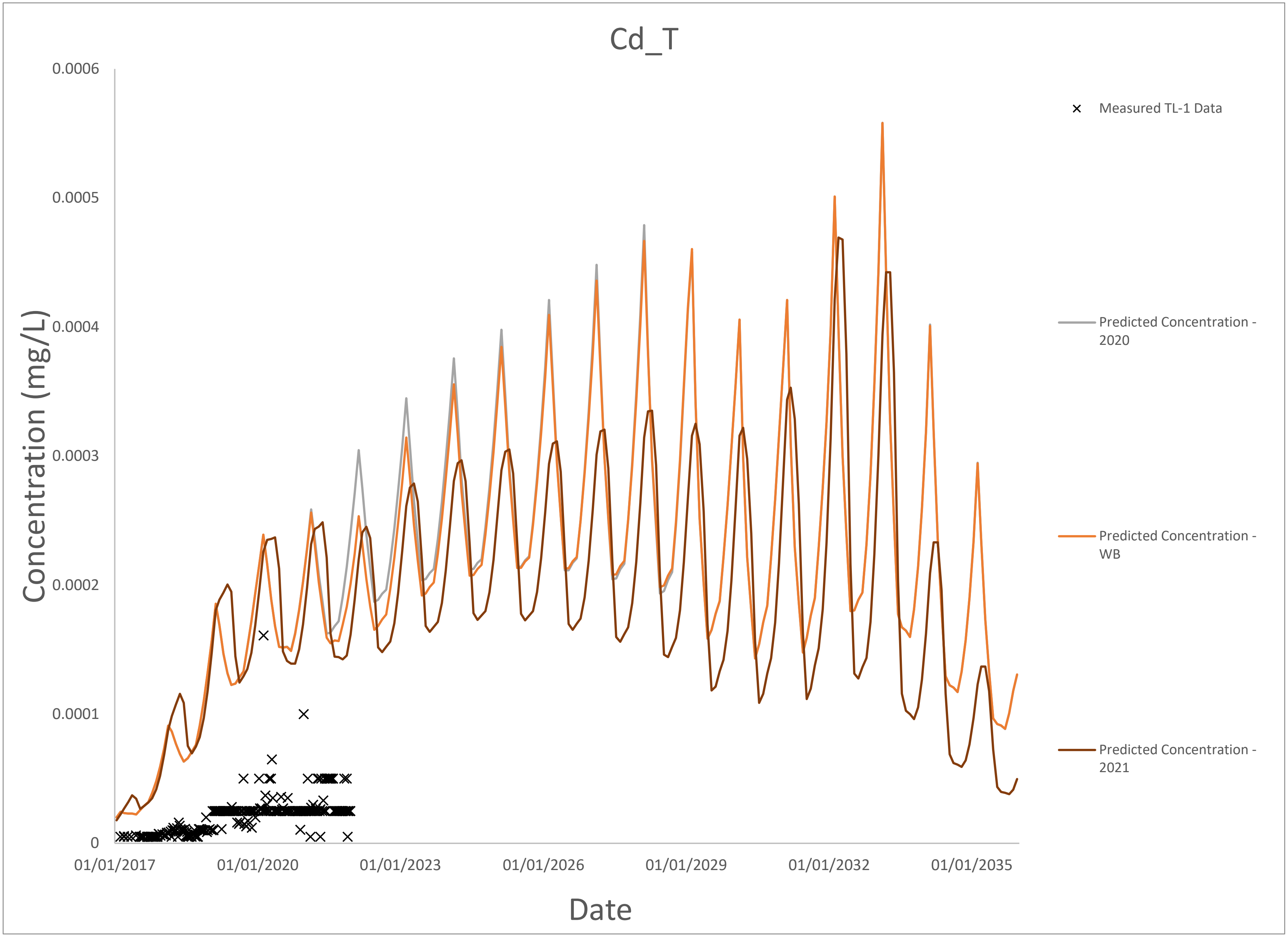
Ba_T
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

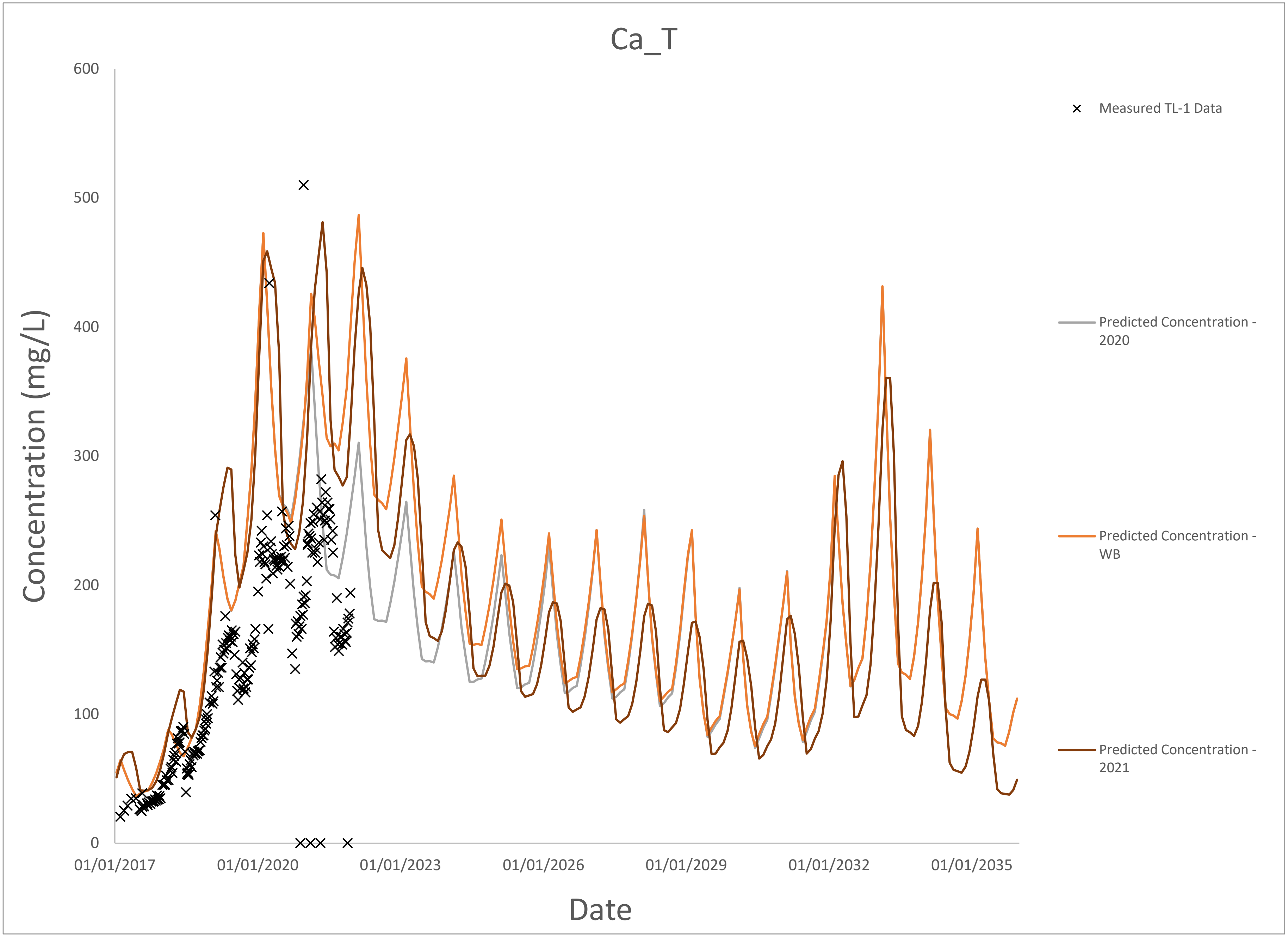


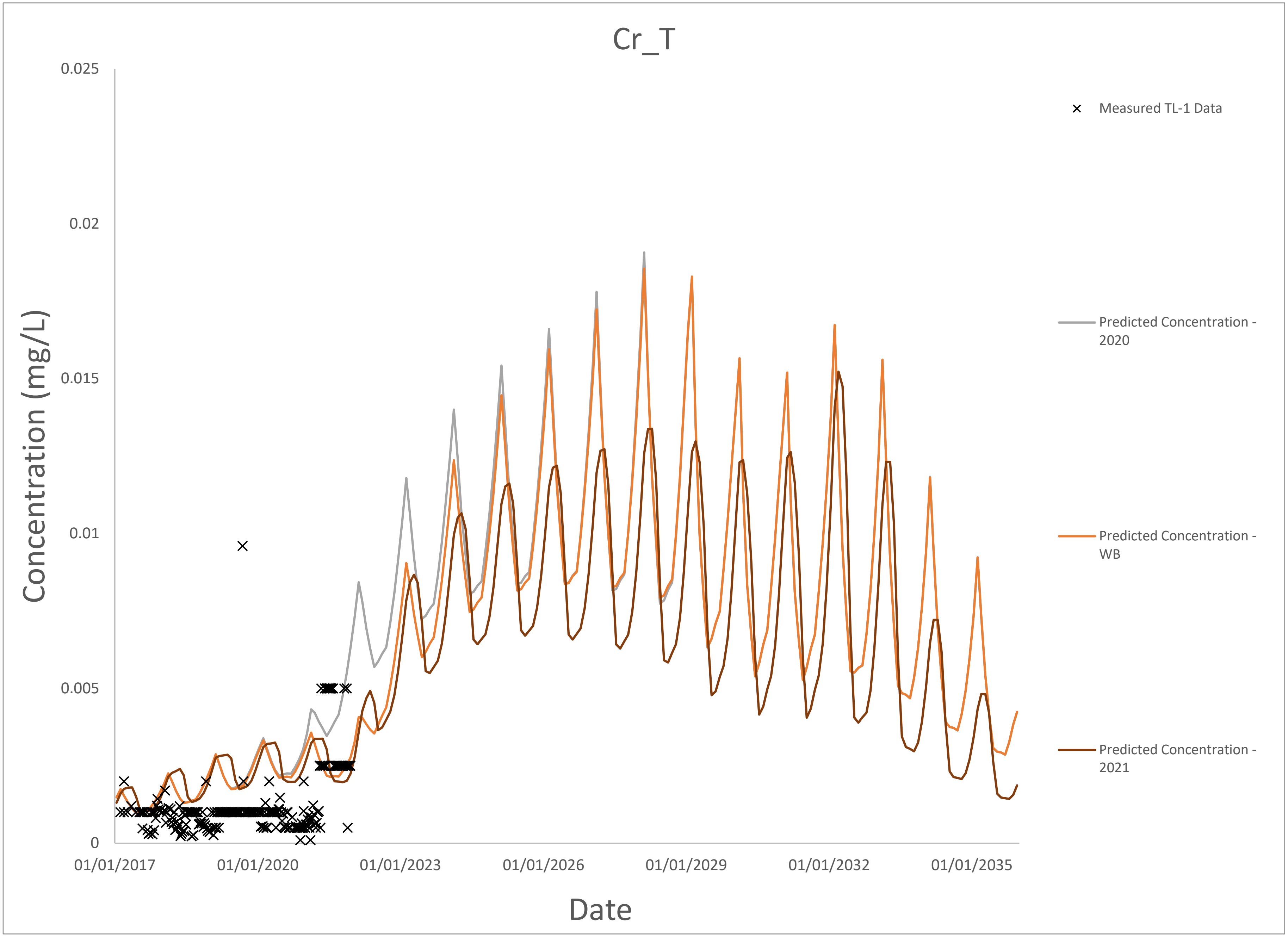
Be_T
0.025
0.02
0.015
0.01
0.005
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



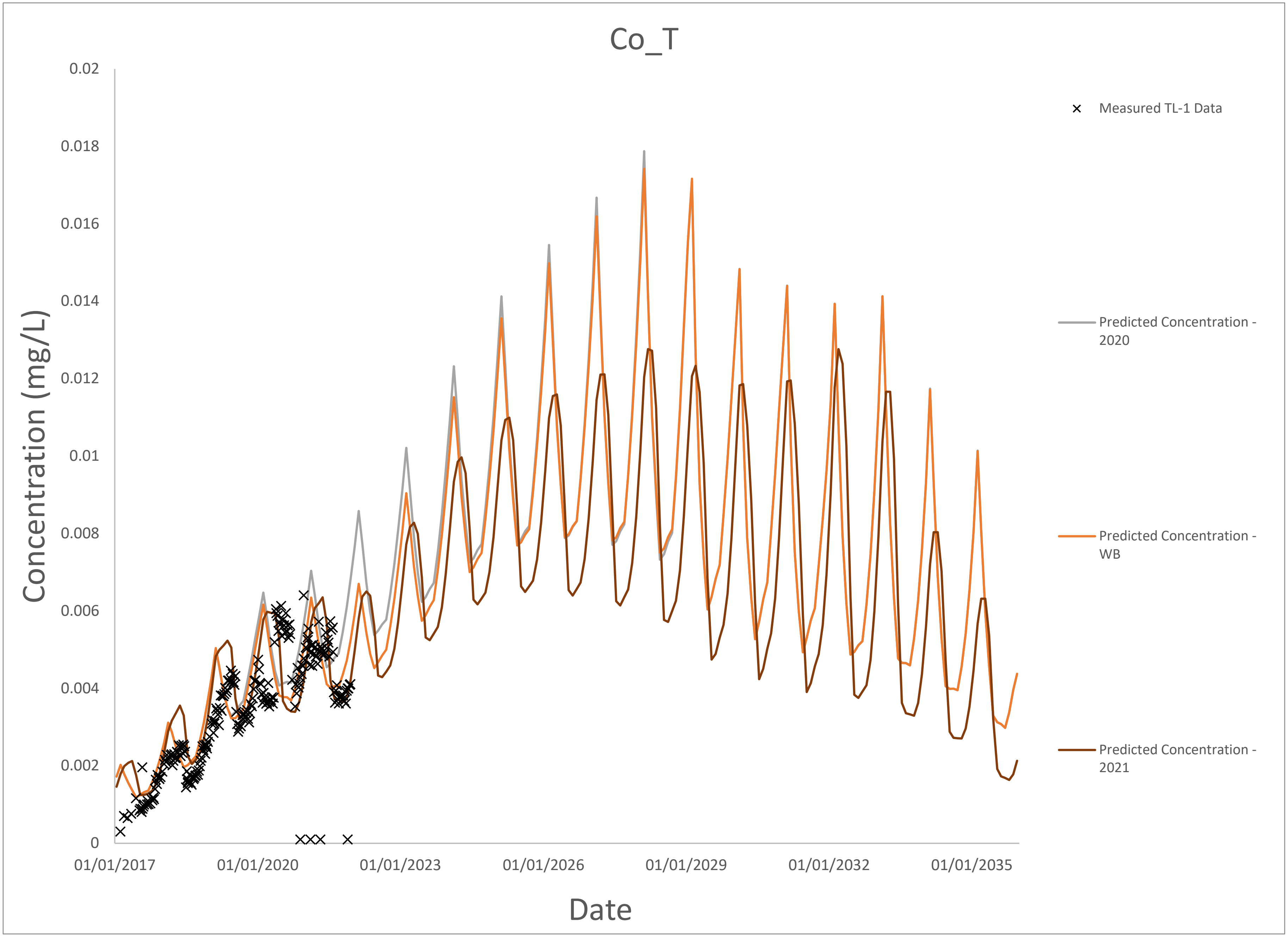
B_T
Concentration (mg/L)
3
2.5
2
1.5
1
0.5
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021


Cd_T
Concentration (mg/L)
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

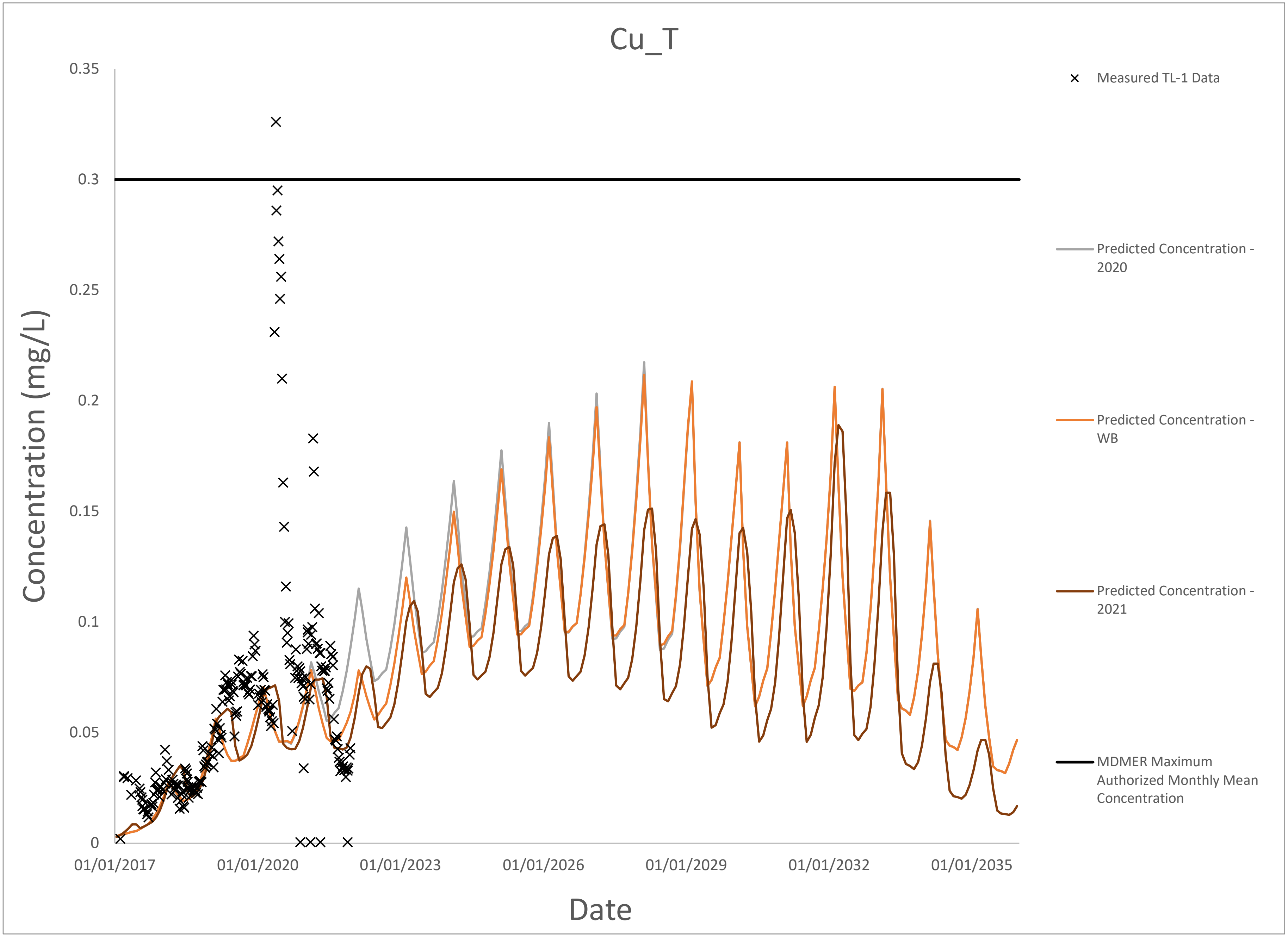

Ca_T
Concentration (mg/L)
600
500
400
300
200
100
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



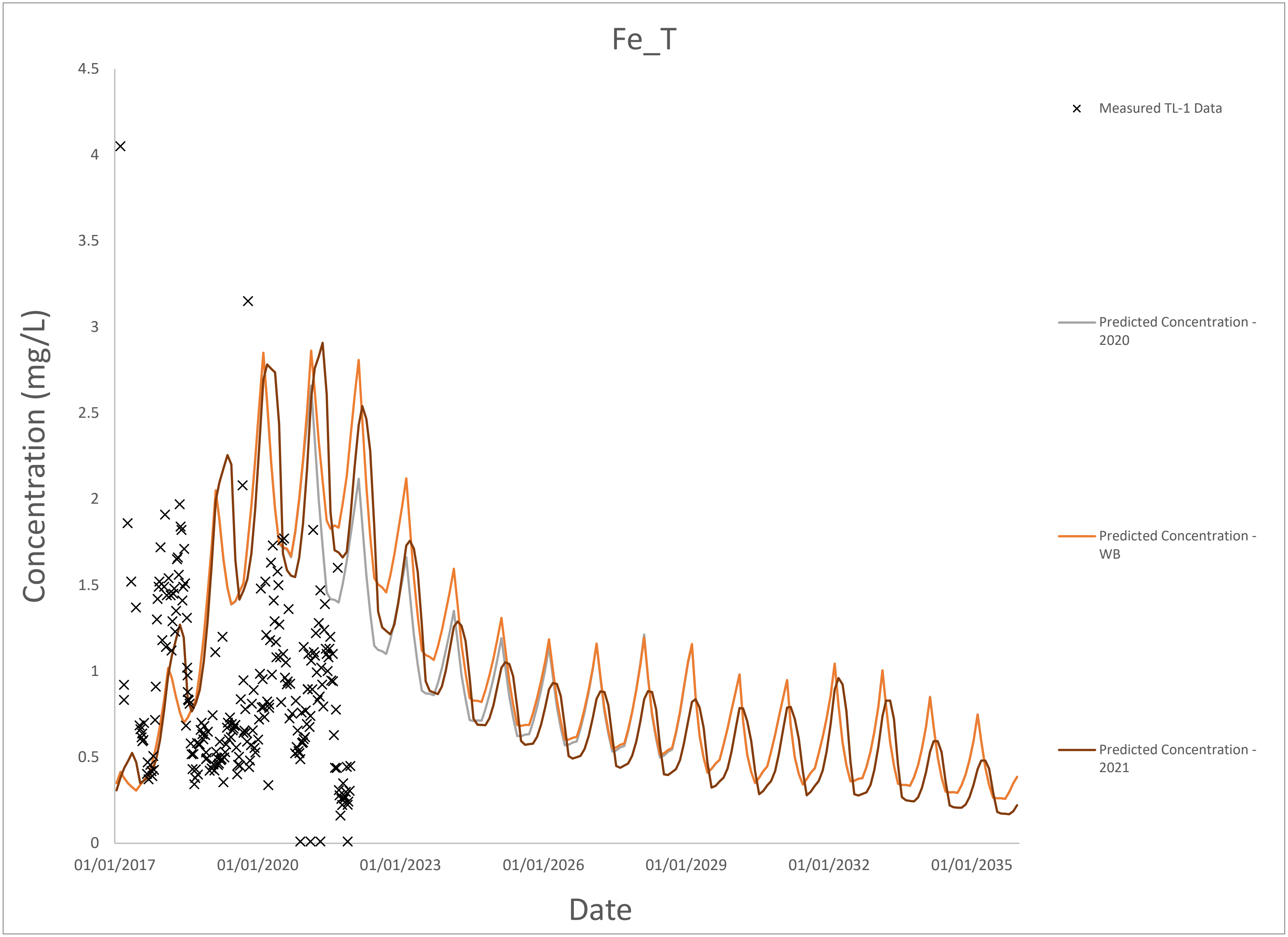
Cr_T
0.025
0.02
0.015
0.01
0.005
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



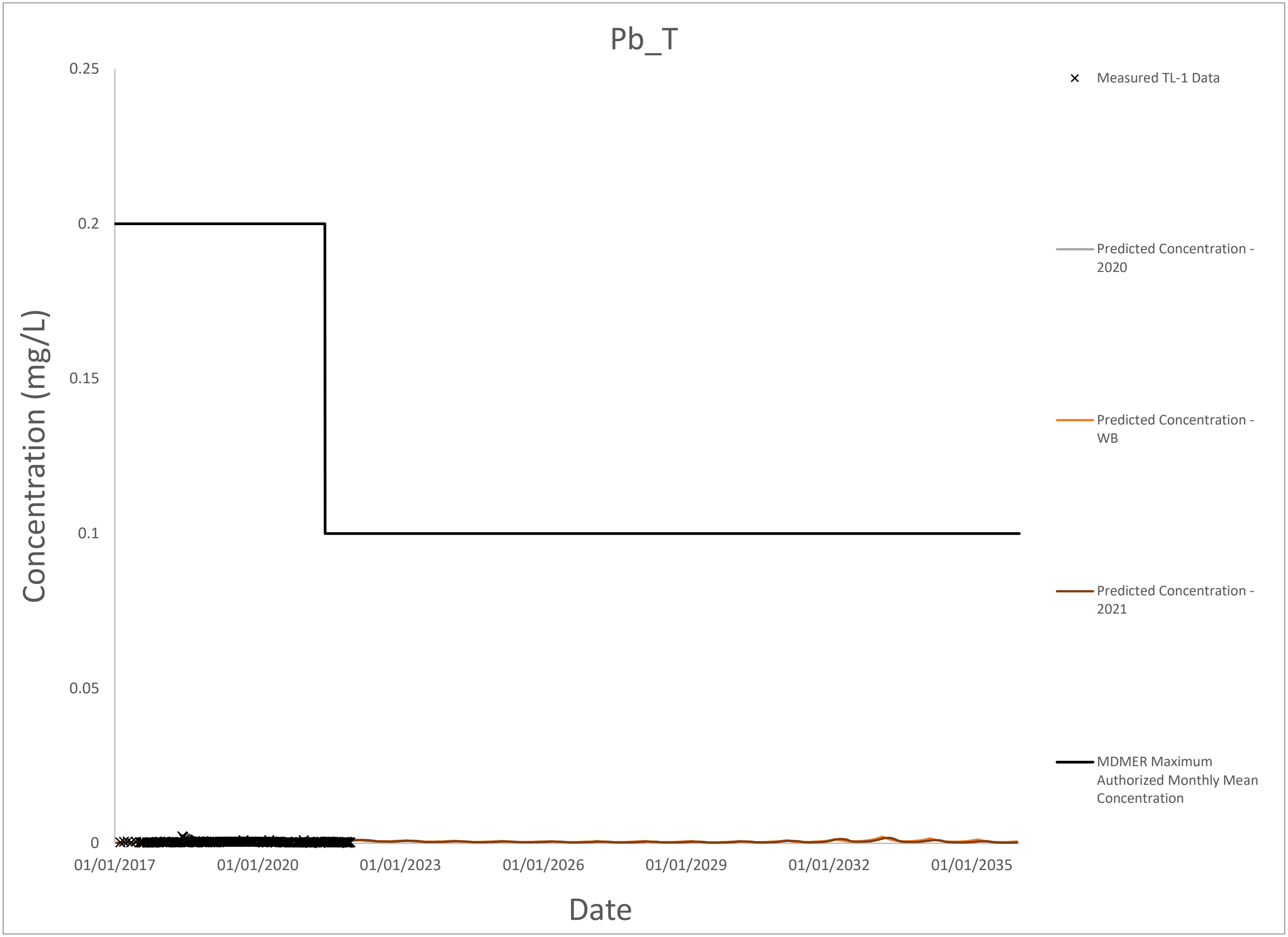
Co_T
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



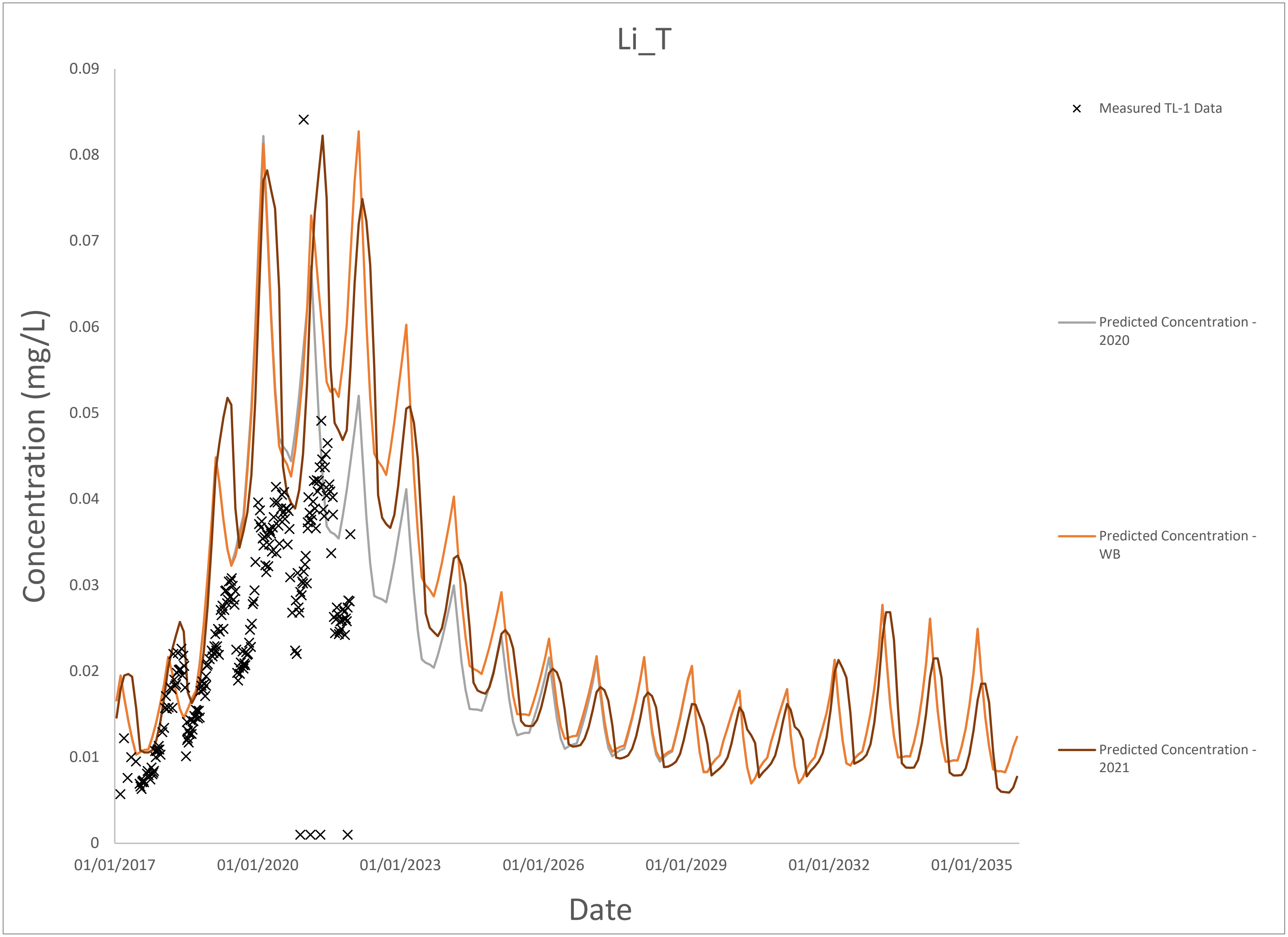
Cu_T
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021
MDMER Maximum Authorized Monthly Mean Concentration



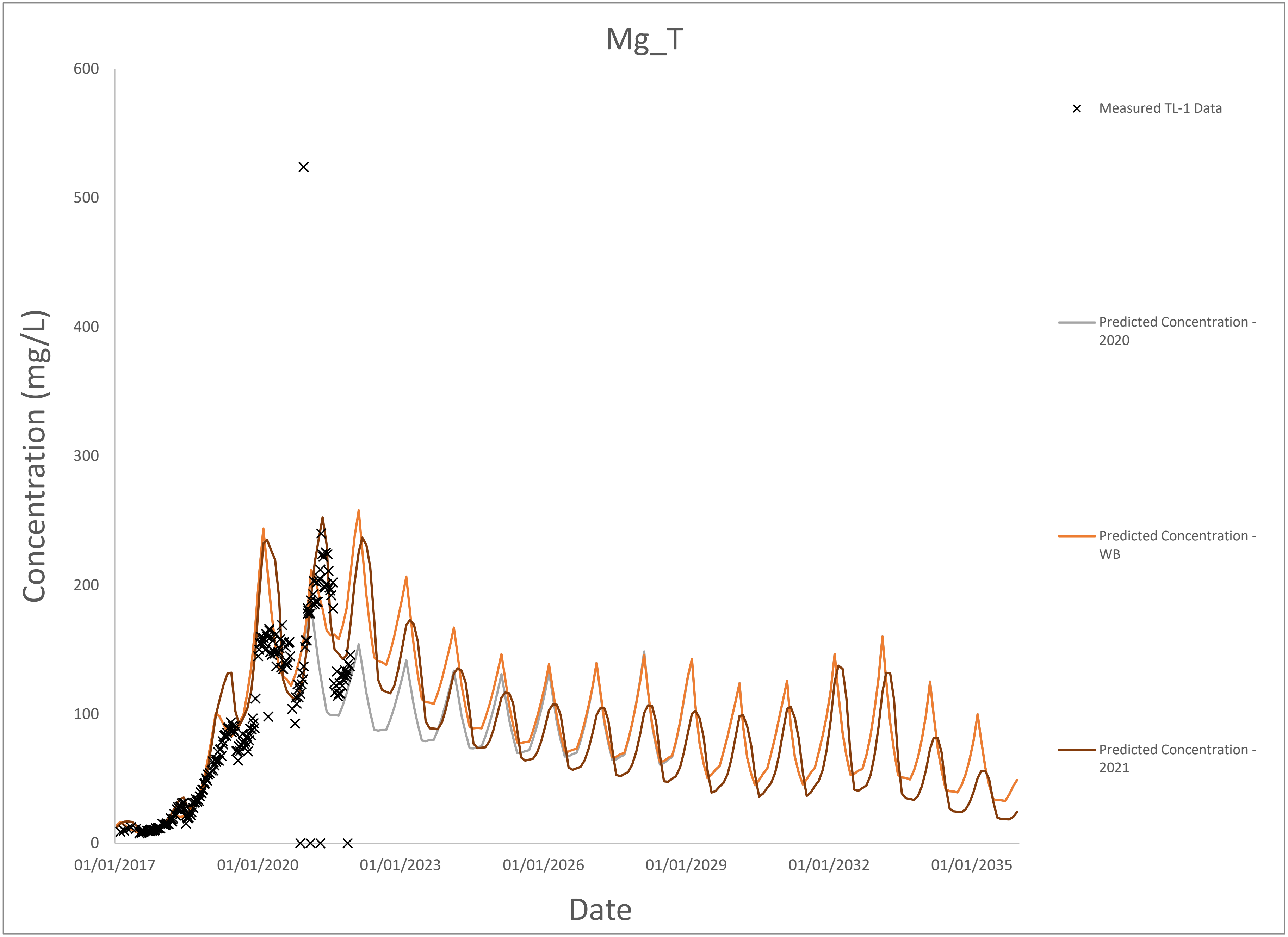
Fe_T
Concentration (mg/L)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



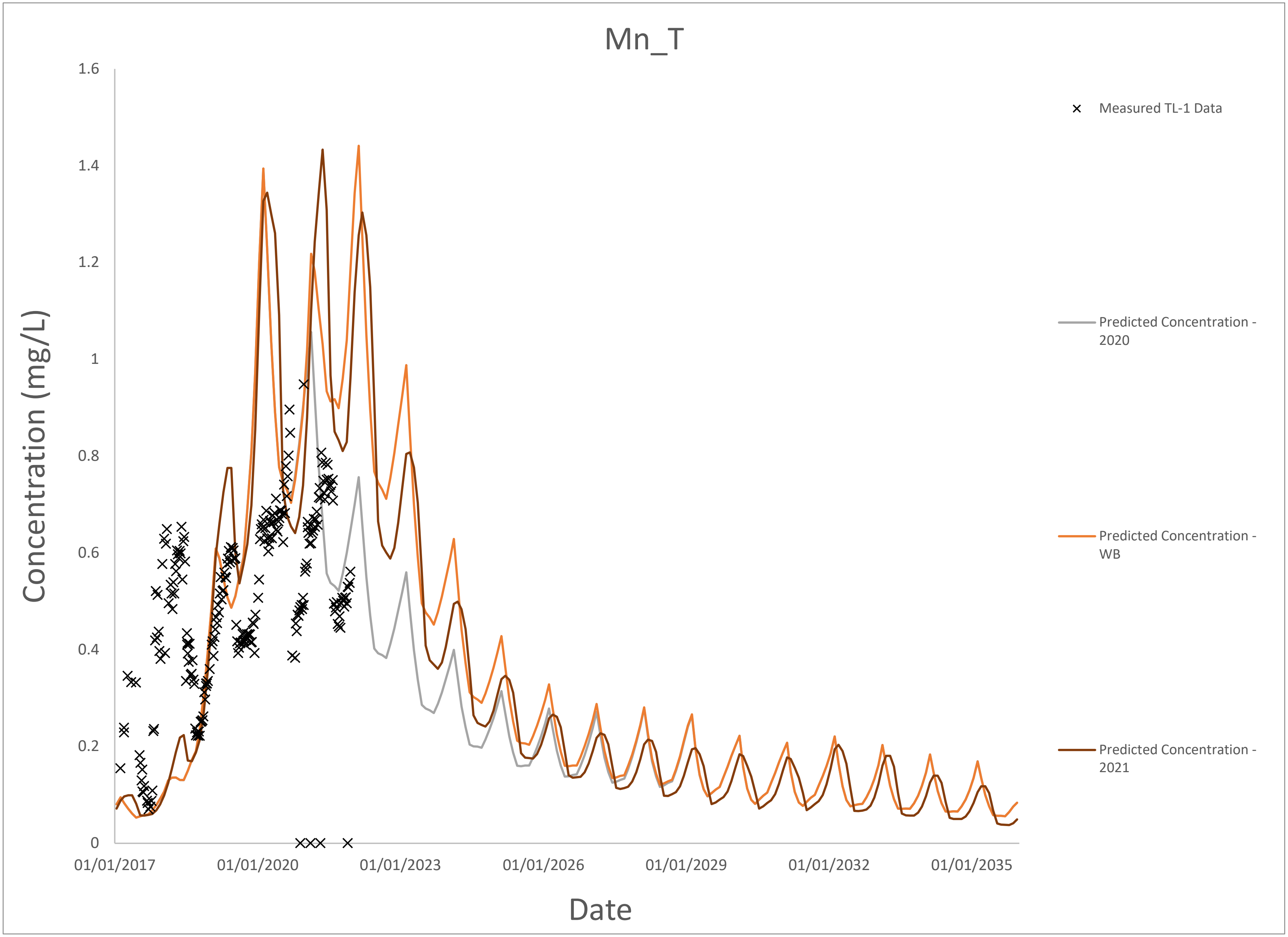
Pb_T
0.25
0.2
0.15
0.1
0.05
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021
MDMER Maximum Authorized Monthly Mean Concentration



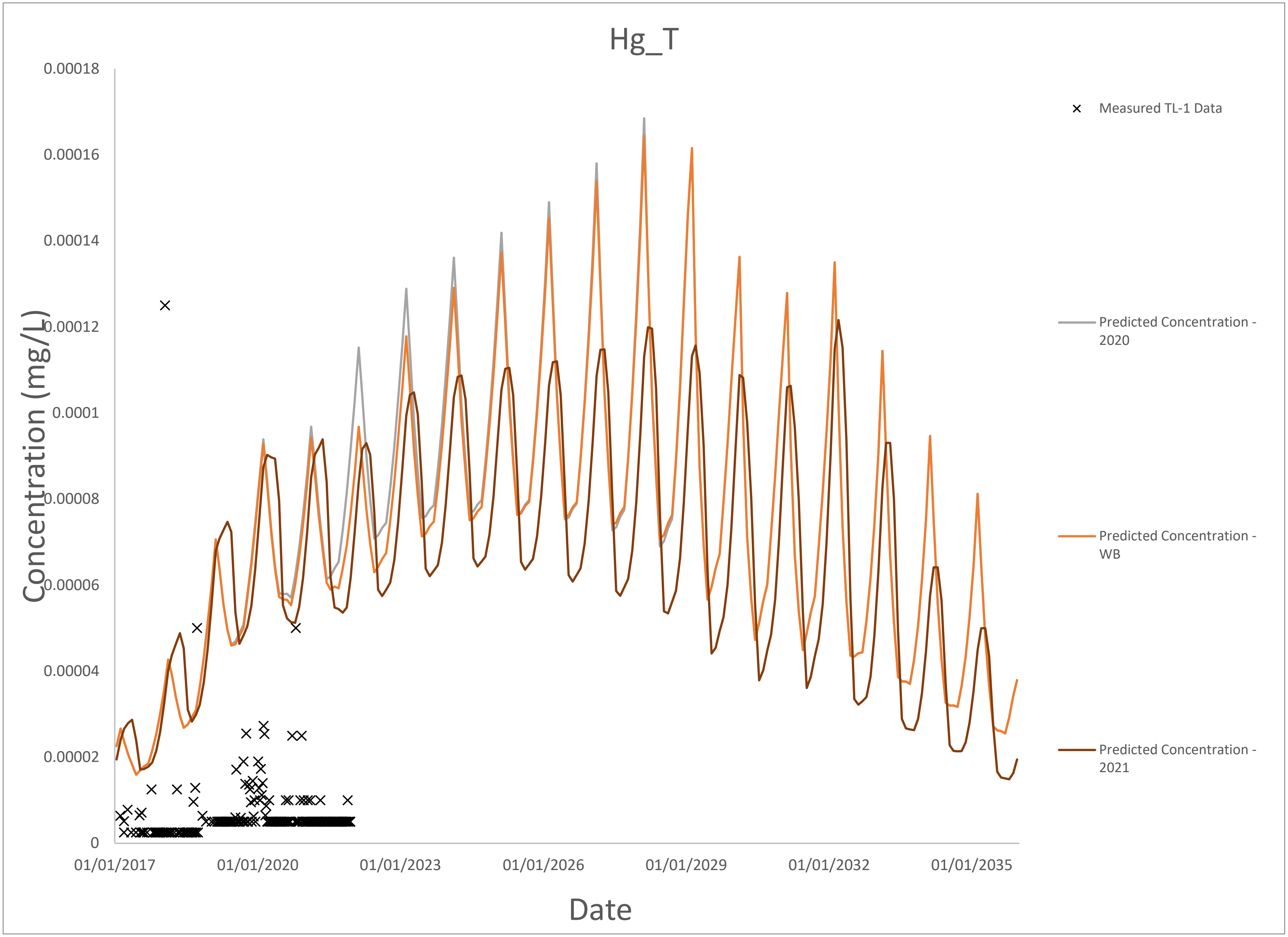
Li_T
Concentration (mg/L)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



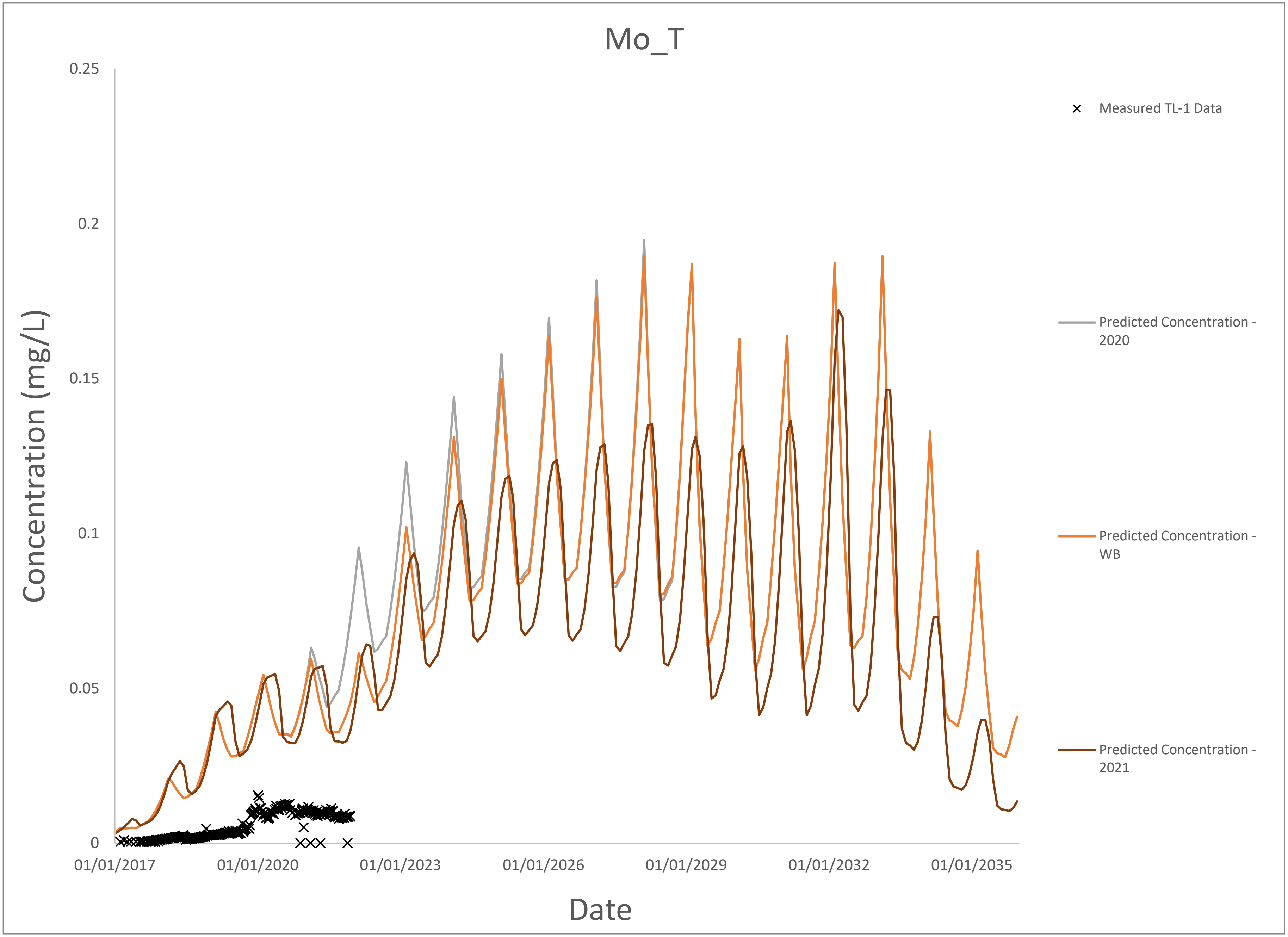
Mg_T
Concentration (mg/L)
600
500
400
300
200
100
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



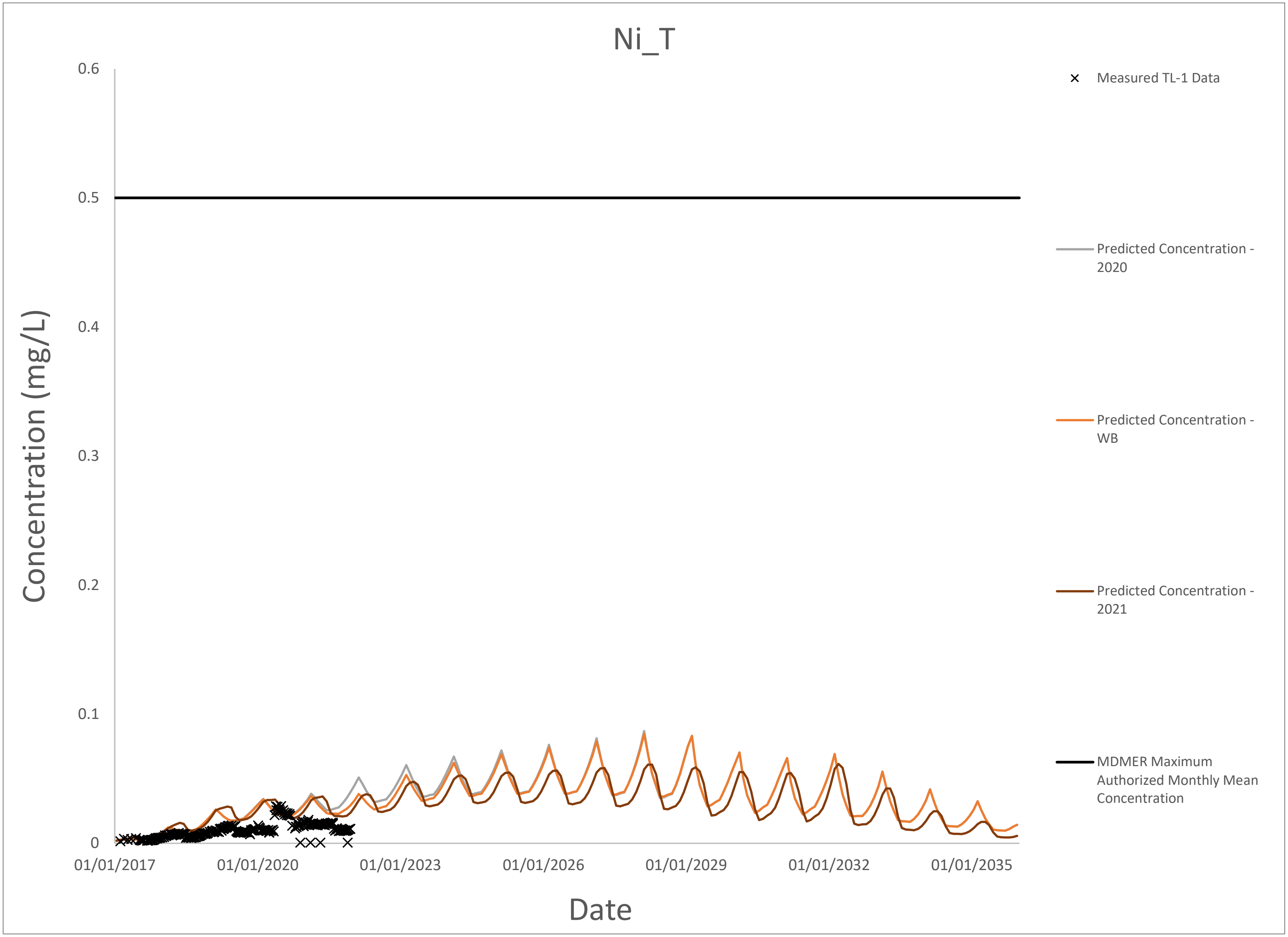
Mn_T
Concentration (mg/L)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

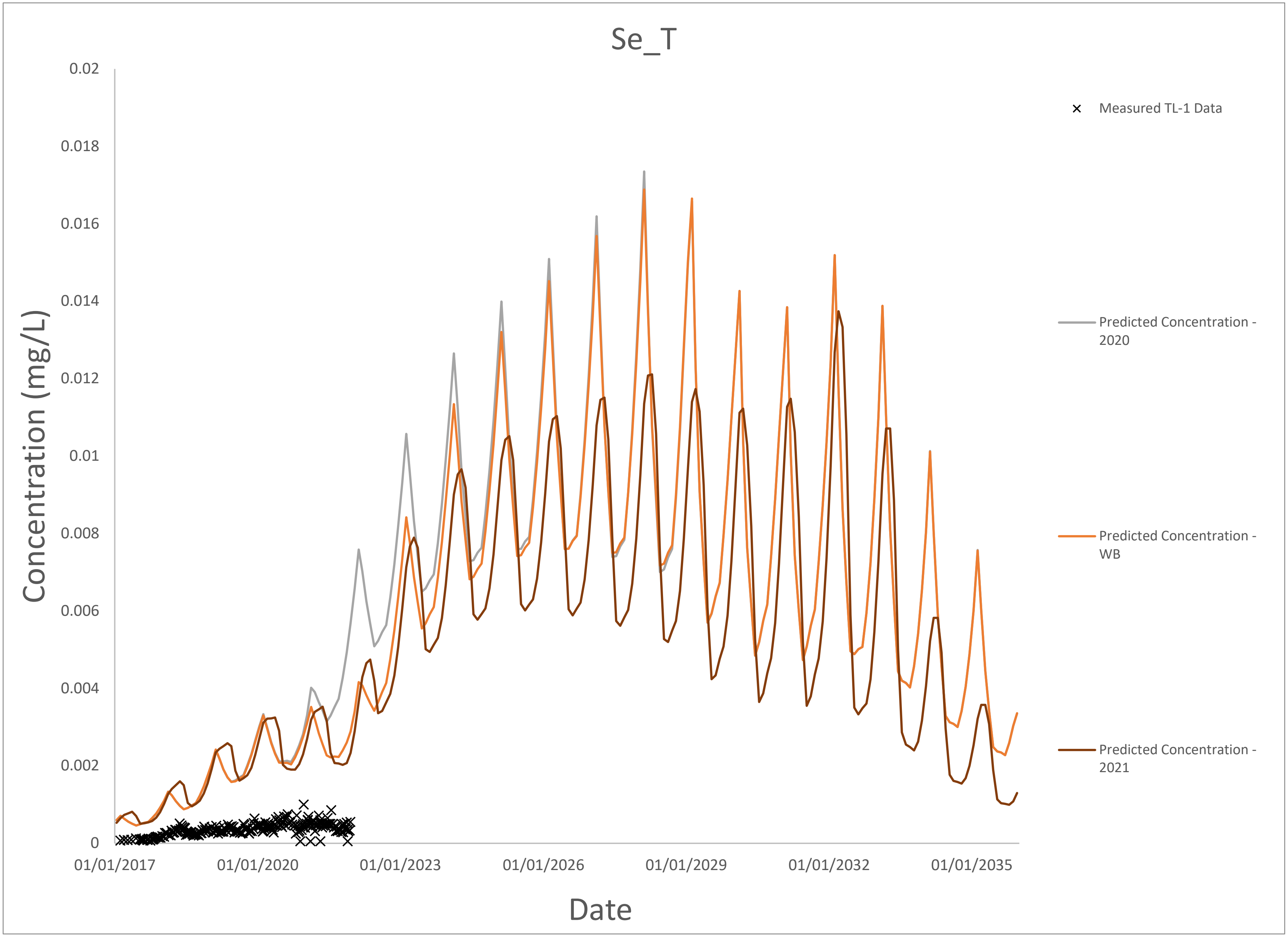


Hg_T
Concentration (mg/L)
0.00018
0.00016
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

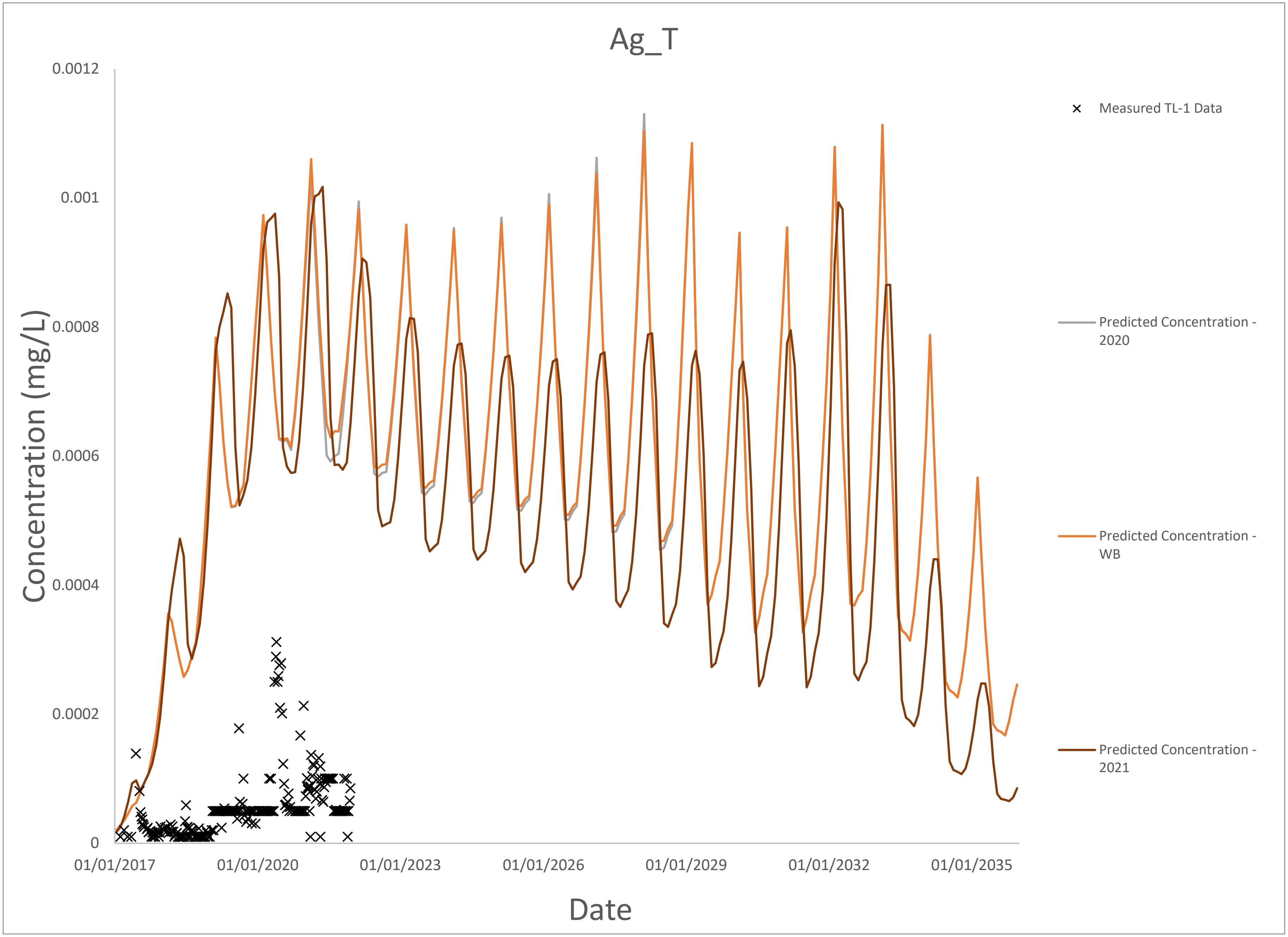


Mo_T
Concentration (mg/L)
0.25
0.2
0.15
0.1
0.05
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

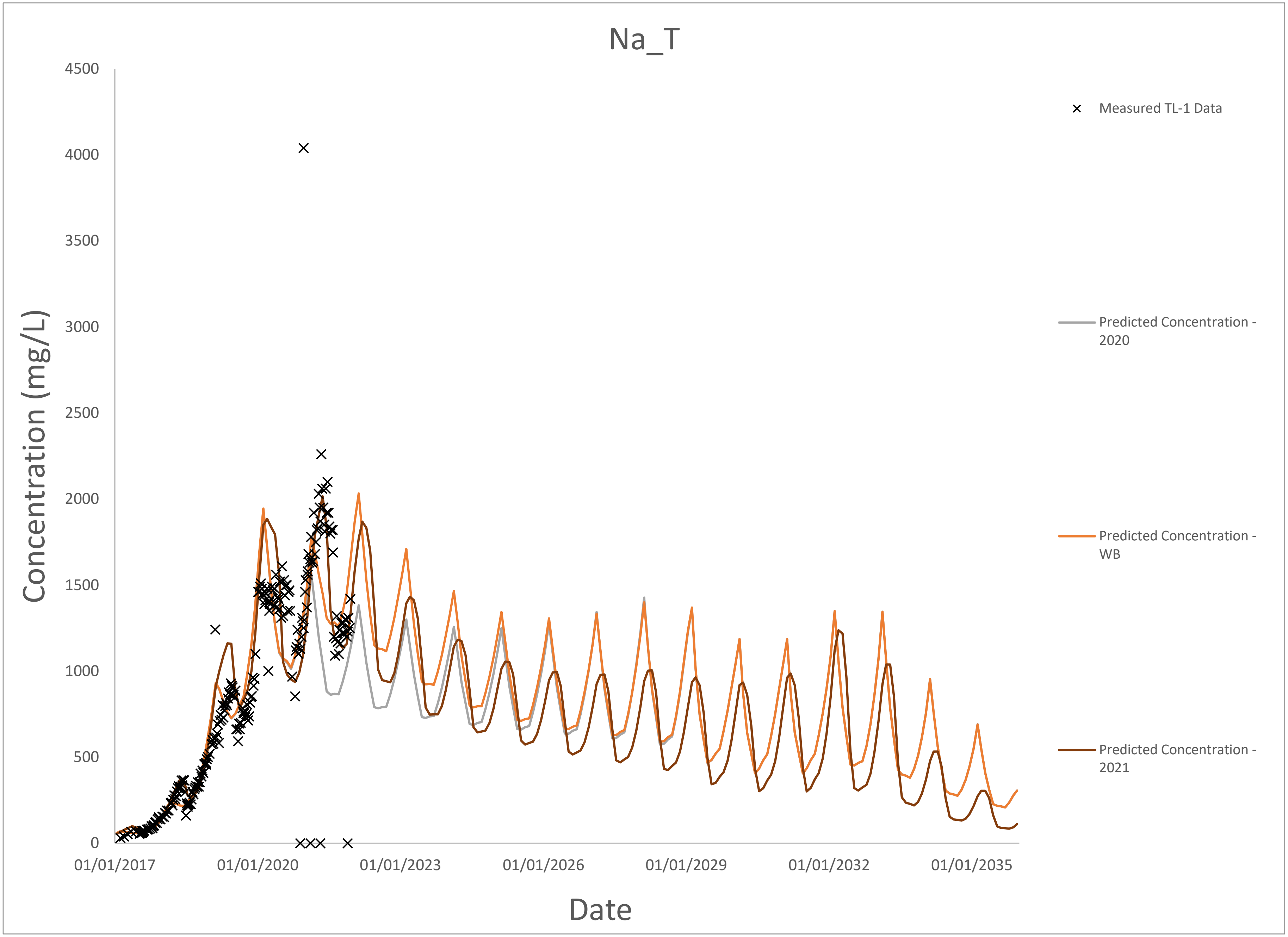

Ni_T
Concentration (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021
MDMER Maximum Authorized Monthly Mean Concentration

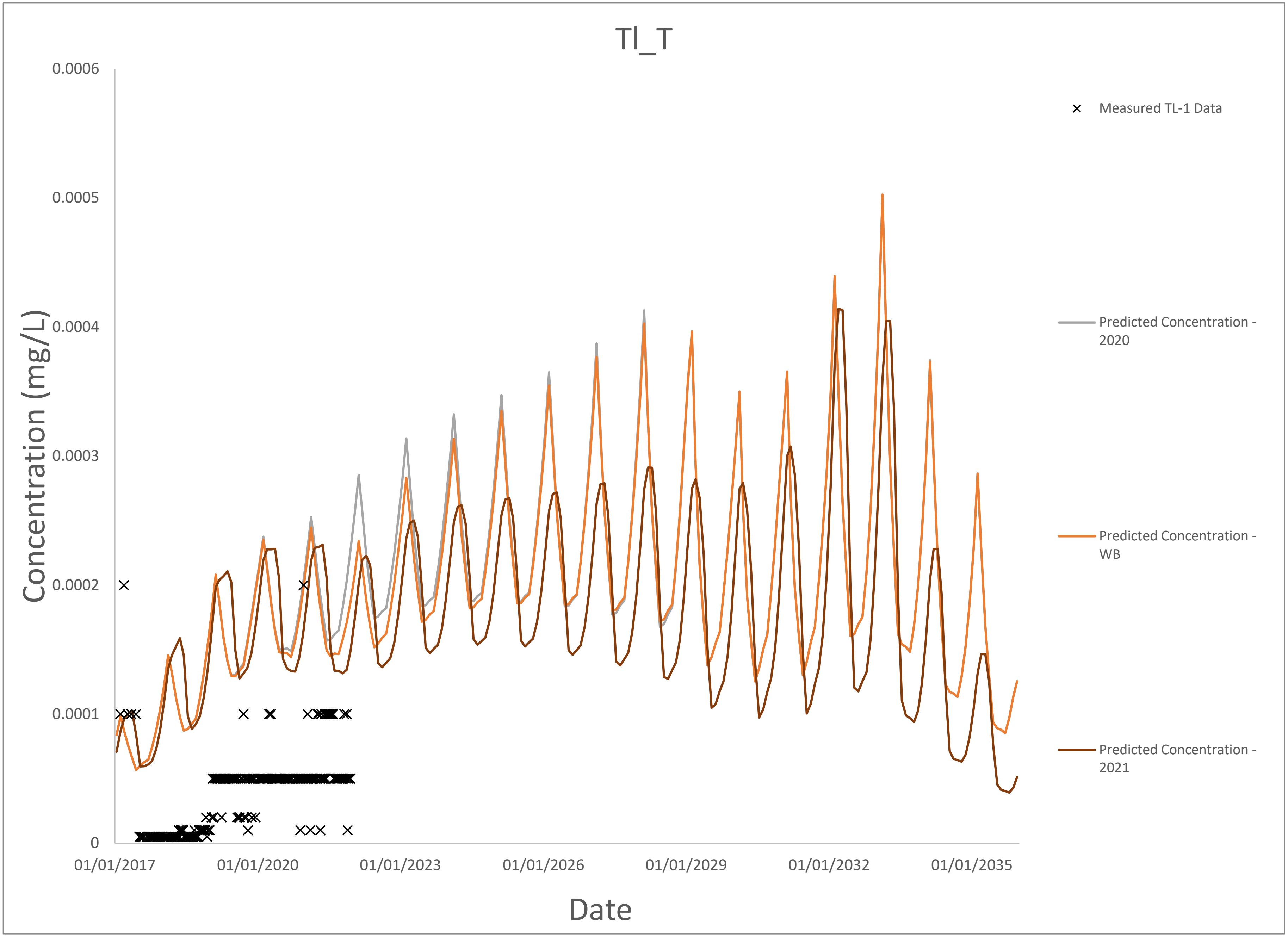


Se_T
Concentration (mg/L)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

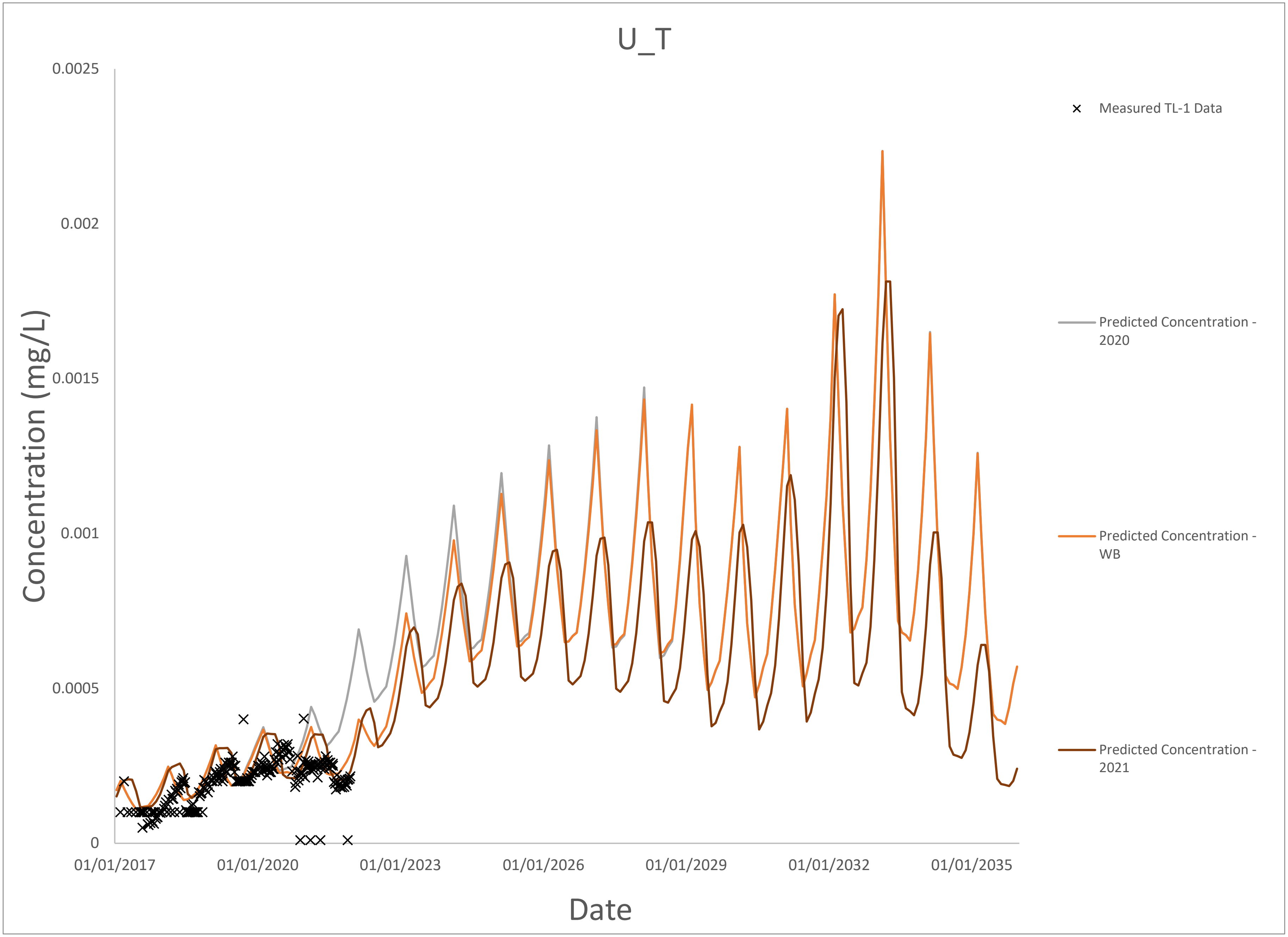


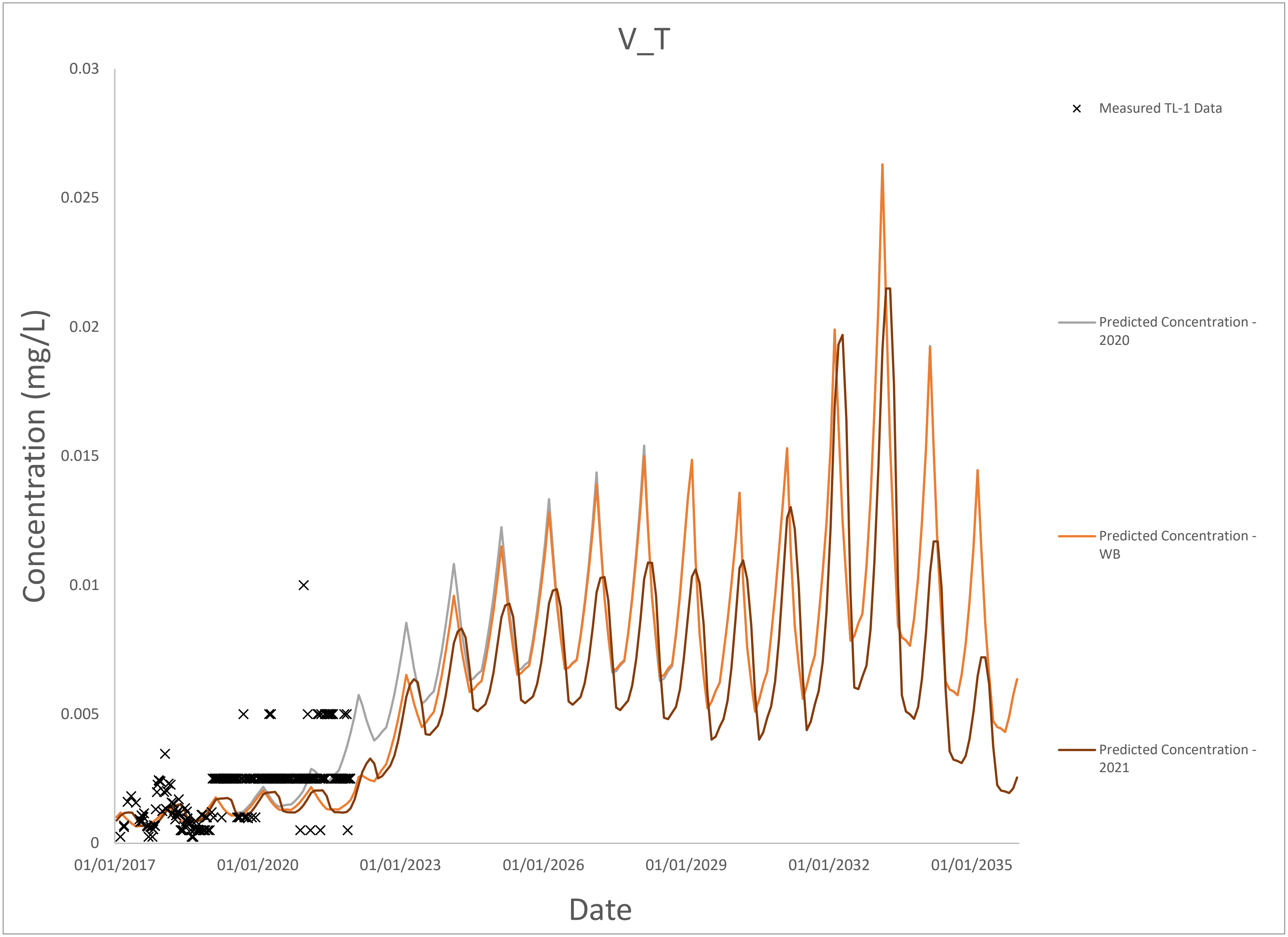
Ag_T
Concentration (mg/L)
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021


Na_T
Concentration (mg/L)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

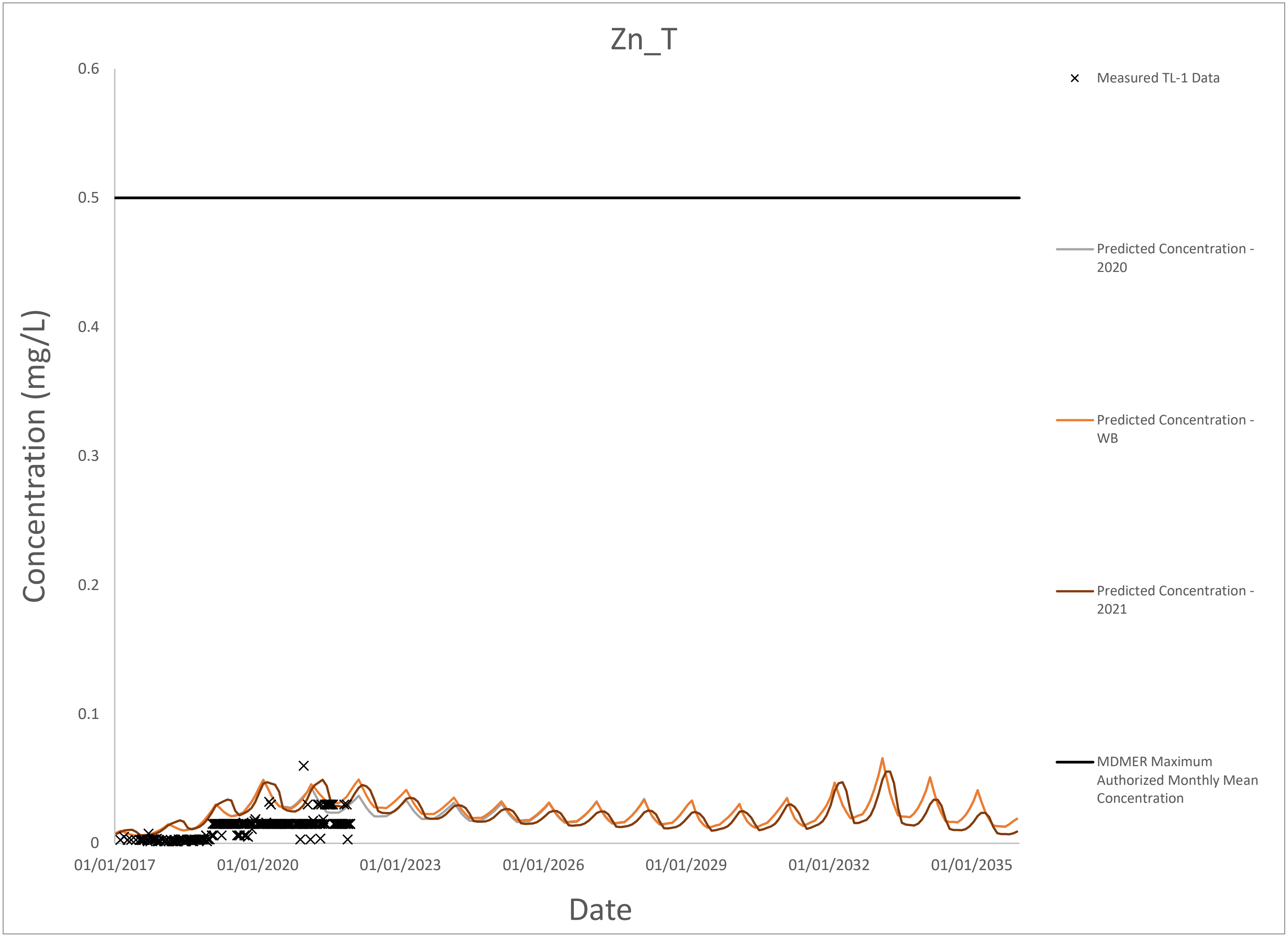


Tl_T
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

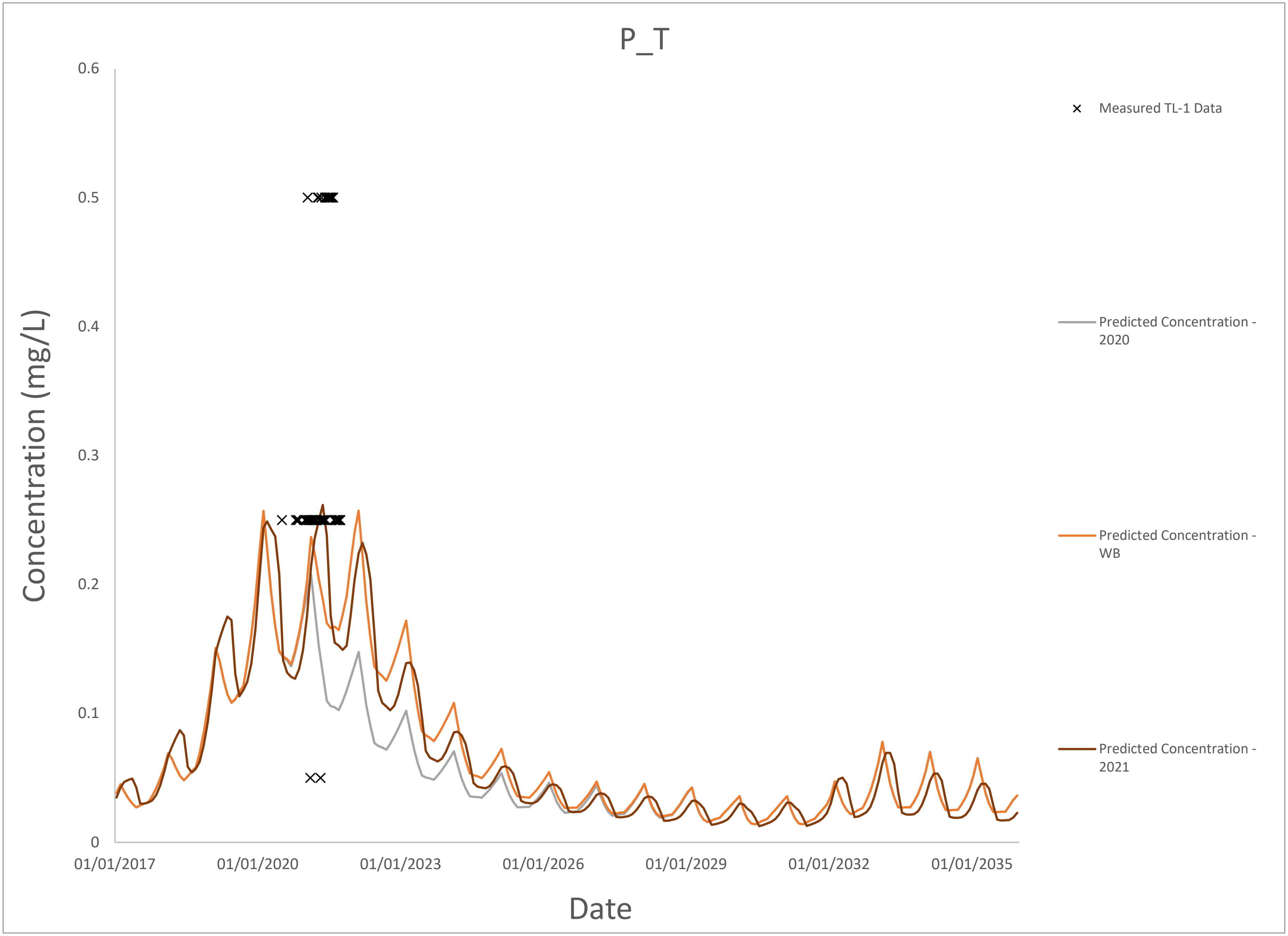

U_T
Concentration (mg/L)
0.0025
0.002
0.0015
0.001
0.0005
0
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



V_T
0.03
0.025
0.02
0.015
0.01
0.005
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021



Zn_T
0.6
0.5
0.4
0.3
0.2
0.1
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021
MDMER Maximum Authorized Monthly Mean Concentration



P_T
0.6
0.5
0.4
0.3
0.2
0.1
0
Concentration (mg/L)
01/01/2017
01/01/2020
01/01/2023
01/01/2026
01/01/2029
01/01/2032
01/01/2035
Date
Measured TL-1 Data
Predicted Concentration - 2020
Predicted Concentration - WB
Predicted Concentration - 2021

Appendix F

2021 Waste Rock, Quarry and Tailings Monitoring Report, Doris and Madrid Mines, Hope Bay Project

AGNICO EAGLE

FINAL

2021 Waste Rock, Quarry and Tailings Monitoring Report, Doris and Madrid North Mines

Hope Bay Project, Nunavut Canada

Agnico Eagle Mines Ltd.

SRK Consulting (Canada) Inc. ▪ 1CT022.073 ▪ March 2022

FINAL

2021 Waste Rock, Quarry and Tailings Monitoring Report, Doris and Madrid North Mines

Hope Bay Project, Nunavut Canada

Prepared for:
Agnico Eagle Mines Ltd.
145 King Street East, Suite 400
Toronto, ON, M5C 2Y7
Canada

+1 416 947 1212
www.agnicoeagle.com

Prepared by:
SRK Consulting (Canada) Inc.
2200–1066 West Hastings Street
Vancouver, BC V6E 3X2
Canada

+1 604 681 4196
www.srk.com

Lead Author: Amanda Schevers, GIT (BC) **Initials:** AJS
Reviewer: Lisa Barazzuol, PGeo (NT/NU) **Initials:** LNB

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Contents

Tables

Appendices

Useful Definitions

This list contains definitions of symbols, units, abbreviations, and terminology that may be unfamiliar to the reader.

ABA	Acid based accounting
ARD	Acid rock drainage
BV	Bureau Veritas Laboratories
CPR	Crown Pillar Recovery
CPRT	Crown Pillar Recovery Trench
CRM	Certified reference materials
EC	Electrical conductivity
HCT	Humidity cell test
LOD	Limit of detection
ML	Metal leaching
NP	Neutralization potential
ORP	Oxidation reduction potential
PCP	Pollution control pong
QA/QC	Quality assurance/quality control
SFE	Shake flask extraction
TDS	Total dissolved solids
TSS	Total suspended solids
WRP	Waste rock pile

1 Introduction

Development of the Doris and Madrid North mine has resulted in the development of quarries; use of quarry rock and waste rock for construction of roads, pads and other infrastructure; placement of waste rock in surface stockpiles at Doris and Madrid; processing of ore at Doris resulting in flotation tailings slurry and detoxified tailings; and placement of waste rock and detoxified tailings as backfill in the underground stopes of Doris Mine. Monitoring plans are in place to confirm metal leaching and acid rock drainage (ML/ARD) potential for quarry rock, waste rock and tailings (flotation and detoxified) are consistent with geochemical characterization studies conducted at the environmental assessment and/or water licence applications for Doris and Madrid, and to monitor the chemistry of seepage and runoff associated with these materials.

This report presents results from the 2021 waste rock, quarry, construction rock, and tailings geochemical monitoring programs for Doris and Madrid North. The report is organized as follows:

- Section 2: Summary of the monitoring requirements.
- Section 3: A summary of the geological inspections and monitoring of Doris underground waste rock.
- Section 4: A summary of the geological inspections and monitoring of Madrid North waste rock.
- Section 5: A summary of the geochemical inspections and monitoring of quarry and construction rock.
- Section 6: A summary of the seepage surveys around infrastructure areas and downgradient of the waste rock surface stockpiles.
- Section 7: A summary of geochemical monitoring of flotation tailings slurry and detoxified tailings solids.
- Appendix A to E: Detailed technical memorandum for each monitoring program. The quarry and construction rock memorandum will be available at a later date for reasons outlined in Section 5.

2 Monitoring Requirements and Conformity Assessment

2.1 Waste Rock

2.1.1 Doris Mine

Monitoring plans for Doris waste rock are provided in the "*Waste Rock, Ore and Mine Backfill Management Plan, Hope Bay Project, Nunavut [WROMP]*" (TMAC 2019), which is a part of Licence 2AM-DOH1335 Amendment No. 2 (NWB 2018). The program includes inspection and geochemical monitoring of the waste rock solids from the underground mine and Doris crown pillar recovery (CPR) and routine monitoring of the pollution control pond (PCP).

A summary of the requirements of TMAC (2019) is summarized in Table 2.1.

Table 2.1: Doris Waste Rock Monitoring Requirements and 2021 Monitoring Summary

Monitoring Reference	Monitoring Item	Report Section	2021 Monitoring Summary
TMAC (2019)	Conduct waste rock geological inspections: i) underground at the blast face by AEM qualified geologists, with internal record keeping and ii) surface waste rock stockpile (Pad T);	Section 3.1 - Mine Backfill Monitoring; Table 3-1 – Overview of Mine Backfill Monitoring Programs and Objectives for Doris, Madrid North, Madrid South and Boston	Completed. Refer to Section 3 and Appendix A.
TMAC (2019)	Geochemical sampling program for CPR waste rock to confirm that it is suitable for use as construction rock: sampling frequency of one sample for every 20,000 tonnes;	Section 3.2 - Use of Waste Rock for Construction	Not applicable. CPR reclaimed with placement backfill and cover.
TMAC (2019), NWB (2018)	Monitoring and recording the volumes of waste rock mined, waste rock management designations (mineralized and non-mineralized) and placement locations, including any waste rock that is approved and used for construction (pending confirmatory test work and approval from NWB); to be reported monthly;	Section 3.1 - Mine Backfill Monitoring; Table 3-1 – Overview of Mine Backfill Monitoring Programs and Objectives for Doris, Madrid North, Madrid South and Boston	Completed. Refer to Section 3 and Appendix A. All waste rock managed as mineralized.
NWB (2018)	Annual water quality monitoring will be carried out at a surveillance monitoring station ST-2 located in the pollution control pond; parameters include pH, TSS, total ammonia, nitrate, nitrite, total sulphate, total cyanide, total oil and grease, alkalinity, chloride, and total metals by ICP-MS;	Schedule I - Conditions Applying to General and Aquatic Effects Monitoring; Table 3 – Monitoring Program	Completed. Refer to Appendix D of the Hope Bay Project 2021 Nunavut Water Board Annual Report.

Monitoring Reference	Monitoring Item	Report Section	2021 Monitoring Summary
TMAC (2019)	Annual inspections by a qualified geochemist of the designated non-mineralized areas of the waste rock pile to confirm that there are no areas with elevated amounts of sulphide mineralization, and inspections of the designated mineralized areas of the pile to look for signs of weathering and oxidation of the sulphides; representative sample set of waste rock to be collected;	Section 3.1.3 - Annual Inspections and Geochemical Characterization of Waste Rock; Table 3-1 – Overview of Mine Backfill Monitoring Programs and Objectives for Doris, Madrid North, Madrid South and Boston	Completed. Five samples geochemically characterized from Pad T. Refer to Section 3 and Appendix A.
TMAC (2019)	Seep surveys along the down-gradient toe of the waste rock pile and below the pollution control ponds and access road throughout operations. The seep survey will be completed at the same time and will follow the same procedures as used for the seep survey around other infrastructure areas. However, given the increased importance of obtaining samples from this area, all distinct seeps in the immediate vicinity of the waste rock pile (i.e., any seeps spaced more than 50 metres apart) will be tested for a full suite of laboratory parameters; and	Section 3.1.4 - Seep Survey	Completed. Refer to Section 6 and Appendix D. Reference stations and select areas (Doris access road to vent raise) not included in 2021.
TMAC (2019), NWB (2018)	An annual waste rock monitoring report, including the results and an interpretation of the geochemical data and a summary of all mitigation activities undertaken as a result of monitoring will be prepared and submitted to the NWB by March 31 of the year following sample collection (i.e., within 6 months of collecting the final quarry samples).	TMAC (2019): Section 3.3 - Documentation and Reporting NWB (2018): Part F - Conditions Applying to Waste Deposit and Management	Completed. Refer to Section 3 and Appendix A.

2.1.2 Madrid North Mine

Waste rock monitoring at Madrid North is outlined in in *Waste Rock, Ore and Mine Backfill Management Plan* (TMAC 2019), which is a part of Licence 2AM-DOH1335 Amendment No. 2 (NWB 2018) except for waste rock from the Naartok East CPR. Geochemical monitoring of waste rock from NE CPR is documented in *Classification of Waste Rock in Support of Segregating Construction Rock from Naartok East Crown Pillar Recovery, Madrid North, Hope Bay* (SRK 2019). SRK (2019) includes a field geochemical classification method and associated criteria to identify waste rock that is non-PAG and with low potential for neutral pH arsenic leaching and recommendations for operational implementation of the field-based geochemical characterization program that identifies waste rock that is suitable for use as construction rock.

A summary of the requirements for Madrid North waste rock monitoring as outlined in SRK (2019) and TMAC (2019) is summarized in Table 2.2. Of note is that the program of geochemical sampling for Madrid North waste rock from the underground mine has been modified, with rationale outlined in Table 2.2.

Table 2.2: Madrid North Waste Rock Monitoring Requirements and 2021 Monitoring Summary

Monitoring Reference	Monitoring Item	Report Section	2021 Monitoring Summary
TMAC (2019)	Conduct waste rock geological inspection at underground blast face by TMAC geologists, with internal record keeping.	Section 3.1 - Mine Backfill Monitoring; Table 3-1 – Overview of Mine Backfill Monitoring Programs and Objectives for Doris, Madrid North, Madrid South and Boston	Completed. Refer to Section 4 and Appendix B.
SRK (2019)	Geological inspection and pXRF analysis of Naartok East Crown Pillar Recovery (NE CPR) drill cuttings for geochemical classification of waste rock to determine suitability of waste rock as construction rock.	Section 5 – Field Classification of Construction Rock	Not applicable.
TMAC program documented in SRK (2020)	Operational application of field based geochemical classification program of NE CPR waste rock (SRK 2019) to identify and segregate run-of-mine waste rock geochemically suitable as construction rock.	Section 3.1.1 – Field-Based Classification of Waste Rock as Construction Rock	Not applicable.
TMAC (2019), NWB (2018)	Monitoring and recording the volumes of waste rock mined and placement locations, including waste rock that is approved for use in construction (pending confirmatory test work and approval from NWB); to be reported monthly.	Section 3.1 - Mine Backfill Monitoring; Table 3-1 – Overview of Mine Backfill Monitoring Programs and Objectives for Doris, Madrid North, Madrid South and Boston	Completed. Refer to Section 4 and Appendix B.

Monitoring Reference	Monitoring Item	Report Section	2021 Monitoring Summary
TMAC (2019)	Annual inspections by a qualified geochemist of Madrid North WRSA to confirm that there are no areas with elevated amounts of sulphide mineralization, and inspections of the designated mineralized areas of the pile to look for signs of weathering and oxidation of the sulphides; representative sample set of waste rock to be collected.	Section 3.1.3 - Annual Inspections and Geochemical Characterization of Waste Rock; Table 3-1 – Overview of Mine Backfill Monitoring Programs and Objectives for Doris, Madrid North, Madrid South and Boston	Completed. Refer to Section 4 and Appendix B.
Refer to footnotes[1]	Geochemical verification sampling program of underground waste rock with samples collected from underground mine. Sample frequency of one sample for every 20,000 t as per underground sampling program for underground mines.	--	Sample not collected because 3,682 t of waste rock was mined. Refer to Section 4 and Appendix B.
TMAC (2019)	Seep surveys along the down-gradient toe of the Madrid North WRSA and below the CWP and access road throughout operations and for at least 2 years following mining and backfilling activities. The seep survey will be completed at the same time and will follow the same procedures as used for the seep survey around other infrastructure areas. However, given the increased importance of obtaining samples from this area, all distinct seeps in the immediate vicinity of the waste rock pile (i.e., any seeps spaced more than 50 meters apart) will be tested for a full suite of laboratory parameters.	Section 3.1.4 - Seep Survey	Completed. Refer to Section 6 and Appendix D. Reference stations and select areas (Madrid Shop Laydown) not included in 2021.
NWB (2018)	Routine water quality monitoring (sampled twice annually, weekly water levels) will be carried out at a surveillance monitoring station MMS-1, located at the Madrid North CWP.	Schedule I - Conditions Applying to General and Aquatic Effects Monitoring; Table 3 – Monitoring Program	Completed. Refer to Appendix D of the Hope Bay Project 2021 Nunavut Water Board Annual Report.
TMAC (2019), NWB (2018)	An annual waste rock monitoring report, including the results and an interpretation of the geochemical data will be prepared and submitted to the NWB by March 31 of the year following sample collection (i.e., within 6 months of collecting the final quarry samples).	TMAC (2019): Section 3.3 – Documentation and Reporting NWB (2018): Part F – Conditions Applying to Waste Deposit and Management	Completed. Refer to Section 4 and Appendix B.

Notes:

[1] Not in TMAC (2019). TMAC executed monitoring based on advice of SRK.

2.2 Quarry and Construction Rock

Details on the monitoring program for quarries and as-built construction rock for Doris and Madrid infrastructure are provided in "*Quarry Management and Monitoring Plan*" (TMAC 2017). A summary of the requirements is provided in Table 2.3.

Table 2.3: Quarry and Construction Rock Monitoring Requirements and 2021 Monitoring Summary

Monitoring Item[1]	Report Section	2021 Monitoring Summary
Visual inspections and sampling at the quarry face by site geologist or geochemist at least once per week when the quarries are in active use.	Section 3.1.1- Quarry Visual Inspection	Completed. Refer to Section 5 and Appendix C.
Collection and testing of two samples per year from each active quarry for total sulphur analysis, and, if the sulphur content exceeds 0.1%, the samples would be subjected to full ABA tests. A subset of samples will be subjected to shake flask extraction tests. The ABA tests would be done on the whole sample and on the -2mm size fraction to determine whether there is any concentration of sulphides in the fine component of the rock.	Section 3.1.3 – Quarry Rock Sampling	Completed. Data report pending. Refer to Section 5 and Appendix C.
Quarry sumps will be monitored as described under the routine site water quality monitoring program.	Section 3.1.4 – Quarry Sump Monitoring	Quarry sump monitoring was not required in 2021 because it was not necessary to discharge water from Quarry 2.
Visual inspection of each mined-out quarry will be completed at least once per year in order to ensure that the site remains safe, and no environmental or public health and safety concerns have developed. If potentially acid generating (PAG) waste rock has been placed in the quarries, the area will be inspected to ensure that the 2 m cover remains intact, and no seeps are evident.	Section 3.3.1	Completed. PAG rock has not been placed in the quarries.
After construction of roads and other infrastructure components that were constructed using the quarry or waste rock since the previous inspection will be inspected by a qualified geologist or geochemist to verify that the rock used in construction was suitable for that purpose. During the inspection, samples (<1" and -2 mm fractions, when available) will be collected for total sulphur analysis. If the sulphur content exceeds 0.1%, the samples will be subjected to full ABA tests. A subset of samples will be subjected to shake flask extraction tests.	Section 3.3.2	Not applicable in 2021.
A seep survey will be conducted around all infrastructure components that have been constructed or modified within the previous year. Field pH, electrical conductivity (EC), Eh, and temperature readings will be collected. A water sample will be collected from a minimum of 10% of the identified ephemeral seeps and will be submitted for laboratory analyses, as detailed in Quarry Management and Monitoring Plan (TMAC 2017). Established reference stations will also be	Section 3.3.2	Completed. Refer to Section 6 and Appendix D.

Monitoring Item[1]	Report Section	2021 Monitoring Summary
monitored to provide basis for comparing this to waters that are not influenced by the development activities.		
An annual quarry monitoring report, including the results and an interpretation of the geochemical data will be prepared and submitted to the NWB by March 31 of the year following sample collection (i.e. within 6 months of collecting the final quarry samples).	Section 4 – Documentation and Reporting	Completed. Quarry data wil be provided as an addendum. Refer to Section 5 and Appendix C. Section 7 and Appendix E.

Notes:

[1] Monitoring program outlined in TMAC (2017).

2.3 Tailings

The geochemical monitoring program for flotation tailings slurry and detoxified tailings are specified in Schedule I, Tables 1 to 3 of NWB Type A Water Licence 2AM-DOH1335 Amendment No. 2 (the "Water Licence", Nunavut Water Board 2018) and includes the following monitoring stations: process plant tailings water discharge (TL-5), flotation tailings solids (TL-6), detoxified tailings solids[1] (TL-7A), detoxified tailings supernatant (TL-7B) and seepage from underground backfilled stopes (TL-11). Station TL-7B was added to the Water Licence (NWB 2018) and monitoring commenced in 2019. A summary of the monitoring requirements is summarized in Table 2.4.

Table 2.4: Tailings Monitoring Requirements and 2021 Monitoring Summary

Monitoring Item	Report Section	2021 Monitoring Summary
Sampling of the supernatant from flotation tailings slurry discharge (TL-5) once per month for the analysis of pH, TSS, ammonia, nitrate, nitrite, sulphate, cyanide (WAD, free and total), and total metals by ICP-MS. Cyanate and thiocyanate should be analyzed quarterly.	Schedule I – Conditions Applying to General and Aquatic Effects Monitoring; Table 3 – Monitoring Program	Completed. Refer to Section 7 and Appendix E.
Maintain monthly records of tonnages and locations of disposal for flotation tailings (TL-6) discharged into the TIA and detoxified tailings (TL-7A) placed in the underground mine in stopes as backfill.	Schedule I – Conditions Applying to General and Aquatic Effects Monitoring; Table 3 – Monitoring Program	Completed. Refer to Section 7 and Appendix E.
Analysis of a homogenized monthly composite sample of flotation tailings solids (TL-6), from equal amounts of weekly samples, for total sulphur, sulphate sulphur, TIC, and trace element content.	Schedule I – Conditions Applying to General and Aquatic Effects Monitoring; Table 3 – Monitoring Program	Completed. Refer to Section 7 and Appendix E.
Monthly sampling and analysis of detoxified tailings solids (TL-7A) for moisture content[1].	Schedule I – Conditions Applying to General and Aquatic Effects	Completed[1]. Refer to Section 7 and Appendix E.

[1] Detoxified tailings are referred to as cyanide leach residue in the Water Licence and prior to 2019 was monitored as station TL-7.

Monitoring Item	Report Section	2021 Monitoring Summary
	Monitoring; Table 3 – Monitoring Program	
Monthly sampling and analysis of detoxified tailings filtrate (TL-7B) for total metals by ICP-MS (including sulphur), TIC[2], WAD cyanide, cyanate and thiocyanate.	Schedule I – Conditions Applying to General and Aquatic Effects Monitoring; Table 3 – Monitoring Program	Completed. Refer to Section 7 and Appendix E.
Bi-annual seepage surveys of underground backfilled stopes with opportunistic sampling of seepage (TL-11) for the analysis of pH, electrical conductivity (EC), trace metals by ICP-MS, alkalinity, acidity, sulphate, cyanide (WAD, free, and total), total ammonia, nitrate and nitrite.	Schedule I – Conditions Applying to General and Aquatic Effects Monitoring; Table 3 – Monitoring Program	Completed. Refer to Section 7 and Appendix E.
Preparation of an annual tailings monitoring report to be submitted to the NWB by March 31 of the year following sample collection and including the results and interpretation of the geochemical data for tailings solids (TL-6, TL-7A, TL-7B), and results and interpretation of seepage data from the bi-annual underground seepage survey of backfilled stopes (TL-11).	Schedule B – General Conditions	Completed. Refer to Section 7 and Appendix E.

Notes:

[1] A full geochemical characterization of TL-7A is required to validate geochemical characterization of tailings and the project closure planning, therefore, TMAC conducts monthly sampling and full analysis of the detoxified tailings solids (TL 7A) including moisture content, total sulphur, sulphate sulphur, TIC, and trace element content.

[2] Total Inorganic Carbon (TIC) is specified as a requirement for the filtrate analysis of TL-7B in the Water Licence however this is not an analytical parameter for aqueous samples but is analyzed for detoxified tailings solids (TL-7A).

3 Monitoring of Doris Waste Rock Geochemistry

Full details of the 2021 Doris waste rock monitoring program are presented in Appendix A. Data are presented in Tables 3-1 to 3-4 of Appendix A.

3.1 Overview of Waste Rock Production and Placement

In April 2015, underground mining was re-initiated at Doris, with placement of waste rock on surface commencing in October 2015. In 2021 a total of 227,926 t of waste rock was produced from mining activities in the Doris mine, of which 133,542 t remained underground and used as backfill and 80,384 t was placed in the surface waste rock stockpile on Pad T. In addition, approximately 14,000 t of waste rock was removed from the surface waste rock stockpile on Pad T and placed as backfill in stopes of the Doris mine (Table 3-1).

Table 3-1: Summary of 2021 Waste Rock Placement Locations and Volume, Doris Mine

<table>
<tr><th>Doris Mine</th><th>Source Location</th><th>Placement Location</th><th>Volume (t)</th><th>Total (t)</th></tr>
<tr><td rowspan="3">Underground</td><td rowspan="2">Underground</td><td>Backfill in Stopes</td><td>133,542</td><td rowspan="3">227,926</td></tr>
<tr><td>Pad T</td><td>80,384</td></tr>
<tr><td>Pad T</td><td>Backfill in Stopes</td><td>14,000</td></tr>
</table>

3.2 Doris Underground Mine

3.2.1 Geological Inspections

Waste Rock, Ore and Mine Backfill Management Plan (TMAC 2019) outlines two types of waste rock inspections: routine underground geological inspections at the blast face by site geologists and annual inspection of the surface waste rock stockpile on Pad T.

Underground Mine

Underground geological inspections were conducted by at the working face by AEM qualified geologists. The data were recorded in geological inspection logs and maps. Waste rock intersected by the Doris underground workings in 2021 was geologically described as 95% mafic volcanics with trace sulphide and 1 to 2% quartz-carbonate veining; 4% sericite altered mafic volcanics with up to 1% sulphide and 2 to 5% quartz-carbonate veining; and 1% diabase dyke with trace to 1% sulphide and trace quartz-carbonate veining.

Waste Rock Stockpile (Pad T)

In August 2021, Amanda Schevers, GIT (BC) a qualified geochemist from SRK, completed a geological inspection of waste rock placed on Pad T. SRK inspected accessible waste rock areas indicated by AEM to contain waste rock placed since August 2020, examining rock types and the presence of sulphide and carbonate content.

The waste rock observed on Pad T was a mixture of approximately 90% chloritic green mafic metavolcanics (1a), 8% light tan colored sericite altered mafic metavolcanics (1as), <1% white quartz veins (12q), <1% dark gray diabase (11c), and <0.5% light brown felsic dyke (rock code undefined).

3.2.2 Sampling and Testing Programs

Waste Rock Stockpile (Pad T)

SRK collected five samples with sample distribution according to the rock types visually identified by SRK during the stockpile inspection, the proportion of rock types that were intersected by mining, as provided by AEM qualified geologists, and spatial distribution of the inspected areas.

Each sample consisted of a sieved coarse fraction (screened to -1 cm) and a finer fraction (screened to -2 mm) for rinse tests. SRK visually described the samples for rock type, sulphide content (quantity, type, and occurrence) and carbonates (fizz test with 10% HCl, type, and occurrence). SRK shipped samples to Bureau Veritas (BV) in Burnaby, BC for analysis of acid base accounting and elemental analysis on the coarse fraction. Three samples were selected by SRK for shake flask extraction (SFE) testing based upon the range of rinse EC values.

3.2.3 Results

Waste Rock Stockpile (Pad T)

As part of the TMAC (2019) waste rock monitoring program, SRK collected five samples (three of mafic metavolcanics (1a), one of altered mafic metavolcanics (1as), and one diabase (11c)) from the surface waste rock stockpile on Pad T. The results are summarized as follows:

- For mafic metavolcanics samples (1a), total sulphur ranged from 0.20 to 1.4% and median levels of 0.27%. The sample with 1.4% total sulphur contained 1% to 2% visible sulphides and was selected to characterize a high sulphur sample. TIC and Modified NP content was high ranging from 203 to 321 kg $CaCO_3$/t and 154 to 186 kg $CaCO_3$/t, respectively. All samples were classified as non-PAG based on TIC/AP and NP/AP.
- The one sample of altered mafic metavolcanics (1as) had a total sulphur content of 0.21%. TIC and Modified NP content was 319 and 159 kg $CaCO_3$/t, respectively. The sample was classified as non-PAG based on TIC/AP and NP/AP.

- The one sample of diabase (11c) had a total sulphur content of 0.33%. TIC and Modified NP content was 168 and 161 kg $CaCO_3$/t, respectively. The sample was classified as non-PAG based on TIC/AP and NP/AP.
- Trace element content was below the screening criteria for all samples except for arsenic, sulphur, and tungsten in the mafic metavolcanics (1a) sample containing 1.4% sulphur. Total metal concentrations for all other samples were less than ten times the average crustal abundance for basalt indicating no appreciable enrichment.
- SFE tests on a sample each of mafic metavolcanics (1a), altered mafic metavolcanics (1as), and diabase (11c) had alkaline pH (7.8 to 8.9). Nitrate concentrations and chloride values ranged from 7.3 to 43 mg/L and 79 to 394 mg/L, respectively and are indicative of blasting and drilling brine residuals present on waste rock surfaces, and possibly also naturally saline groundwater that is present in areas of the mine.

Two mafic volcanic (1a) waste rock samples collected from Pad T in 2021 had similar sulphur content compared to the Type A, UG monitoring and CPR sample sets; one mafic volcanic sample was sampled as an end-member and biased high in sulphur. The sample of altered mafic metavolcanic (1as) collected in 2021 had similar sulphur, TIC, and NP content compared to the previous UG monitoring and CPR sample sets[2]. The diabase (11c) sample collected from Pad T in 2021 was on the upper end of the range of geochemical characteristics (sulphur, arsenic) seen in the Type A and UG waste rock sample sets.

The geochemical behaviour of the waste rock is monitored through the annual seep survey along the downgradient toe of the waste rock and ore stockpile area and routine monitoring of the Pollution Control Pond (PCP). The results of the seepage survey are reported in Section 6 and Appendix D, while results of the routine monitoring program are included in monthly water quality reports prepared by AEM and submitted to the Nunavut Water Board.

[2] The mafic metavolcanic waste rock samples that were geochemically characterized as part of the Type A Doris water licence amendment application (SRK 2015a) were geologically logged as part of the exploration drilling program, at which time the lithology code 1as (altered mafic metavolcanics) was not used. Based on the geochemistry and spatial coverage of the ABA sample set, SRK assumes that altered mafic metavolcanics (1as) is represented in SRK (2015a).

4 Monitoring of Madrid North Waste Rock Geochemistry

Details of the 2021 geochemical monitoring program for Madrid North waste rock are presented in Appendix B as an addendum to this report. Sample locations are presented in Figure 4-1 of Appendix B and data is presented in Table 3-1 to 3-3 of Appendix B.

4.1 Overview of Waste Rock Production and Placement

In 2019, mining was initiated at Madrid North with the development of the Naartok East Crown Pillar Recovery (NE CPR) in July and then the decline for the underground mine in December. Mining at Madrid North was halted at the end of March 2020 due to the Covid-19 global pandemic. In 2021, mining included development of the underground decline in January and February. During this period 3,682 t of underground waste rock was produced and placed as backfill in the NE CPR.

4.2 Methods

4.2.1 Geological Inspections

Underground

AEM site geologists inspect and document the fronts and back of the blast face and maintain internal records of these inspections. Protocols for geological inspections are documented in TMAC (2019).

Waste Rock as Backfill

In August 2021, Amanda Schevers, GIT (BC) a qualified geochemist from SRK, completed a surface geological inspection of a stockpile of waste rock placed as backfill along the western edge of the NE CPR. SRK inspected approximately 90% of the stockpile surface and did not inspect the area adjacent to the pit that was unsafe to access.

AEM indicated that the stockpile contained waste rock placed in 2021 from the Madrid North underground mine and construction rock excavated as part of the reclamation of the Madrid North Portal Pad. Construction rock excavated from the Madrid North Portal Pad was within the flow path of hypersaline seepage and was waste rock sourced from the NE CPR that was geologically logged at the Portal Pad as mafic metavolcanics with sediments (1aj/1oj) and sedimentary units (5, SRK 2021b).

4.2.2 Sample Collection and Geochemical Test Work Program

Underground

The geochemical sampling and testing frequency of the underground waste rock is a minimum of one sample per 20,000 tonnes of rock. AEM did not collect a sample during development of the underground because 3,682 t of waste rock was produced.

Waste Rock as Backfill

As per the Waste Rock, Ore and Mine Backfill Management Plan (TMAC 2019), SRK collected one sample of waste rock from the surface stockpile of waste rock placed in the NE CPR based on the range of rock types identified during the geological inspection. SRK collected one sample that included the sieved coarse fraction (screened to -1 cm) and a finer fraction (screened to -2 mm) for rinse tests. SRK visually described the samples for rock type, sulphide content (quantity, type, and occurrence), and carbonates (fizz test with 10% HCl, type, and occurrence). Rinse tests involved mixing a one-to-one ratio of distilled water and solids and measuring the resulting pH and electrical conductivity (EC).

4.3 Results

4.3.1 Underground

Based on geological inspections of the decline by AEM, waste rock was logged as 99% mafic metavolcanics (1) with the balance (1%) logged as quartz-carbonate veining.

4.3.2 Waste Rock as Backfill

Based on the visual inspection by SRK, the majority (99%) of waste rock was chloritic green mafic metavolcanics (1a) with lesser (1%) quartz-carbonate veining (12). The mafic metavolcanics were unoxidized, dark blackish green and weakly foliated with <1% medium-grained disseminated pyrite, no fizz on the groundmass, and moderate fizz on rare <0.5 cm white quartz-carbonate veins. The absence of sedimentary units suggests that the source of waste rock inspected was from the underground mine and was not the NE CPR waste rock excavated from the Portal Pad, which were logged as sedimentary units.

Rinse and paste pH indicate the one sample was non-acidic. The rinse EC value is within the range of values of Portal Pad rock (5^{th} to 95^{th} percentile values of 90 to 320 uS/cm, n=10; SRK 2021b) and Doris underground waste rock (e.g. 87 to 6,700 uS/cm, SRK 2021a and 2022). Total sulphur and sulphide were 0.20% and 0.17%, respectively. TIC and Modified NP were 130 kg $CaCO_3$/t and the sample was classified as non-PAG. The sample was classified as not enriched for all parameters compared to the screening criterion. The stockpile also contained saline construction rock that was removed from the Portal Pad in 2021, however on the basis of geological inspection that indicated an absence of sedimentary units (1aj/1oj/5), the sample is interpreted to be underground rock.

5 Monitoring of Quarry and Construction Rock Geochemistry

Due to an error by the laboratory, data are pending for the quarry samples and were not available at the time of reporting. As such, the quarry and construction rock memo are not appended to this report; however, methods and results of the geological inspections are summarized below. The final quarry memo will be provided as an addendum after data are received.

5.1 Overview of Quarry and Construction Activity

In 2021, there were six blasts at Quarry 2 in September (7th and 12th), November (25th, 27th, and 30th), and December (4th). No construction took place in 2021 and therefore, no construction rock monitoring was conducted in 2021.

5.2 Quarry Monitoring

5.2.1 Methods

AEM conducted geological inspections of six blast faces in Quarry 2 and documented the lithology, sulphide content and veining plus the presence or absence of fibrous actinolite.

AEM collected six samples of run of quarry (ROQ) rock as two size fractions: a sieved coarse fraction (screened to -1 cm) and a finer fraction (screened to -2 mm). The samples were shipped to Bureau Veritas (BV) in Burnaby, BC for analysis of total sulphur by Leco. Five samples contained total sulphur content >0.1% and were subsequently tested for acid-base accounting (ABA) and trace element content. The -2 mm samples also underwent a shake flask extraction (SFE) test on the as-received fraction using the MEND (2009) method. Data are currently pending.

5.2.2 Results

Quarry Face Inspections

The geological inspections of the quarry blast faces indicated mafic volcanics (1a) described as very fine grained to medium grained green / grey material with moderate to strong pervasive chlorite alteration and lesser amounts of epidote alteration. Occasional hematite staining was reported on fractures and joint surface. Trace amounts of quartz-carbonate veinlets at a mm to cm scale and sulphides of less than 1% were noted. Fibrous actinolite was not present.

Acid Base Accounting

Data are pending and will be reported in an Addendum.

Elemental Analyses

Data are pending and will be reported in an Addendum.

SFE Tests

Data are pending and will be reported in an Addendum.

6 Seepage Survey

Details of the 2021 seep survey are provided in Appendix D, with sample locations presented in Attachment 1 of Appendix D and data presented in Tables 3-1 to 3-3 of Appendix D.

6.1 Overview of Seepage Survey

In 2021, AEM conducted a seepage survey of the waste rock at Doris and Madrid. The seepage survey at Doris included the waste rock influenced area (WRIA) defined as the waste rock stockpile on Pad T, waste rock and ore stockpile on Pad I and access road located down-gradient of the Doris waste rock stockpiles. At Madrid North the waste rock seepage survey included the Waste Rock Storage Area (WRSA) Pad and the downstream berm of the Madrid Contact Water Pond (CWP). In addition to the seepage survey, AEM conducted routine water quality sampling of waste rock drainage managed and collected in the Madrid CWP and Sumps 1 to 3.

The scope of the 2021 construction rock seepage survey included the following areas, with rationale stated in parentheses: Madrid North Overburden Stockpile (saline seepage quality), Madrid North Portal Pad (saline seepage quality), Madrid Shop laydown (seepage not observed in 2020), Doris access road to the vent raise (seepage not observed since 2019, which was the first year of monitoring) and reference stations (background seepage quality).

6.2 Sampling and Testing Program

AEM conducted the 2021 freshet seepage survey between June 14 to 25 and monitoring of drainage from waste rock at the Madrid WRSA and managed and collected in the Madrid CWP and Sumps 1 to 3 on July 7, August 4, and September 6. Seepage survey locations were established where seepage was observed or suspected by examining the toes of the waste rock stockpile, infrastructure, roadways, and berms. Samples were collected and field measurements were taken at locations where water was observed flowing into and out of rock; this included seepage where precipitation runoff and snowmelt came into contact with rock along the roadways, building pads, and berms. Electrical conductivity (EC), pH, temperature, oxidation-reduction potential (ORP), and flow rates (where possible) were measured at each of these locations at the time of monitoring.

AEM collected a total of 34 samples with 20 freshet seepage samples, six monthly samples from the Contact Water Pond (sample locations MMS-1N and MMS-1S), and eight samples from Sumps 1 to 3 downstream of the Madrid WRSA. At each station, the chemical and physical properties of seepage water were measured, and samples were taken for laboratory analysis. The three reference sites, located in the undisturbed tundra and not subject to mine influences, the Madrid Shop Laydown, and the Doris access road to the vent raise were not sampled in 2021.

All samples were analyzed at ALS Environmental Laboratory, Burnaby, BC for pH, EC, sulphate, alkalinity, ammonia, bromide, chloride, fluoride, nitrate, nitrite, phosphorus, sulphate, and total suspended sediments (TSS). For Doris, Madrid North Overburden Stockpile, Portal Pad, and Madrid WRSA freshet seepage samples (WRP-01, CWP-01, and CWP-02) total dissolved solids (TDS), acidity, and dissolved metals were also analyzed. For the remainder of the Madrid CWP and Sump samples, total metals were analyzed as per the Water Licence.

6.3 Results

6.3.1 Doris

Waste Rock Influenced Area

Prior to 2020, the seepage chemistry at the toe of the access road had the signature of waste rock and was more dilute than seepage at the toe of Pad I. Since 2020, seepage chemistry has indicated a loading source other than waste rock and has been geochemically characterized according to two loading sources: i) the downstream toe of the waste rock/ore stockpile on Pad I (21-DC-01 to 21-DC-03) and ii) toe of the access road (21-DC-04 and 21-DC-05). The seepage chemistry is summarized as follows:

- pH for all seepage samples was non-acidic (7.5 to 7.9). EC values were lower at the toe of the stockpile (2,100 µS/cm) and 4,100 and 4,200 µS/cm for samples at the toe of the access road.
- The differences in major ion chemistry are summarized as follows:
  - For the stockpile samples (21DC-01 to 21DC-03), major cation chemistry was dominated by sodium (280 to 300 mg/L) with lesser calcium (99 to 100 mg/L), while major anion chemistry was dominated by sulphate (530 mg/L), chloride (250 mg/L), and
  - For the access road samples (21DC-04 and 21DC-06) the cation chemistry was dominated by calcium (350 and 360 mg/L) and sodium (340 mg/L), while major anion chemistry was dominated by chloride (1,100 mg/L), sulphate (170 and 180 mg/L) and nitrate (63 and 64 mg/L as N).
- Concentrations were higher in chloride and ammonia concentrations in the road seepage samples than the Pad I samples, suggesting a loading source other than waste rock.
- A comparison of seepage trace element concentrations is summarized as follows:
  - Higher for stockpile stations: sulphate (530 mg/L), arsenic (ranging from 0.0040 to 00042 mg/L and three times higher), cobalt (0.034 to 0.035 mg/L and one order of magnitude higher), molybdenum (0.012 to 0.013 mg/L and one order of magnitude higher), and nickel (0.051 to 0.053 mg/L and one order of magnitude higher). Trends in these parameters were relatively stable except sulphate, which has been increasing with time.
  - Higher for road stations: cadmium (ranging from 0.00019 and 0.00021 mg/L and one order of magnitude) and manganese concentrations (0.42 and 0.49 mg/L and 4 times greater for manganese).
  - Equivalent: dissolved selenium and zinc were similar for all samples.
- For stockpile seepage, trends for all parameters were either decreasing or stable except for sulphate, which was increasing.

- For the access road seepage, concentrations for all parameters have decreased since 2020.

All drainage from the Doris camp pad, including seepage captured in the collection sumps downstream of the toe of the access road, is pumped to the sediment control pond (SCP) prior to transfer to the TIA. In 2021, water from the SCP accounted for 1.4% of total inflow volumes entering the TIA and 0.4% of the total volume stored in the TIA.

6.3.2 Madrid North

Waste Rock Storage Area

SFE arsenic concentrations for Madrid North waste rock at WRSA exhibited a positive trend with solid-phase arsenic and sulphur content. SFE arsenic did not have a relationship with gold in WRSA rock suggesting arsenic leaching is not higher for the oxide stockpile containing ore (SRK 2021c).

Discharge of effluent onto tundra from the CWP is in accordance with the effluent quality limits provided in the Water License. Water that does not meet these criteria is transferred to the TIA via water truck.

The water quality sample set in 2021 included i) one seepage sample collected downstream of the WRSA pad and near Sump 1, ii) monthly water quality samples from the contact water pond (CWP), Sump 1, Sump 2, and Sump 3 and iii) seepage samples collected upstream and downstream of the CWP berm. The purpose of the seepage monitoring upstream and downstream of the CWP berm was to geochemically characterize seepage that is bypassing the CWP.

A summary of the results are as follows:

- All waste rock drainage samples were non-acidic and EC values (240 to 5,100 µS/cm) indicated the temporal and spatial variability at all stations.
- As with EC, concentrations of all major ions were variable with time (e.g. sulphate, chloride and calcium). The major cation chemistry for most Madrid WRSA samples was typically dominated by sodium (12 to 440 mg/L) and calcium (20 to 540 mg/L), with concentrations for Sumps 1, 2, and 3 lower than CWP samples. Seepage at Sump 2 was dominated by magnesium (14 to 70 mg/L) and calcium (20 to 42 mg/L) with lesser sodium (12 to 31 mg/L). Seepage near Sump 1 (21-WRP-01) was lower than Sump 1 samples. Major anions for all samples were dominated by chloride (16 to 1,500 mg/L), sulphate (3.8 to 420 mg/L), and alkalinity (39 to 230 mg/L).
- Chloride concentrations ranged from 320 to 510 mg/L for all stations in June except the seepage sample near Sump 1 (86 mg/L).
- The seepage sample near Sump 1 had chloride (86 mg/L) and sulphate (74 mg/L) concentrations that were two times smaller than the nearby sump sample from 18 days prior. The lower concentration suggests that the seepage is less representative of waste rock contact water than the Sump 1.
- There was a temporal decrease in chloride concentrations at Sump 3 (maximum 620 mg/L) and CWP samples MMS1-N and MMS1-S (maximum values of 970 and 1,500 mg/L, respectively)

between July and September. Decreases are likely due to increased dilution from inflows to the CWP and reduced loading from underground waste rock that reports to Sump 3. The temporal increase in chloride concentrations at Sump 2 (from 16 mg/L in July to 270 mg/L in September) suggests that a minor loading source from underground waste rock reports directly to this water management collection point.

- In June, concentrations of chloride and sulphate were slightly higher for samples downstream of the CWP berm (410 to 510 mg/L) compared to samples upstream of the CWP berm (320 to 410 mg/L), but overall the chemistry was roughly equivalent.

In 2022, AEM is scheduled to construct a sump downstream of the CWP berm to intercept any CWP bypassing containment.

Infrastructure and Roads

Infrastructure surveyed at Madrid North included the Overburden Stockpile and Madrid North Portal Pad.

Madrid North Portal Pad

Construction rock from the portal pad was sourced from NE CPR waste rock. A comprehensive summary of sources of the portal pad seepage chemistry is documented in Appendix E. Between the 2020 and 2021 seepage surveys, AEM remediated the Portal Pad by excavating areas of Portal Pad that were saline with disposal within the NE CPR. Accordingly, the results of the 2021 seepage survey are an indicator of the reclamation activities. The 2021 Portal Pad seepage chemistry in the context of reclamation activities is summarized as follows:

- All seepage observed in 2021 was non-acidic.
- EC values (780 to 2,000 µS/cm) were lower by one order of magnitude compared to 2020.
- Concentrations of calcium (71 to 190 mg/L) and chloride (110 to 510 mg/L) were lower by one order of magnitude compared to 2020. Sulphate concentrations (68 to 120 mg/L), which are an indicator of sulphide oxidation, were notably equivalent between years.
- Nitrogen nutrients, which are present in or residuals of explosives, were present at significantly lower concentrations in 2021, including ammonia (two orders of magnitude lower), nitrate (three to five orders of magnitude lower) and nitrite (up to two orders of magnitude lower).
- Trace element concentrations were lower for all elements indicated as having high rates of metal leaching by the 2020 seepage survey, including dissolved cadmium (one to two orders of magnitude), cobalt (two orders of magnitude), iron (three to four orders of magnitude), manganese (one order of magnitude), nickel (one order of magnitude), selenium (one order of magnitude) and zinc (one order of magnitude).

The results of the 2021 Portal Pad seepage survey indicates that reclamation activities have improved seepage chemistry.

Madrid Overburden Stockpile

In addition to overburden, the Overburden Stockpile contains some construction rock sourced from two areas: Quarry D for construction in early 2019 of access roads and NE CPR waste rock for construction in late 2019 interior access roads and placement as cladding. Overall, seepage from the Overburden Stockpile in 2021 was characterized by lower concentrations than 2020 and is summarized as follows:

- Seepage from the Overburden Stockpile in 2021 was characterized by lower concentrations of EC and most major ions, whereby EC, sulphate, calcium, and potassium were one order of magnitude lower than 2020 samples and chloride, magnesium and sodium were up to two orders of magnitude lower. The major ion composition of 2021 samples was relatively uniform and distinctive from 2020 seepage samples.
- Ammonia and phosphorus concentrations in 2021 were two orders of magnitude lower than in 2020.
- Concentrations of dissolved trace elements were lower in 2021 with levels one or two orders of magnitude lower for antimony, cadmium, cobalt, iron, lead, manganese, molybdenum, nickel, selenium, and zinc. Notably, arsenic concentrations were roughly equivalent.
- The significant decrease in concentrations of major ions and trace elements in seepage from 2020 to 2021 validates the conceptual geochemical model that the source loading to seepage chemistry in 2020 was the thawing and draining of frozen saline porewater within overburden. Seepage samples collected in 2021 were from a different location than 2020 samples and therefore may represent drainage from non- and less saline overburden that is present in the stockpile (SRK 2021d).

7 Monitoring of Tailings

Details of the 2021 tailings monitoring programs are provided in Appendix E with data presented in Tables 4-3 to 4-9 of Appendix E.

7.1 Overview of Tailings Production and Placement

The geochemical monitoring program for flotation tailings slurry and detoxified tailings includes the following monitoring stations: process plant tailings water discharge (TL-5), flotation tailings solids (TL-6), detoxified tailings solids[3] (TL-7A), detoxified tailings filtrate (TL-7B)[4] and seepage from underground backfilled stopes (TL-11). In 2021, the process plant operated on a reduced schedule between January 1 and October 5 whereby the process plant operated for three-weeks for every six-week period. Between mid-October and December 31, the process plant did not operate. In total, 253,160 t (dry weight equivalent) of flotation tailings were deposited in the Doris TIA in 2021 and 10,006 t of detoxified tailings were placed as backfill in Doris Mine.

7.2 Sampling and Testing Program

7.2.1 Process Plant Flotation Tailings Slurry Discharge: Solids (TL-6) and Supernatant (TL-5)

Samples of the flotation tailings solids (TL-6) and the supernatant solution (TL-5) are collected from the flotation tailings thickener tank. The filtrate from the detox filter press (where detoxified tailings are dewatered) is pumped to the flotation tailings thickener tank prior to discharge to the TIA. The 2021 monitoring program for TL-5 included geochemical characterization of nine monthly samples of tailings process supernatant collected from January to September with a duplicate sample collected in January. The 2021 monitoring program for TL-6 included geochemical characterization of six composite samples of flotation tailings in January, March, April, May, August, and September. Samples representing February and June were not collected when the plant was not operating. The July sample was discarded by AEM in error before it could be analyzed.

7.2.2 Detoxified Tailings Solids (TL-7A) and Filtrate (TL-7B)

The 2021 monitoring program included geochemical characterization of nine samples of detoxified tailings solids (TL-7A). A sample was collected each month between January and September. Nine samples of filtrate (TL-7B) from the detoxified tailings were collected from January to September.

[3] Detoxified tailings are referred to as cyanide leach residue in the Water Licence and prior to 2019 was monitored as station TL-7.

[4] Station TL7-B was added to the Water Licence as part of Amendment No. 2 and monitoring commenced in 2019.

7.2.3 Seepage Survey of Underground Backfilled Stopes (TL-11)

AEM completed underground seepage inspections of backfilled stopes in August and December 2021. Visual surveys were conducted of all backfilled stopes that could be accessed safely at the time of the survey, i.e., not all backfill could be inspected. Three seepage locations were sampled in August and three locations were sampled in December. During the August sampling survey, AEM collected three seepage samples from Levels 120, 114, and 110. In December, AEM collected three samples from Level 120, 114, and 74. SRK concluded that the sample from Level 74 did not represent contact water of backfill. Results for seepage collected Level 74 are presented in Appendix E but not summarized herein.

Field measurements of pH, EC, ORP, temperature and flow rate (where applicable) were recorded at each station. AEM submitted samples to ALS in Yellowknife, NT for analysis of pH, EC, TSS, TDS, alkalinity, chloride, sulphate, total, free, and WAD cyanide, and dissolved and total metals. The sample for dissolved metals was filtered and preserved at the time of sampling.

7.3 Results

7.3.1 Tailings Slurry to TIA

The tailings slurry is pumped from the flotation tailings thickener tank to the TIA. Inputs to the flotation tailings thickener tank include the flotation tailings solids (monitored as TL-6) and flotation process water (monitored as TL-5) and filtrate from the detox filter press (monitored as TL-7A).

Flotation Tailings Solids (TL-6)

All flotation tailings samples were classified as non-PAG, which in consistent with 2017 to 2020 operational tailings monitoring (SRK 2020b) and metallurgical tailings samples (SRK 2015b). Sulphur concentrations ranged between 0.10 and 0.32% with a median value of 0.17%. TIC content ranged between 200 and 280 kg $CaCO_3$/t.

All parameters were below the screening criteria indicating no appreciable enrichment except arsenic was enriched for January and August samples. The higher arsenic content reported in August is roughly equivalent to tailings produced between June 2019 and March 2020, but overall, 2021 concentrations are typically lower than 2020. Processing of Madrid North ore, which has higher arsenic content than Doris (SRK 2017) commenced in 2019 and continued in 2021.

Tailings Detoxified Filtrate (TL-7B) and Process Plant Tailings Discharge (TL-5)

Monthly monitoring of TL-5 and TL-7B is summarized as follows:

- pH was stable in both TL-5 (8.1 to 8.4) and TL-7B (8.5 to 8.7).
- Sulphate concentrations ranged from 1,300 to 3,000 mg/L in TL-5 and from 13,000 to 20,000 mg/L in TL-7B, both of which are within the range of historical data.

- Sodium ranged between 1,600 and 2,900 mg/L in TL-5 and between 7,200 and 11,000 mg/L in TL-7B. TL-B concentrations were within the range of previous data. Sodium concentrations at TL-5 were equivalent to 2020 and generally higher than concentrations reported mid-2019 and earlier.
- Concentrations of total ammonia were 25 to 47 mg/L as N in TL-5 and 190 to 370 mg/L as N in TL-7B. Results were similar to previous data except for a new maximum at TL-7B in March. Concentrations of ammonia at TL-5 were higher since January 2019 compared to 2018 and earlier.
- Total cyanide concentrations ranged from 0.9 to 4.7 mg/L in TL-5 and from 0.15 to 5.3 mg/L in TL-7B and were also within range of previous data except for at TL-7B in March (5.3 mg/L).
- WAD cyanide and free cyanide was either at limit of detection or at concentrations similar to previous data in TL-5 and TL-7B.
- Thiocyanate ranged from 12 to 51 mg/L in TL-5 and from 190 mg/L to 580 mg/L in TL-7B. These concentrations were within range of the previous data except for TL-7B in March and July, which were 580 and 560 mg/L, respectively. Cyanate ranged from 41 to 130 mg/L in TL-5 and from 540 mg/L to 1,100 mg/L in TL-7B. Cyanate concentrations fluctuated with periodic increases including February, March, and April.
- Chloride data is available for TL-5 from April 2019 onward. Concentrations ranged between 2,500 and 4,100 mg/L showing an oscillating trend with two distinctive spikes in spring 2020 and 2021 (March and April) which are likely related to cryoconcentration within the TIA. Chloride was not analyzed in TL-7B.
- Arsenic ranged from 0.002 to 0.005 mg/L in TL-5 and 0.04 to 0.23 mg/L in TL-7B. Concentrations have been stable since late 2019 except for two operational maximums at TL-7B indicated previously in 2020.
- Cobalt and nickel concentrations were within range of historical data except for a new operational maximum result for cobalt in TL-7B in March (0.3 mg/L).
- Concentrations of antimony in TL-5 and TL-7B ranged between 0.002 and 0.004 mg/L in TL-5 and 0.02 to 0.04 mg/L in TL-7B. TL-5 reported an increasing trend in 2019 and stable concentrations since. TL-7B concentrations were equivalent to the range observed between late-2019 and early 2020. Antimony concentrations in TL-7B were lower in early 2019 and periodic spikes were observed in 2020.
- Molybdenum concentrations were 0.02 to 0.03 mg/L in TL-5 and 0.08 to 0.13 mg/L in TL-7B and within the range of previous data.
- Copper concentrations ranged from 0.01 to 0.6 mg/L in TL-5 and from 1.5 to 11 mg/L in TL-7B and were similar to or lower than previous years.
- Cadmium and zinc concentrations were consistently at or close to detection limit in both TL-5 and TL-7B, similar to previous years.
- Concentrations of manganese ranged from 0.1 to 0.3 mg/L in TL-5 and from 59 to 99 mg/L in TL-7B, similar to previous data.

- Selenium concentrations ranged from 0.002 to 0.005 mg/L in TL-5 and from 0.006 to 0.04 mg/L in TL-7B, within range of the previous data.

7.3.2 Detoxified Tailings to Doris Mine

Detoxified Tailings Solids (TL-7A)

The results of the 2021 geochemical monitoring program of detoxified tailings solids (TL-7A) are summarized as follows:

- All detoxified tailings samples were classified as PAG, which is consistent with 2017 to 2020 operational tailings monitoring and metallurgical tailings samples (SRK 2015b). Sulphur concentrations ranged between 19 and 37% in 2021. TIC results for 2021 ranged between 89 and 160 kg $CaCO_3$/t.
- All detoxified tailings samples were elevated in arsenic, bismuth, copper, selenium, and silver compared to the screening criteria. More than half of the 2021 samples were also elevated for cadmium. Selected samples were elevated in zinc (n=3) and lead (n=3) compared to the screening criteria. All other parameters, including cobalt and nickel were below the screening criteria indicating no appreciable enrichment.

Underground Seepage Survey (TL-11)

The results of the opportunistic seepage sampling from underground backfilled stopes (TL-11) are summarized as follows:

- The major ion composition for of TL-11 samples has the equivalent chemical signature and are considered to be contact water of mine backfill. Ion chemistry was dominated by chloride (2,100 to 6,900 mg/L) and sodium (3,900 to 3,900 mg/L). Seepage collected from Level 120 and Level 110 had higher concentrations of major ions and EC than Level 114.
- The pH and EC ranged between 8.0 to 8.2 and 7,200 to 22,000 µS/cm respectively.
- Levels of ammonia, nitrate, and nitrite were lower than 50th percentile concentrations of TL-11 samples collected between 2017 and 2020 (n=20).
- The following parameters were elevated for all samples relative to the 50^{th} percentile concentrations of TL-11 samples collected between 2017 and 2020 (n=20) set unless otherwise noted:
  - TSS concentrations were between 250 and 550 mg/L except for the Level 120 (December, 19 mg/L)
  - Sulphate concentrations in the Level 110 (August, 1,900 mg/L)
  - Alkalinity with concentrations from 190 to 260 mg/L as $CaCO_3$.
  - Total cyanide from Level 114 from August and December with concentrations of 0.33 and 0.06 mg/L, respectively.

  - Boron (2.6 mg/L), cobalt (0.14 mg/L), nickel (0.36 mg/L), selenium (0.008 mg/L), and sulphur (760 mg/L) in the Level 110 sample only.

- Arsenic and silver concentrations were within the same range as previous seepage surveys (0.002 to 0.005 mg/L and 0.00005 to 0.0003 mg/L, respectively).
- Copper and zinc concentrations were notably lower than indicated by previous seepage surveys (0.004 to 0.04 mg/L and 0.006 to 0.04 mg/L, respectively).
- Manganese and cadmium concentrations were also lower than the 50th percentile concentrations from the historical sample set in all samples (0.002 to 2.8 mg/L and 0.00001 to 0.0005 mg/L, respectively).

8 Conclusions

8.1 Doris Waste Rock

Mining at Doris in 2021 resulted in production of 227,926 t of waste rock; this material was kept underground and used as backfill. In addition, approximately 14,000 t of waste rock was removed from the surface waste rock stockpile on Pad T and placed as backfill in stopes of the Doris mine (Table 3-1). In 2020, Doris underground workings were geologically described as 95% mafic volcanics with trace sulphide and 1 to 2% quartz-carbonate veining; 4% sericite altered mafic volcanics with up to 1% sulphide and 2 to 5% quartz-carbonate veining; and 1% diabase dyke with trace to 1% sulphide and trace quartz-carbonate veining.

Waste rock observed on Pad T was a mixture of approximately 90% chloritic green mafic metavolcanics (1a), 8% light tan colored sericite altered mafic metavolcanics (1as), <1% white quartz veins (12q), <1% dark gray diabase (11c), and <0.5% light brown felsic dyke (rock code undefined). SRK collected five samples (three of mafic metavolcanics (1a), one of altered mafic metavolcanics (1as), and one diabase (11c)) from the surface waste rock stockpile on Pad T.

For mafic metavolcanics samples (1a), total sulphur ranged from 0.20 to 1.4% and median levels of 0.27%. The sample with 1.4% total sulphur contained 1% to 2% visible sulphides and was selected to characterize a high sulphur sample. TIC and Modified NP content was high ranging from 203 to 321 kg $CaCO_3$/t and 154 to 186 kg $CaCO_3$/t, respectively. All samples were classified as non-PAG based on TIC/AP and NP/AP. The one sample of altered mafic metavolcanics (1as) had a total sulphur content of 0.21%. TIC and Modified NP content was 319 and 159 kg $CaCO_3$/t, respectively. The sample was classified as non-PAG based on TIC/AP and NP/AP. The one sample of diabase (11c) had a total sulphur content of 0.33%. TIC and Modified NP content was 168 and 161 kg $CaCO_3$/t, respectively. The sample was classified as non-PAG based on TIC/AP and NP/AP. Trace element content was below the screening criteria for all samples except for arsenic, sulphur, and tungsten in the mafic metavolcanics (1a) sample containing 1.4% sulphur. Total metal concentrations for all other samples were less than ten times the average crustal abundance for basalt indicating no appreciable enrichment. SFE tests on a sample each of mafic metavolcanics (1a), altered mafic metavolcanics (1as), and diabase (11c) had alkaline pH (7.8 to 8.9). Nitrate concentrations and chloride values ranged from 7.3 to 43 mg/L and 79 to 394 mg/L, respectively and are indicative of blasting and drilling brine residuals present on waste rock surfaces, and possibly naturally saline groundwater that is present in areas of the mine.

Two mafic volcanic (1a) waste rock samples collected from Pad T in 2021 were similar to the Type A, UG monitoring and CPR sample sets; one mafic volcanic sample was sampled as an end-member and biased high in sulphur. The sample of altered mafic metavolcanic (1as) collected in 2021 was similar to the previous UG monitoring and CPR sample sets. The diabase (11c) sample collected from Pad T in 2021 was on the upper end of the range of geochemical characteristics (sulphur, arsenic) seen in the Type A and UG waste rock sample sets.

The geochemical behaviour of the waste rock is monitored through the annual seep survey along the downgradient toe of the waste rock and ore stockpile area and routine monitoring of the Pollution Control Pond (PCP). The results of the seepage survey are reported in Section 6 and Appendix D, while results of the routine monitoring program are included in monthly water quality reports prepared by AEM and submitted to the Nunavut Water Board.

8.2 Madrid North Waste Rock

In 2021, mining included development of the underground decline between January and February. During this period 3,682 t of underground waste rock was produced and placed as backfilled in the NE CPR. AEM indicated that the stockpile contained waste rock placed in 2021 from the Madrid North underground mine and construction rock excavated as part of the reclamation of the Madrid North Portal Pad. Based on geological inspections of the decline by AEM, waste rock was logged as 99% mafic metavolcanics (1) with the balance (1%) logged as quartz-carbonate veining. SRK collected one sample of waste rock from the surface stockpile placed in the NE CPR. Sample selection was based on the range of rock types identified during the geological inspection. One sample of mafic metavolcanic (1a) was collected for analysis. The sample was characterized by low total sulphur content (0.20%) and levels of Modified NP and TIC of 130 kg $CaCO_3$/t. The sample was classified as non-PAG. The sample was not classified as enriched compared to the screening criterion.

8.3 Quarry and Construction Rock

8.3.1 Quarry 2

The laboratory data for quarry rock monitoring is pending. Results will be submitted as an Addendum.

8.4 Seepage Monitoring

8.4.1 Doris Waste Rock Influenced Area

Waste Rock Impacted Area

Consistent with previous years, seepage at the waste rock influenced area was characterized according to two groups: i) the downstream toe of the waste rock/ore stockpile on Pad I and ii) toe of the access road.

The pH for all seepage samples was non-acidic (7.5 to 7.9).

The seepage chemistry at the toe of Pad I was indicated contact water of mine rock (waste rock and ore) based on the following:

Prior to 2020, the seepage chemistry at the toe of the access road had the signature of waste rock and was more dilute than seepage at the toe of Pad I. Since 2020, seepage chemistry has indicated a loading source other than waste rock based on the following:

EC values were 2,100 µS/cm at the toe of the stockpile and 4,100 and 4,200 µS/cm for samples at the toe of the access road. Prior to 2020, seepage at the toe of the road had the chemical signature of waste rock and was more dilute that waste rock contact water, e.g., DC-01 because the seepage was mixed with other flows. Since 2020, the higher chloride and ammonia concentrations in the road seepage samples suggests a loading source other than waste rock.

The following concentrations that were higher for stockpile stations include sulphate (530 mg/L), arsenic (ranging from 0.0040 to 00042 mg/L and three times higher), cobalt (0.034 to 0.035 mg/L and one order of magnitude higher), molybdenum (0.012 to 0.013 mg/L and one order of magnitude higher), and nickel (0.051 to 0.053 mg/L and one order of magnitude higher). Trends in these parameters were relatively stable except sulphate, which has been increasing with time. Element concentrations that were higher for road stations included cadmium (ranging from 0.00019 and 0.00021 mg/L and one order of magnitude) and manganese (0.42 and 0.49 mg/L and 4 times greater for manganese). Dissolved selenium and zinc were similar for all samples.

All drainage from the Doris camp pad, including seepage captured in the collection sumps downstream of the toe of the access road, is pumped to the sediment control pond (SCP) prior to transfer to the TIA. In 2021, water from the SCP accounted for 1.4% of total inflow volumes entering the TIA and 0.4% of the total volume stored in the TIA.

8.4.2 Madrid North

Waste Rock Storage Area

Of the 101,126 t of waste rock present at WRSA, most waste rock originated from NE CPR (83,968 t). Approximately, 17,158 t of waste rock from the decline of the Madrid North underground mine was also placed at the WRSA. A small volume of briny waste rock from the Madrid North portal pad was also placed on the WRSA in 2020. Waste rock at the WRSA was geochemically classified as non-PAG and placed in two stockpiles (SRK 2021c). The stockpiles at the WRSA include:

1. A smaller stockpile located directly upstream of the contact water pond (CWP) that contains oxide rock. The oxide rock is ore hosted in mafic volcanics with sediments (1aj) from NE CPR that could not operationally be segregated from waste rock.
2. A larger stockpile located adjacent to Sumps 1 to 3 that contains a mixture of waste rock from NE CPR and the underground mine (the latter as indicated by rinse tests).

Water management at the Madrid North WRSA includes three water collection sumps (Sump 1, Sump 2, and Sump 3) and the Madrid North CWP. Water from the sumps is pumped to the contact water pond, therefore water chemistry at the CWP is influenced by waste rock seepage draining to CWP and the collection sumps. Discharge of effluent onto tundra from the CWP is in accordance with the effluent quality limits provided in the Water Licence. Water that does not meet these criteria is transferred to the TIA via water truck.

The water quality sample set in 2021 included i) one seepage sample collected downstream of the WRSA pad and near Sump 1, ii) monthly water quality samples from the contact water pond (CWP), Sump 1, Sump 2, and Sump 3 and iii) seepage samples collected upstream and downstream of the CWP berm. The purpose of the seepage monitoring upstream and downstream of the CWP berm was to geochemically characterize seepage that is bypassing the CWP. Selected data did not pass QC checks and dissolved metals data were not available for all samples. Consequently, data interpretation was based on data that was determined to be acceptable to SRK. A summary of the results are as follows:

- All waste rock drainage samples were non-acidic and EC values (240 to 5,100 µS/cm) indicated the temporal and spatial variability at all stations.
- As with EC, concentrations of all major ions were variable with time. The major cation chemistry for most Madrid WRSA samples was typically dominated by sodium (12 to 440 mg/L) and calcium (20 to 540 mg/L), with concentrations for Sumps 1, 2, and 3 lower than CWP samples. Seepage at Sump 2 was dominated by magnesium (14 to 70 mg/L) and calcium (20 to 42 mg/L) with lesser sodium (12 to 31 mg/L). Seepage near Sump 1 (21-WRP-01) was lower than Sump 1 samples. Major anions for all samples were dominated by chloride (16 to 1,500 mg/L), sulphate (3.8 to 420 mg/L), and alkalinity (39 to 230 mg/L).
- Chloride concentrations ranged from 320 to 510 mg/L for all stations in June except the seepage sample near Sump 1 (86 mg/L).
- The seepage sample near Sump 1 had chloride (86 mg/L) and sulphate (74 mg/L) concentrations that were two times smaller than the nearby sump sample from 18 days prior. The lower concentration suggests that the seepage is less representative of waste rock contact water than the Sump 1.
- There was a temporal decrease in chloride concentrations at Sump 3 (maximum 620 mg/L) and CWP samples MMS1-N and MMS1-S (maximum values of 970 and 1,500 mg/L, respectively) between July and September. Decreases are likely due to increased dilution from inflows to the CWP and reduced loading from underground waste rock that reports to Sump 3. The temporal increase in chloride concentrations at Sump 2 (from 16 mg/L in July to 270 mg/L in September) suggests that a minor loading source from underground waste rock reports directly to this water management collection point.
- In June, concentrations of chloride and sulphate were slightly higher for samples downstream of the CWP berm (410 to 510 mg/L) compared to samples upstream of the CWP berm (320 to 410 mg/L), but overall, the chemistry was roughly equivalent.

In 2022, AEM is scheduled to construct a sump downstream of the CWP berm to intercept any CWP bypassing containment.

Infrastructure and Roads

In 2020, seepage at the Overburden Stockpile and Madrid North Portal Pad was saline and selected seepage at the Portal Pad was mildly acidic. In 2021, all seepage samples were non-acidic, major ion and dissolved metal concentrations were significantly lower than concentrations quantified in 2020 (SRK 2021d). Lower seepage concentrations at the Overburden Stockpile suggest much of the saline ice lenses have been flushed through the stockpile. The significant decrease in concentrations of major ions and trace elements in seepage from the Overburden Stockpile from 2020 to 2021 validates the conceptual geochemical model that the source loading to seepage chemistry in 2020 was the thawing and draining of frozen saline porewater within overburden. The results of the 2021 Portal Pad seepage survey indicates that reclamation activities have improved seepage chemistry.

8.5 Tailings

In 2021, a total of 253,160 t (dry weight equivalent) of flotation tailings were deposited in the Doris TIA and 10,006 t of detoxified tailings were placed as backfill in Doris Mine.

8.5.1 Flotation Tailings Slurry

For flotation tailings solids (TL-6), sulphur concentrations ranged between 0.10 and 0.32% with a median value of 0.17%. TIC content ranged between 200 and 280 kg $CaCO_3$/t. All flotation tailings samples were classified as non-PAG, which is consistent with 2017 to 2020 operational tailings monitoring (SRK 2020b) and metallurgical tailings samples (SRK 2015b). All parameters were below the screening criteria indicating no appreciable enrichment except arsenic was enriched for January and August samples.

pH was stable in both the tailings detoxified filtrate (TL-7B) (8.5 to 8.7) and the process plant tailings discharge (TL-5) (8.1 to 8.4). Concentrations were within the range of historical data for the following parameters except when noted:

- Sulphate with concentrations ranged from 1,300 to 3,000 mg/L in TL-5 and 13,000 to 20,000 mg/L in TL-7B.
- Total cyanide concentrations ranged from 0.9 to 4.7 mg/L in TL-5 and from 0.15 to 5.3 mg/L in TL-7B (except for at TL-7B in March, 5.3 mg/L).
- WAD cyanide and free cyanide was either at limit of detection or at concentrations similar to previous data in TL-5 and TL-7B.
- Thiocyanate ranged from 12 to 51 mg/L in TL-5 and from 190 mg/L to 580 mg/L in TL-7B. These concentrations were within range of the previous data except for TL-7B in March and July, which were 580 and 560 mg/L, respectively.
- Cyanate ranged from 41 to 130 mg/L in TL-5 and from 540 mg/L to 1,100 mg/L in TL-7B. Cyanate concentrations fluctuated with periodic increases including February, March, and April.
- Arsenic concentrations have been stable since late 2019 except for two maximums at TL-7B indicated previously in 2020.
- Cobalt and nickel concentrations were within range of historical data except for a new maximum result for cobalt in TL-7B in March (0.3 mg/L).

8.5.2 Detoxified Tailings to Doris Mine

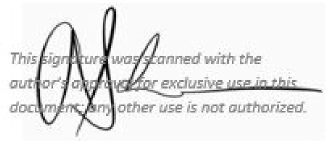
For detoxified tailings solids (TL-7A), total sulphur concentrations ranged between 19 and 37% in 2021. TIC results for 2021 ranged between 89 and 160 kg $CaCO_3$/t. All of the detoxified tailings samples were classified as PAG, which is consistent with 2017 to 2020 operational tailings monitoring and metallurgical tailings samples (SRK 2015b). All detoxified tailings samples were elevated in arsenic, bismuth, copper, selenium, and silver compared to the screening criteria. More than half of the 2021 samples were also elevated for cadmium. Selected samples were elevated in zinc (n=3) and lead (n=3) compared to the screening criteria. All other parameters, including cobalt and nickel were below the screening criteria indicating no appreciable enrichment.

Major ion chemistry for opportunistic seepage samples from the base of backfilled stopes indicated that all five samples had the same geochemical composition. pH and EC ranged from 8.0 to 8.2 and 7,200 to 22,000 µS/cm, respectively. Ion chemistry was dominated by chloride and sodium. Levels of ammonia, nitrate, and nitrite were lower than the 50th percentile concentrations of TL-11 samples collected between 2017 and 2020 (n=20).

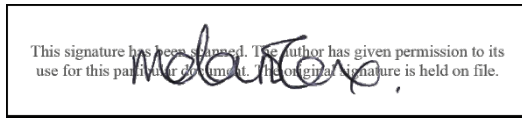
Concentrations of cadmium, copper, and silver, noted as parameters of potential concern based on the humidity cell test (HCT) program (SRK 2015b), reported concentrations less than the 50th percentile concentrations from the historical sample set. Nickel and selenium, also noted as parameters of potential concern, were elevated relative to the 50^{th} percentile concentrations from the historical sample set from the Level 110 sample collected in August. Zinc was not noted as a parameter of potential concern in the HCT program but has historically reported elevated concentrations; all samples were below the 50^{th} percentile from the historical sample set.

Closure

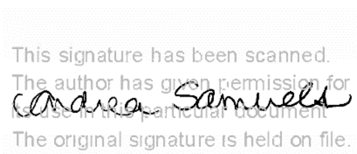
This report, 2021 Waste Rock, Quarry and Tailings Monitoring Report, Doris and Madrid North Mines, was prepared by



Amanda Schevers, GIT (BC)
Staff Consultant (Geochemistry)
Qualified Geochemist



Melanie Cox
Senior Consultant (Geochemistry)
Qualified Geochemist



Andrea Samuels, PGeo (BC)
Associate Senior Consultant (Geochemistry)
Qualified Geochemist

and reviewed by

Lisa Barazzuol, PGeo (NT/NU)
Principal Consultant (Geochemistry)
Qualified Professional and Hope Bay Project Geochemist

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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Appendix A 2021 Geochemical Monitoring of Waste Rock, Doris Mine

SRK Consulting (Canada) Inc.
1066 West Hastings Street, Suite 2200
Vancouver, BC V6E 3X2
Canada

+1 604 681 4196 office
+1 604 687 5532 fax

vancouver@srk.com
www.srk.com

FINAL

Technical Memo

March 18, 2022

To	Nancy Duquet Harvey, Agnico Eagle Mines Ltd.
From	Andrea Samuels, Amanda Schevers, Lisa Barazzuol, SRK
Cc	Ashley Mathai, Agnico Eagle Mines Ltd.
Subject	2021 Geochemical Monitoring of Waste Rock, Doris Mine
Client	Agnico Eagle Mines Ltd.
Project	1CT022.073

1 Introduction

In 2021, Agnico Eagles Mines (AEM) assumed ownership of the Hope Bay project. In April 2015, underground mining was re-initiated at Doris, with placement of waste rock on surface commencing in October 2015. Requirements for management and monitoring of waste rock and ore are specified in the *Waste Rock, Ore and Mine Backfill Management Plan* (TMAC 2019), which is part of Water Licence 2AM DOH1335 Amendment No. 2 (Nunavut Water Board 2018).

In 2021 a total of 213,926 t of waste rock was produced from mining activities in the Doris mine, of which 133,542 t remained underground and used as backfill and 80,384 t was placed in the surface waste rock stockpile on Pad T. In addition, approximately 14,000 t of waste rock was removed from the surface waste rock stockpile on Pad T and placed as backfill in stopes of the Doris mine (Table 1-1, Figure 1-1).

Table 1-1: Summary of 2021 Waste Rock Placement Locations and Volume

Doris Mine	Source Location	Placement Location	Volume (t)	Total Moved (t)
Underground	Underground	Backfill in Stopes	133,542	227,926
		Pad T	80,384	
	Pad T	Backfill in Stopes	14,000	

This memo documents the geochemical monitoring of underground waste rock on the Pad T surface waste rock stockpile executed by SRK according to the requirements of the waste rock management plan outlined in TMAC (2019). Other 2021 geochemical monitoring activities in the Doris mine area related to waste rock included an annual seep survey and routine monitoring of the toe of the waste rock stockpile on Pad T, pollution control pond (PCP) embankment immediately downstream of the waste rock and ore stockpile on Pad I, and toe of the access road located down-gradient of the Doris waste rock stockpiles. The results of the seepage surveys are reported in the accompanying memo (SRK 2022), while results of the routine monitoring program of the PCP are included in monthly water quality reports prepared by AEM and submitted to the NWB.

Figure 1-1: Area of Inspection on Pad T Waste Rock Stockpile showing sample SRK21-PadT-05 adjacent to the Low-Grade Ore Stockpile

2 Methods

2.1 Geological Inspections

Waste Rock, Ore, and Mine Backfill Management Plan (TMAC 2019) outlines two types of waste rock inspections: routine underground geological inspections at the blast face by AEM site geologists and annual inspection of the surface waste rock stockpile on Pad T.

In August 2021, SRK geochemist Amanda Schevers, GIT (BC) completed a geological inspection of waste rock placed on Pad T. The objective of the inspection was to determine the geological composition of waste rock, to examine for signs of sulphide oxidation and weathering and to collect samples for geochemical characterization of waste rock for comparison with baseline geochemical characterization (Section 3.1.3, Table 3.1; TMAC 2019). SRK's inspection included areas indicated by AEM to contain waste rock placed since August 2020, which included the upper lift of the waste rock stockpile as denoted in yellow in Figure 1-1. Initially, AEM also indicated waste rock had been placed along the eastern side of the Low-Grade Ore Stockpile (as denoted by red in Figure 1-1), however, subsequent communication concluded the waste rock present in this location was not produced in 2021. The small amount of waste rock on the eastern margin of the Low-Grade Ore Stockpile (not shown in photo in Figure 1-1) was included in the inspection.

The inspection was carried out by walking over the area of the stockpile examining rock types and the presence of sulphide and carbonate content (Attachment A).

2.2 Sample Collection and Geochemical Test Work Program

As per the Waste Rock, Ore, and Mine Backfill Management Plan (TMAC 2019), SRK collected samples of waste rock from Pad T. SRK collected five samples (Table 2-1) with sample distribution according to the rock types visually identified by SRK during the stockpile inspection (Section 2.1), the proportion of rock types that were intersected by mining, as indicated by AEM geologists, and spatial distribution of the inspected areas (Section 3.1). Four samples were collected from the primary waste rock stockpile and sample SRK21-PadT-05 was collected from waste rock adjacent to the Low-Grade Ore Stockpile. Subsequent to sample collection, AEM indicated that SRK21-PadT-05 did not represent waste rock from 2021; however, results are included herein for completeness. One field duplicate was also collected from the stockpile for quality assurance and quality control (QA/QC) purposes (see Section 2.4 for more detail).

Each sample consisted of a sieved coarse fraction (screened to -1 cm) and a finer fraction (screened to -2 mm) for rinse tests. SRK visually described the samples for rock type, sulphide content (quantity, type, and occurrence) and carbonates (fizz test with 10% HCl, type, and occurrence). Rinse tests involved mixing a 1 to 1 ratio of distilled water and solids and measuring the resulting pH and electrical conductivity (EC).

SRK shipped samples to Bureau Veritas (BV) in Burnaby, BC for analysis of ABA (Section 2.3) and elemental analysis on the -1 cm fraction. Three samples were selected by SRK for shake flask extraction (SFE) testing based upon the low, medium, and high values of rinse EC, as well as each of the rock types. SFE samples were sieved to -2 mm at BV from the -1 cm size fraction.

Table 2-1: Pad T Waste Rock Monitoring Samples Collected and Associated Test Program

Rock Type[1]	ABA & Elemental Analysis	SFE	Rinse Test (pH and EC)
1a	3	1	3
1as	1	1	1
11c	1	1	1
Total Number of Tests	5	3	5

Source: C:\Users\asamu\Dropbox\Hope Bay_2022\2021 Memo\[HB_2021_SolidsGeochem_DorisWR_1CT022.056_als_Rev01.xlsx]

Notes:

[1] 1a = mafic metavolcanic, 1as = altered mafic metavolcanics, 11c = diabase

2.3 Analytical Methods

The geochemical analytical methods for waste rock samples are summarized as follows:

- Total sulphur by Leco;
- Sulphate by HCl leach;
- TIC by Leco furnace to directly measure CO_2 gas evolved from HCl treatment of the sample;
- Modified Sobek NP (MEND 1991);
- Elemental analysis by aqua regia digestion followed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) determination of 9 major elements (e.g., aluminum, calcium, magnesium, sodium, potassium, iron, sulphur) and 29 trace elements (e.g., arsenic, zinc, copper, cadmium, lead); and
- SFE tests on the -2 mm size fraction, using a 3:1 solution to solid ratio and a 24-hour shaking period (MEND 2009). SFE leachates were analyzed for pH, EC, total dissolved solids (TDS), SO_4, alkalinity, acidity, chloride, ammonia, NO_3, NO_2, and element analysis by ICP-MS (including Hg).

2.4 Quality Assurance and Quality Control

All results, including results from BV's internal QA/QC program, were reviewed by SRK for quality assurance as outlined in the SRK Expectations for Laboratory Geochemical Data Quality (2019) which have been agreed upon with BV. Table 2-2 presents a summary of the QC checks for the waste rock samples collected from Pad T by SRK, including the assessment of duplicate and blank samples and standard reference materials.

All data passed SRK's QC checks except for the ion balance for sample SRK-PADT-03 in the SFE test was 14% which is greater than SRK's internal QA/QC criterion of +/-10%; however, BV uses +/-15% criterion in their QA/QC procedures, and therefore the data was accepted. SRK determined all data to be acceptable.

Table 2-2: Summary of QA/QC Results

QC Test	SRK QC Criteria	Results
	Paste pH	
Crush/field Duplicate (n=1)	For any samples, +/- 0.5 difference pH unit	All passed.
Pulp Duplicate (n=1)	For any samples, +/- 0.5 difference pH unit	All passed.
Standard Reference Material (n=1)	Within specified tolerance ranges.	All passed.
	Total C and TIC	
Method Blank (n=1) for TIC	<2X detection limit (DL)	All passed.
Crush/field Duplicate (n=1) for TIC	For samples > 10X the detection limit (DL), % RPD within +/-30%	All passed.
Pulp Duplicate (n=1) for TIC	For samples > 10X the detection limit (DL), % RPD within +/-20%	All passed.
Standard Reference Material (n=1) for TIC	Within specified tolerance ranges.	All passed.
	Total S & Total Sulphate	
Method Blank (n=1) for Total S and Sulphate S	<2X detection limit (DL)	All passed.
Sulphur balance (Total S > Sulphate S) (n=5)	For samples > 10X the detection limit (DL), Total Sulphur should be greater than Total Sulphate, if not the % difference should be within +/-20%	All passed.
Crush/field Duplicate (n=1) for Total S and Sulphate S	For samples > 10X the detection limit (DL), % RPD within +/-30%	All passed.
Pulp Duplicate (n=1) for Total S and Sulphate S	For samples > 10X the detection limit (DL), % RPD within +/-20%	All passed.
Standard Reference Material (n=1) for Total S and Sulphate S	Within specified tolerance ranges.	All passed.
	Modified NP	
Method Blank (n=1) for NP	<2X detection limit (DL)	All passed
NP consistent with paste pH (n=5)	Negative NP has paste pH <= 5	All passed.
Crush/field Duplicate (n=1) for NP and fizz	% RPD better than +/-15% for NP>20 kg/t, % RPD better than +/-20% for NP>10 kg/t, Difference within +/- 5kg/t for NP<10 kg/t. Fizz test rating is the same.	All passed.
Pulp Duplicate (n=1) for NP and fizz	% RPD better than +/-15% for NP>20 kg/t, % RPD better than +/-20% for NP>10 kg/t, Difference within +/- 5kg/t for NP<10 kg/t. Fizz test rating is the same.	All passed.
Fizz test rating with NP (n=5)	Max NP does not exceed fizz test rating	All passed.
Standard Reference Material (n=1)	Within specified tolerance ranges.	All passed
	Modified NP and TIC	
Comparison between Modified NP and TIC (n=5)	Check for trends/co-relation	TIC > NP
	Total S-Leco and S-ICP	
Comparison between Total S-Leco and S-ICP (n=5)	For samples >10X detection limit (DL), % RPD within +/-20%	Total S > S-ICP
	Trace Elements (Aqua Regia Digestion with ICP Finish)	
Method Blank (n=1)	<2X detection Limit (DL)	All passed.
Crush/field Duplicate (n=1)	For samples >10X detection limit (DL), % RPD within +/- 30%, For ICP metal scan, it is acceptable for 10% of parameters to be outside of this criterion.	All passed.
Pulp Duplicate (n=1)	For samples >10X detection limit (DL), % RPD within +/- 20%, For ICP metal scan, it is acceptable for 10% of parameters to be outside of this criterion.	All passed.
Standard Reference Material (n=2)	Within specified tolerance ranges.	All passed.
	Shake Flask Extraction	
Method Blank (n=1)	<5X Detection Limit	All passed.
Ion Balance (n=3)	EC>100uS/cm, % difference should be within +/-10%	Ion balance for sample SRK-PADT-03 was 14%; BV uses +/-15% criterion in their QA/QC procedures, and therefore the data is accepted.
Crush/field Duplicate (n=1)	For samples >10X detection limit (DL), % RPD within +/- 30%, For ICP metal scan, it is acceptable for 10% of parameters to be outside of this criterion. For pH, difference unit is +/-0.2	All passed.
Leachate Replicate (n=1)	For samples >10X detection limit (DL), % RPD within +/- 20%, For ICP metal scan, it is acceptable for 10% of parameters to be outside of this criterion. For pH, difference unit is +/-0.2	All passed.
SO_4-S vs S-ICP (n=3)	For samples > 10X the detection limit (DL), the % difference should be within +/-20%	All passed.

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2.5 Data Interpretation Methods

The ratio of TIC to acid generating potential (AP) provides a measure of the acid rock drainage (ARD) potential of the sample. On the basis of sulphide (calculated as the difference between total sulphur and sulphate) and total sulphur content being at near parity, total sulphur was used to calculate AP. Samples are classified as non-potentially ARD generating (non-PAG) when TIC/AP ratios are greater than 3, as PAG when TIC/AP ratios are less than 1, and as having an uncertain potential for ARD when TIC/AP ratios are between 1 and 3. For samples with Modified NP, interpretations of ratios of NP to AP were the same as TIC to AP.

3 Results and Discussion

3.1 Geological Inspection

Based on underground geological mapping by AEM, waste rock intersected by the Doris underground workings in 2021 was geologically described as 95% mafic volcanics with trace sulphide and 1 to 2% quartz-carbonate veining; 4% sericite altered mafic volcanics with up to 1% sulphide and 2 to 5% quartz-carbonate veining; and 1% diabase dyke with trace to 1% sulphide and trace quartz-carbonate veining.

SRK inspected accessible waste rock on the top of Pad T (Figure 1-1). The waste rock observed on Pad T was consistent with AEM inspections and was a mixture of approximately 90% chloritic green mafic metavolcanics (1a), 8% light tan colored sericite altered mafic metavolcanics (1as), <1% white quartz veins (12q), <1% dark gray diabase (11c), and <0.5% light brown felsic dyke (rock code undefined).

The mafic metavolcanics (1a; Figure 3-1) consisted of unoxidized dark gray mafic metavolcanics with no fizz on the groundmass, moderate to strong fizz on <1% carbonate veining and nil to 0.1% matrix fine grain disseminated pyrite. Sample SRK21-PadT-05 was comprised of mafic metavolcanics (1a; Figure 3-2) mixed with 10% sericite altered mafic metavolcanics (1as) and 10% white quartz veins (12q), with no fizz on the groundmass, moderate fizz on trace carbonate veinlets and 1% to 2% matrix disseminated and blebby pyrite associated with quartz.

The sericite altered mafic metavolcanics (1as; Figure 3-3) consisted of light tan brown altered mafic metavolcanics with strong pervasive sericite alteration, weak to moderate fizz on the groundmass, moderate fizz on minor carbonate veining and no visible sulphides. Diabase (11c; Figure 3-4) was dark gray, unoxidized, with no fizz and no visible sulphides.

Figure 3-1: SRK21-PadT-04; showing dark gray mafic metavolcanics (1a)

Figure 3-2: SRK21-PadT-05; showing mix of mafic metavolcanics (dark gray) (1a), sericite altered mafic metavolcanics (1as) (tan) and quartz vein with pyrite

Figure 3-3: SRK21-PadT-01; showing sericite altered mafic metavolcanics (1as) (tan)

Figure 3-4: SRK21-PadT-02; showing dark gray diabase (11c) with greenish black fines

3.2 Rinse Tests

Rinse tests on the sieved -2 mm fraction indicated pH and EC values ranging from 8.7 to 8.7 and 3,080 to 6,670 µS/cm, respectively (Table 3-1).

Table 3-1: Rinse Test Results, Pad T Waste Rock

Rock Type[1]	Sample ID	Rinse pH	Rinse EC
		s.u.	µS/cm
1a	SRK21-PADT-03	8.66	3,100
	SRK21-PADT-04	8.59	3,100
	SRK21-PADT-05	8.65	4,800
1as	SRK21-PADT-01	8.58	5,600
11c	SRK21-PADT-02	8.06	6,700

Source: C:\Users\asamu\Dropbox\Hope Bay_2022\2021 Memo\[HB_2021_SolidsGeochem_DorisWR_1CT022.056_als_Rev01.xlsx]
Note:
[1] 1a = mafic metavolcanic, 1as = altered mafic metavolcanics, 11c = diabase

3.3 ABA

A summary of ABA data are presented in Table 3-2 and Figure 3-5 to Figure 3-8. Complete results are presented in Attachment B.

Values of paste pH for all rock types ranged from 8.4 to 9.4.

Total sulphur for the mafic metavolcanics (1a) ranged from 0.20% to 1.4% with a median of 0.27%. The sample with 1.4% total sulphur contained 1% to 2% visible sulphides and was selected to characterize a high sulphur sample. By comparison, total sulphur content for the altered mafic metavolcanics (1as) sample was 0.21% and the diabase dyke (11c) sample was 0.33%. Sulphate content was at or near the analytical detection limit (0.01%) and ranged from 0.01% to 0.05%. Sulphide sulphur, calculated as the difference between total sulphur and sulphate, was at near parity with total sulphur (Figure 3-5).

For mafic metavolcanics, values of Modified NP ranged from 154 to 186 kg $CaCO_3$/t compared to 159 kg $CaCO_3$/t for the altered mafic metavolcanics and 161 kg $CaCO_3$/t for the diabase dyke. TIC ranged from 203 to 321 kg $CaCO_3$/t in the 1a samples compared to 319 kg $CaCO_3$/t in the 1as sample and 168 kg $CaCO_3$/t in the 11c sample. TIC content was uniformly greater than NP suggesting that TIC values overestimate the amount of carbonate available for buffering due to the presence of NP-neutral iron carbonate (Figure 3-6). All samples were classified as non-PAG on the basis of NP/AP and TIC/AP (Figure 3-7 and Figure 3-8).

Table 3-2: Summary of ABA Analyses for Pad T Waste Rock Samples

Rock Type[1]	Sample ID	Paste pH	Total S	SO_4	AP	TIC	Modified NP	TIC/AP	NP/AP
		s.u.	%	%	kg $CaCO_3$/t	kg $CaCO_3$/t	kg $CaCO_3$/t	-	-
1a	SRK21-PADT-03	8.3	0.20	0.05	6.3	200	170	32	27
	SRK21-PADT-04	8.6	0.27	0.04	8.4	270	150	32	18
	SRK21-PADT-05	8.2	1.4	0.01	44	320	190	7.2	4.2
1as	SRK21-PADT-01	8.4	0.21	0.01	6.6	320	160	49	24
11c	SRK21-PADT-02	7.7	0.33	0.03	10	170	160	16	16

Source: C:\Users\asamu\Dropbox\Hope Bay_2022\2021 Memo\[HB_2021_SolidsGeochem_DorisWR_1CT022.056_als_Rev01.xlsx]

Notes

[1] 1a = mafic metavolcanic, 1as = altered mafic metavolcanics; 11c = diabase

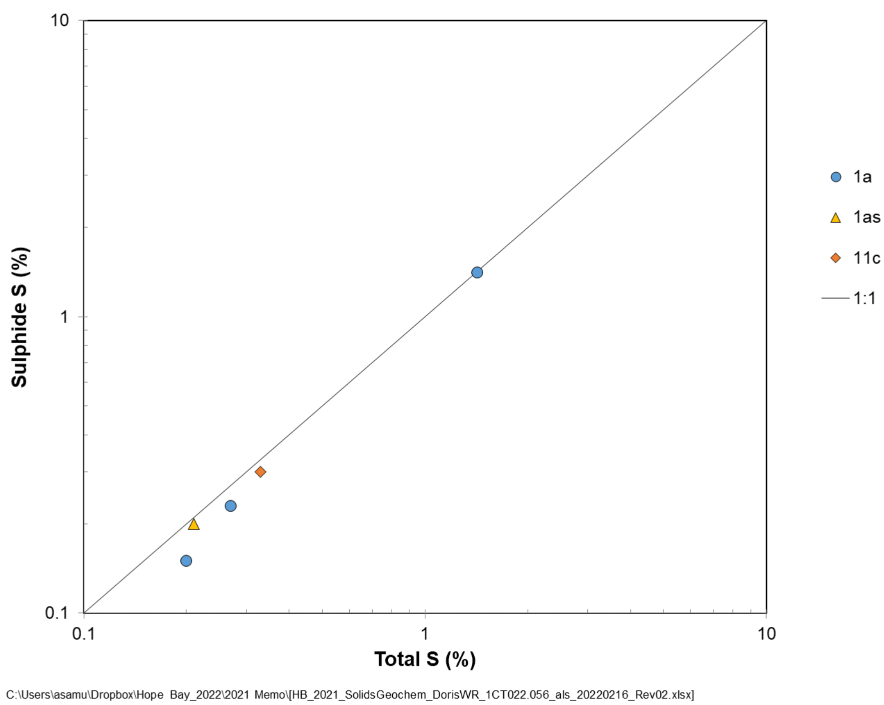

Figure 3-5: Comparison of Total Sulphur versus Sulphide, Pad T Waste Rock

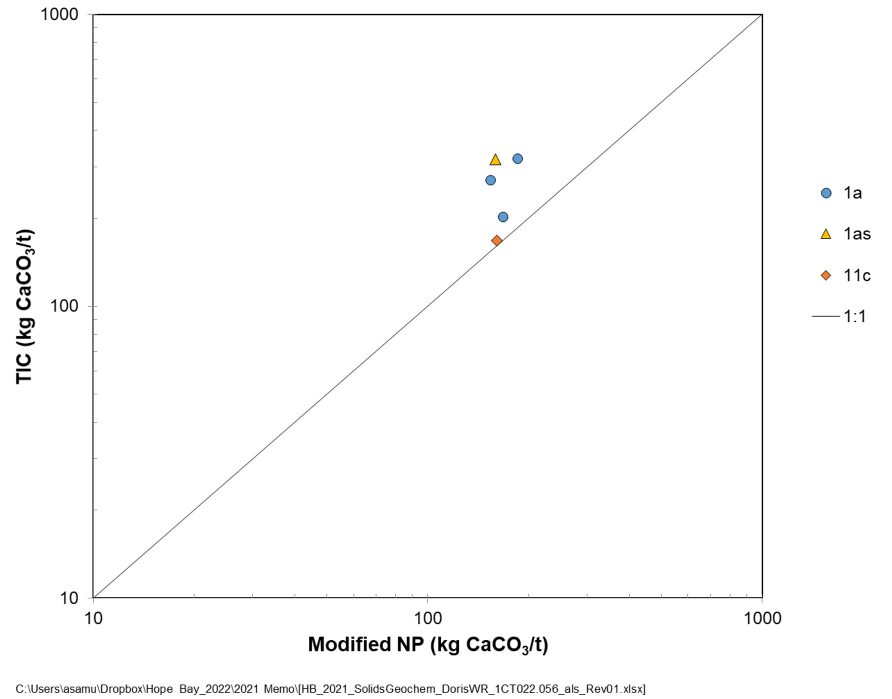

Figure 3-6: Comparison of Modified NP versus TIC, Pad T Waste Rock

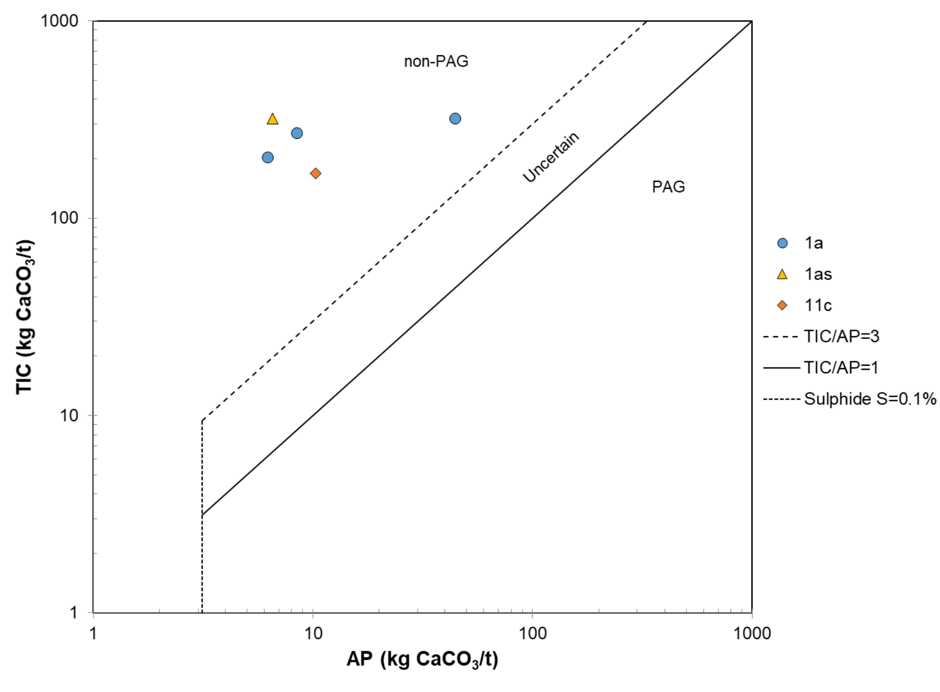

Figure 3-7: ARD Classifications by TIC/AP, Pad T Waste Rock

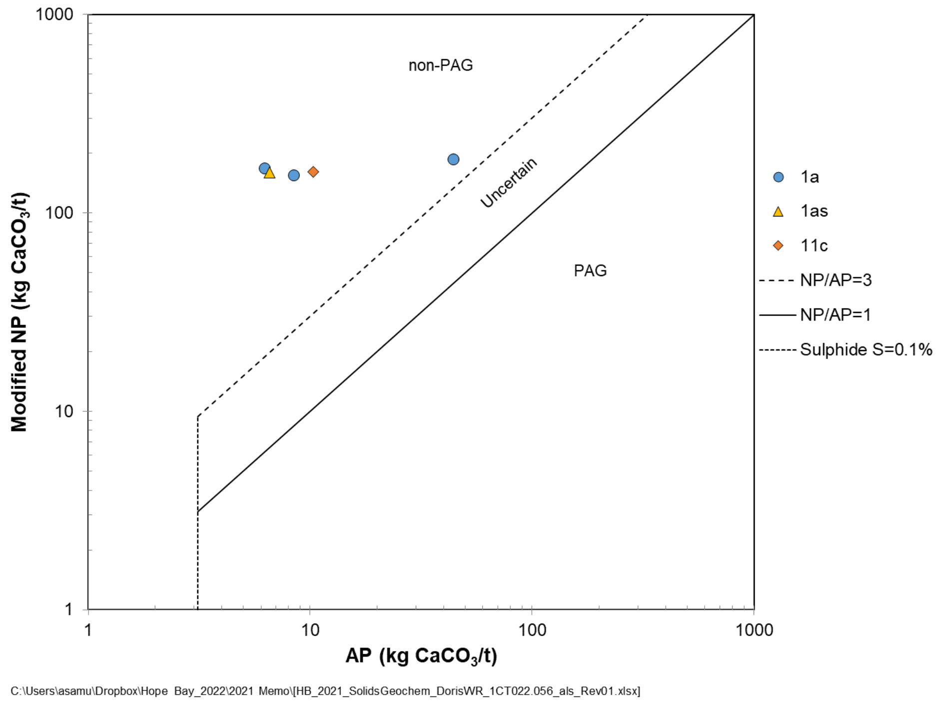

Figure 3-8: ARD Classifications by NP/AP, Pad T Waste Rock

3.4 Trace Elemental Analyses

The trace element content for the sample set is presented in Table 3-3 by rock type with complete laboratory results presented in Attachment C. Results were compared to ten times average crustal abundance (CA) for basalt (Price 1997) as an indicator of enrichment. Selenium could not be assessed because concentrations were below the detection limit or within the range of analytical error.

One sample of mafic metavolcanics (1a) was enriched in arsenic, sulphur and tungsten compared to the average CA of basalt. All other parameters were less than ten times the average crustal abundance for basalt indicating no appreciable enrichment.

Table 3-3: Summary of Elemental Analyses for Pad T Waste Rock

Parameter	Unit	Detection Limit	1a			1as	11c	10x Average Crustal Abundance*
			SRK21-PADT-03	SRK21-PADT-04	SRK21-PADT-05	SRK21-PADT-01	SRK21-PADT-02	
Ag	ppm	0.002	0.052	0.067	0.25	0.032	0.091	1.1
As	ppm	0.1	3.0	3.0	**74**	3.0	5.0	20
Ba	ppm	0.5	6.0	13	5.0	27	10	3300
Ca	%	0.01	5.6	5.8	6.3	5.1	5.9	76
Cd	ppm	0.01	0.11	0.09	0.16	0.10	0.15	2.2
Co	ppm	0.1	30	31	29	29	33	480
Cr	ppm	0.5	25	22	32	25	25	1700
Cu	ppm	0.01	33	63	63	42	45	870
Fe	%	0.01	9.3	8.8	8.3	8.2	9.9	87
Hg	ppm	0.005	*<0.005*	0.007	*<0.005*	*<0.005*	*<0.005*	0.09
Mg	%	0.01	1.6	1.6	1.5	1.4	1.5	46
Mn	ppm	1	2,200	2,200	2,150	1,750	2,000	15,000
Mo	ppm	0.01	0.50	0.50	0.50	0.60	0.40	15
Ni	ppm	0.1	2.6	4.1	8.0	3.8	2.2	1,300
P	%	0.001	0.083	0.089	0.089	0.112	0.089	1
Pb	ppm	0.01	3.1	2.3	3.5	4.5	9.9	60
S	%	0.02	0.19	0.16	**1.3**	0.16	0.29	0.3
Sb	ppm	0.02	0.03	*<0.02*	0.07	0.07	0.09	2
Sr	ppm	0.5	61	55	41	44	72	4,650
U	ppm	0.1	*<0.1*	*<0.1*	*<0.1*	*<0.1*	*<0.1*	10
V	ppm	2	63	34	12	11	68	2,500
W	ppm	0.1	*<0.1*	*<0.1*	**21**	0.1	*<0.1*	7
Zn	ppm	0.1	130	123	85	105	139	1,050

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Notes:

Values in italics represent values below the detection limit.

* Numbers bolded and underlined exceed 10 times the average crustal abundance for basaltic rocks from Price (1997)

[1] 1a = mafic metavolcanic, 1as = altered mafic metavolcanics; 11c = diabase

3.5 SFE Tests

A summary of results for key SFE parameters is presented in Table 3-4 and complete results are included in Attachment D.

All SFE tests had alkaline pH ranging from 7.8 to 8.9. Values of EC ranged from 529 to 1,048 µS/cm. Major cation chemistry was dominated by sodium (50 to 89 mg/L) and calcium (25 to 162 mg/L), while major anion chemistry was dominated by alkalinity (10 to 32 mg/L as $CaCO_3$), sulphate (19 to 25 mg/L), and chloride (79 to 394 mg/L). The source of chloride is drilling brines and possibly naturally saline groundwater that can is present in some mining zones. Concentrations of ammonia and nitrate ranged from 0.49 to 9.6 mg/L and 7.4 to 43 mg/L, respectively. The source of nitrate and ammonia are explosives residues. Trace element concentrations overall were low.

Table 3-4: Shake Flask Extraction Results, 2021 Pad T Waste Rock Samples

Sample ID	Unit	Detection Limit	1a	1as	11c
			SRK21-PadT-03	**SRK21-PadT-01**	**SRK21-PadT-02**
pH	pH Units	N/A	8.9	7.8	8.3
EC	uS/cm	1	529	726	1,048
Total Alkalinity	mg/L	0.5	32	13	10
SO_4	mg/L	0.5	19	35	25
Cl	mg/L	0.5	79	158	394
Ca	mg/L	0.05	28	25	162
Mg	mg/L	0.05	7.9	10	16
K	mg/L	0.05	5.9	6.2	4.1
Na	mg/L	0.05	60	89	50
NO_3	mg/L as N	0.02	43	17	7.4
NO_2	mg/L as N	0.005	*<0.05*	*<0.05*	*<0.05*
NH_3	mg/L as N	0.005	0.48	2.1	9.6
Al	mg/L	0.0005	0.10	0.11	0.11
Sb	mg/L	0.00002	0.00036	0.00020	0.00030
As	mg/L	0.00002	0.00056	0.00019	0.00015
Ba	mg/L	0.00002	0.004	0.011	0.014
B	mg/L	0.05	0.42	0.07	0.07
Cs	mg/L	0.00005	0.00067	0.00019	0.00031
Cd	mg/L	0.000005	*<0.000005*	*<0.000005*	*<0.000005*
Cr	mg/L	0.0001	0.00029	0.00012	0.00034
Co	mg/L	0.000005	0.00013	0.00012	0.00015
Cu	mg/L	0.00005	0.0020	0.00035	0.00029
Fe	mg/L	0.001	*<0.001*	0.0097	0.0034
La	mg/L	0.00005	*<0.00005*	*<0.00005*	*<0.00005*
Pb	mg/L	0.000005	*<0.000005*	*<0.000005*	0.0000054
Li	mg/L	0.0005	0.0027	0.0038	0.0035
Mn	mg/L	0.00005	0.037	0.024	0.21

Sample ID	Unit	Detection Limit	1a	1as	11c
			SRK21-PadT-03	SRK21-PadT-01	SRK21-PadT-02
Hg	mg/L	0.00005	*<0.00005*	*<0.00005*	*<0.00005*
Mo	mg/L	0.00005	0.0024	0.0009	0.0005
Ni	mg/L	0.00002	0.000055	0.000034	0.00020
Se	mg/L	0.00004	0.00018	0.00015	0.00019
Sr	mg/L	0.00005	0.092	0.10	0.32
S	mg/L	10	*<10*	11	*<10*
Tl	mg/L	0.000002	0.000013	0.000003	0.000018
U	mg/L	0.000002	0.0000062	0.0000021	0.0000029
V	mg/L	0.0002	*<0.0002*	*<0.0002*	*<0.0002*
Zn	mg/L	0.0001	*<0.0001*	*<0.0001*	0.00017

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Notes:

All element concentrations are given as dissolved; SFE tests do not represent natural waters.

Values in italics represent values below the detection limit.

3.6 Comparison to Previous Waste Rock Geochemical Characterization Results

This section compares data from the 2021 waste rock monitoring samples to previous sample sets. Specifically, waste rock samples are presented according to rock type and the following samples sets:

1. Waste rock characterized as part of the Type A water licence amendment application (SRK 2015);
2. Underground mine operational waste rock monitoring samples collected prior to 2021;
3. Doris Crown Pillar Recovery (CPR) operational waste rock monitoring samples (2018 to 2019); and
4. Underground mine operational waste rock monitoring samples collected in 2021.

Table 3-5 summarizes the differences in geological logging codes and sample types for the sample sets. The mafic metavolcanic waste rock samples that were geochemically characterized as part of the Type A Doris water licence amendment application (SRK 2015) were geologically logged as part of the exploration drilling program, at which time the lithology code 1as (altered mafic metavolcanics) was not used. Based on the geochemistry and spatial coverage of the ABA sample set, SRK assumes that altered mafic metavolcanics (1as) is represented in SRK (2015).

Figure 3-9 to Figure 3-11 compares by rock type the geochemical results from the 2021 waste rock monitoring program to the other sample sets presented in Table 3-5. The results are discussed in subsequent sections.

Table 3-5: Overview of Waste Rock Geochemical Sample Sets

Rock Type	Sample Set and Source[1]		Geology Code[2]	Geology Codes for Samples[3]	Comment
Mafic Metavolcanics	2021 Operational Monitoring	Pad T	1a,1ad	1a,1as	
	Pre-2021 Operational Monitoring	Pad T	1a, 1as	1a, 1as	
		ROM from Underground	1a, 1as	1a, 1as	
		ROM from CPR	1a	1a	
	Type A	Drill core	1	1, 1a, 1ay, 1p and 1u	Logging code 1as (altered basalt) is not documented in SRK (2015) because this code was not used during the exploration logging program. Based on the geochemistry and spatial coverage of the ABA sample set, SRK assumes that rock type 1as is represented in the sample set.
Diabase	2021 Operational Monitoring	Pad T	11c	11c	
	Pre-2021 Operational Monitoring	ROM from Underground	11c	11c	
	Type A	Drill core	11c	11c	
Quartz Vein	2019 Operational Monitoring	Pad T	12q	12q	
	Pre-2019 Operational Monitoring	ROM from Underground	12q	12q	
	Type A	Drill core	12q	12q, 12 (mixed)	

Notes:

[1]All operational monitoring samples are run-of-mine (ROM) waste rock samples; in 2019 waste rock from 2019 was sampled from the blasted pile underground and the Pad T stockpile

[2]For data interpretation and figures. For the Type A sample set, the sample set is as presented in SRK (2015).

[3] 1a = mafic metavolcanic, 1as = altered mafic metavolcanics; 12q = quartz vein

3.6.1 Mafic Metavolcanics (1a)

For mafic metavolcanics (1a), the median sulphur content for the 2021 waste rock samples (0.27%, n=3) was similar to the CPR sample set (0.22%) and slightly higher than the Type A sample set (0.15%) and underground waste rock samples collected prior to 2021 (0.13%). The 2021 waste rock sample set included a high sulphur sample (1.4%) with 1% to 2% visible sulphides that was sampled as an end-member but was within the overall range of sulphur content reported in the Type A and UG sample sets. The median NP (168 kg $CaCO_3$/t) and TIC (270 kg $CaCO_3$/t) values for the 2021 waste rock samples were roughly equivalent to the median NP and TIC values in the Type A (175 kg $CaCO_3$/t and 258 kg $CaCO_3$/t, respectively) and CPR (175 kg $CaCO_3$/t and 275 kg $CaCO_3$/t, respectively) sample sets, and higher than the sample set for UG operational samples collected prior to 2021 (132 kg $CaCO_3$/t and 151 kg $CaCO_3$/t).

All samples of mafic metavolcanic (1a) collected from Pad T in 2021 were classified as non-PAG on the basis of TIC/AP and NP/AP. This classification was consistent with the majority of the Type A and operational monitoring mafic metavolcanic (1a) samples (Figure 3-10 and Figure 3-11).

Solid-phase arsenic content can be elevated in waste rock (e.g. Section 3.4) and can be mobile at neutral pH, though seepage monitoring of Doris waste rock does not indicate neutral pH arsenic leaching. The maximum arsenic value (74 ppm, n=3) for the 2021 mafic metavolcanic (1a) operational samples was equivalent to the maximum arsenic content in the UG operational samples collected prior to 2021 (77 ppm) and CPR (74 ppm) sample sets, and similar to the 95th percentile (74 ppm) in the Type A sample set. The maximum arsenic value was associated with the high sulphur sample (SRK21-PADT-05) with visible sulphides. The arsenic content in the other two mafic metavolcanic (1a) samples (3 ppm) collected from Pad T in 2021 were comparable to the UG operational samples collected prior to 2021 (median=3 ppm) and Type A (median=10 ppm) waste rock sample sets.

3.6.2 Altered Mafic Metavolcanics (1as)

Total sulphur content for the 2021 altered mafic metavolcanic (1as) sample (0.21%) was roughly equivalent to median values of the operational waste rock samples (0.19%) and CPR samples (0.28%) and was within the 25th to 75th percentile sulphur content of the Type A sample set (0.11 to 0.31%).

TIC and NP content for the 2021 altered mafic metavolcanic sample (319 and 159 kg $CaCO_3$/t, respectively) were equivalent to the 75th percentile values for the previous sample sets (283 to 328 kg $CaCO_3$/t and 179 to 214 kg $CaCO_3$/t, respectively.

The non-PAG classification of the altered mafic metavolcanic (1as) sample was consistent with the Type A and operational monitoring samples of altered mafic metavolcanic (1as).

The one 2021 altered mafic metavolcanic (1as) sample reported an arsenic concentration (3.0 ppm) that was lower than previous samples of altered mafic metavolcanic (1as) operational monitoring samples (25th and 75th percentile levels of 6 and 32 ppm, respectively) and within the Type A range (25th and 75th percentile levels of 1.9 and 30 ppm, respectively).

The ABA characteristics and arsenic content for the 2021 altered mafic metavolcanic (1as) were represented by the Type A waste rock sample set.

3.6.3 Diabase (11c)

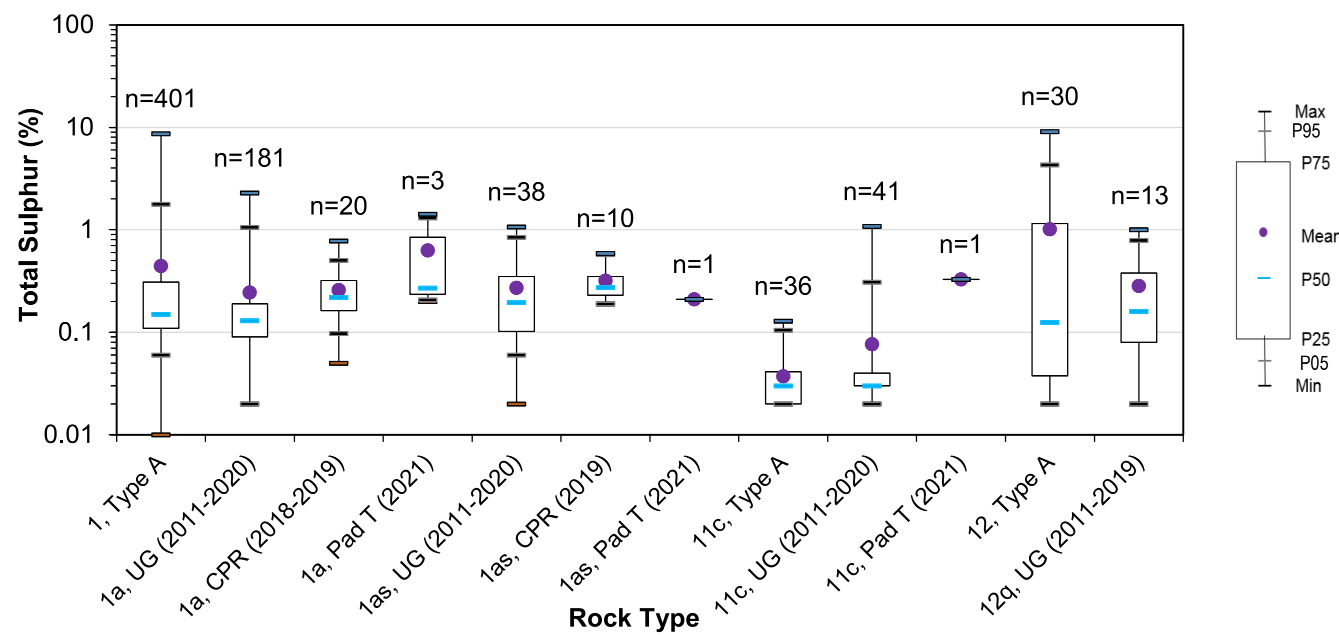
Total sulphur content for the 2021 diabase (11c) sample (0.33%) was roughly equivalent to the 95th percentile of the operational waste rock samples (0.31%) and was higher than the maximum value (0.13%) in the Type A sample set.

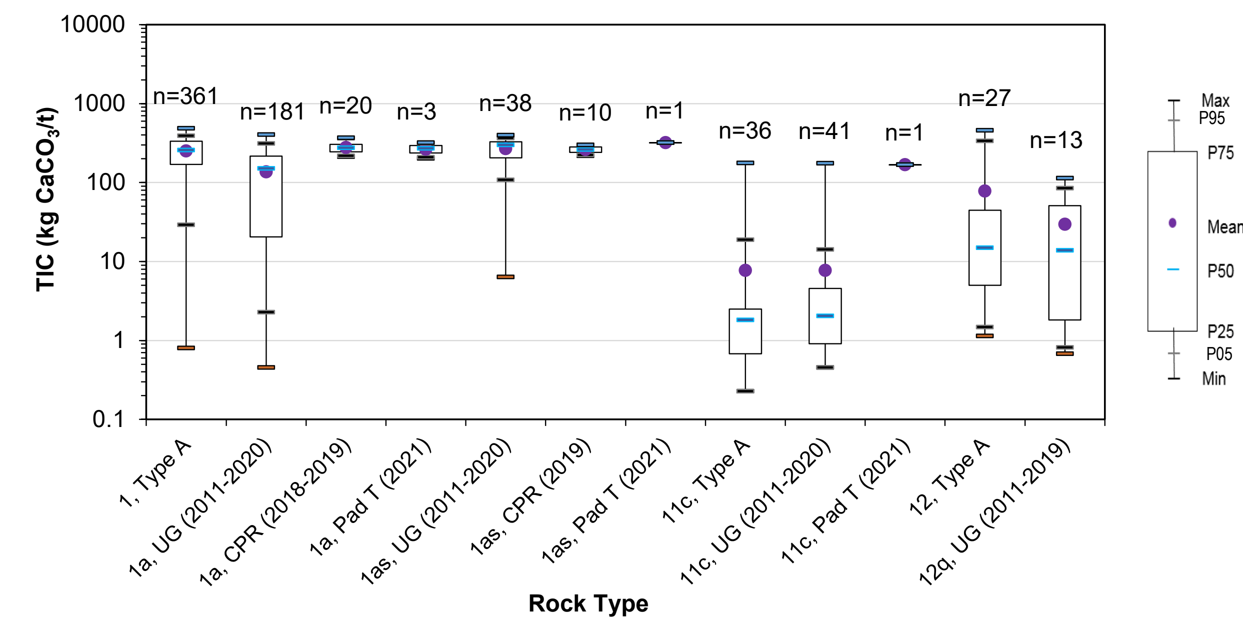
TIC content for the 2021 diabase sample (168 kg $CaCO_3$/t, respectively) was equivalent to the maximum values of the Type A sample set (177 kg $CaCO_3$/t) and the underground samples (175 kg $CaCO_3$/t). NP (161 kg $CaCO_3$/t) was also higher than the maximum values for the datasets (138 to 158 kg $CaCO_3$/t).

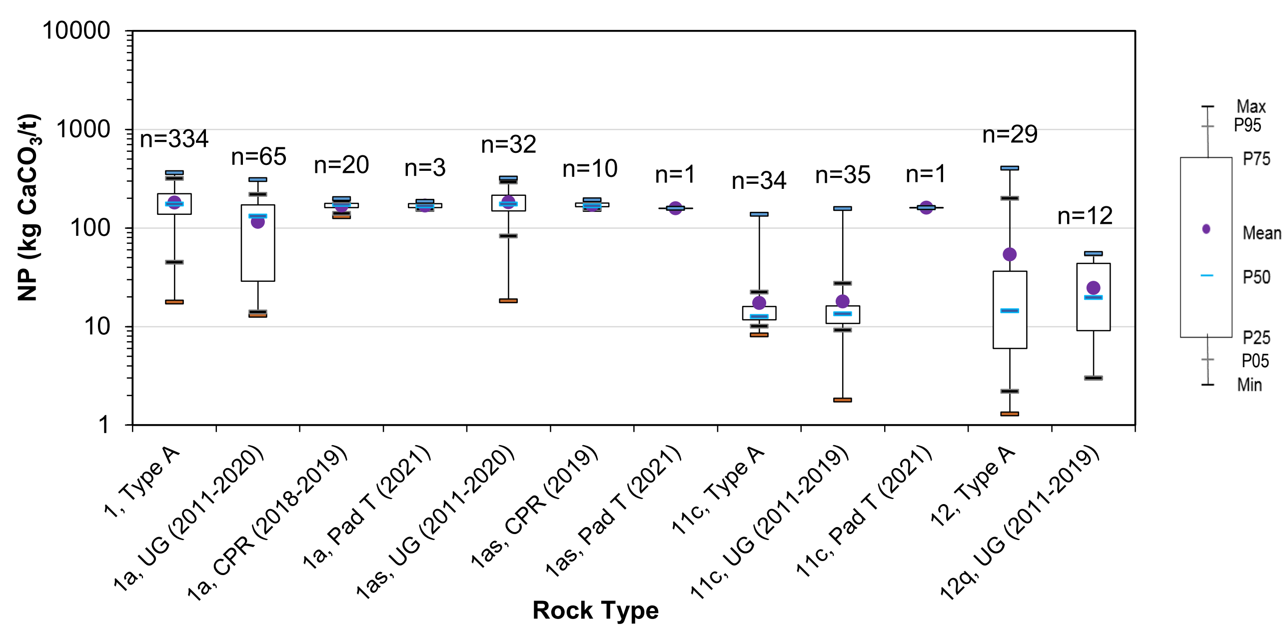
The non-PAG classification of the 2021 diabase (11c) sample was consistent with the majority of the Type A and operational monitoring of diabase (11c).

The one 2021 diabase (11c) sample reported an arsenic concentration (5 ppm) that was equivalent to the maximum value (7 ppm) in the underground operational sampling and the 95th percentile (10 ppm) in the Type A sample set

The ABA characteristics and arsenic content for the 2021 diabase (11c) sample was most represented by the underground operational monitoring waste rock sample set.







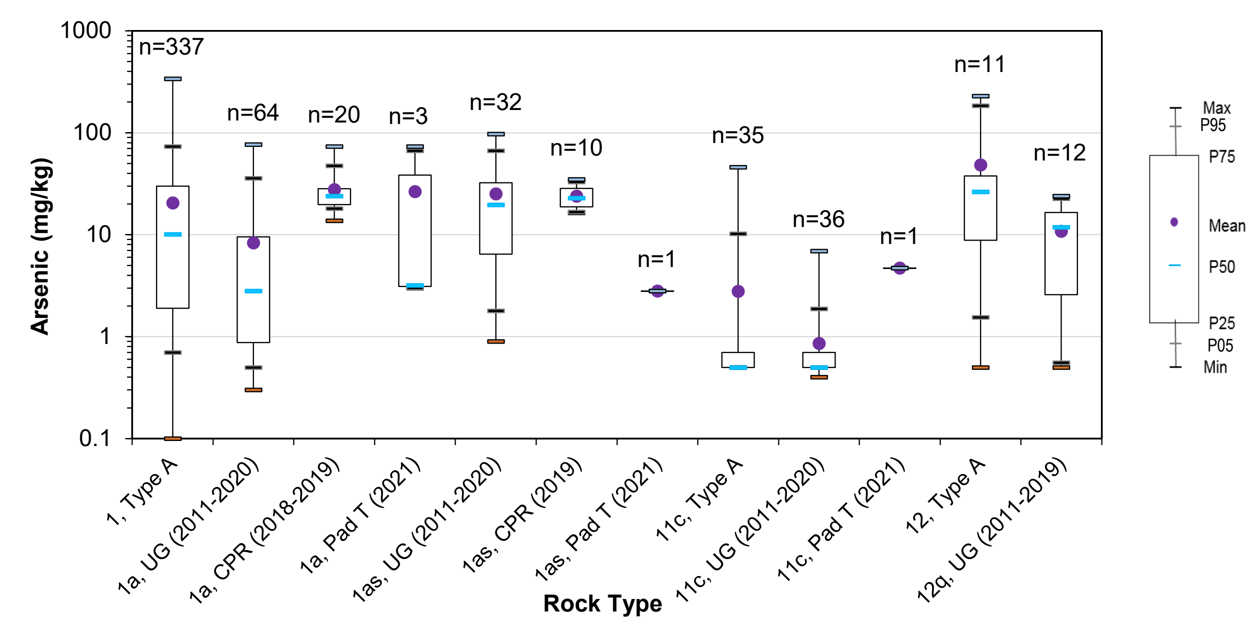


Figure 3-9: Box and Whisker Plots of S, TIC, NP and Arsenic – Comparison of 2021 Doris Waste Rock Monitoring Samples to Other Waste Rock Sample Sets

Notes: (These plots are conventional box and whisker graphs, with the upper and lower extremes showing the minimum and maximum values, tick marks outside of the box showing the 5th and 95th percentiles, outer margins of the box showing the 25th and 75th percentiles and central division in the box showing the median value)

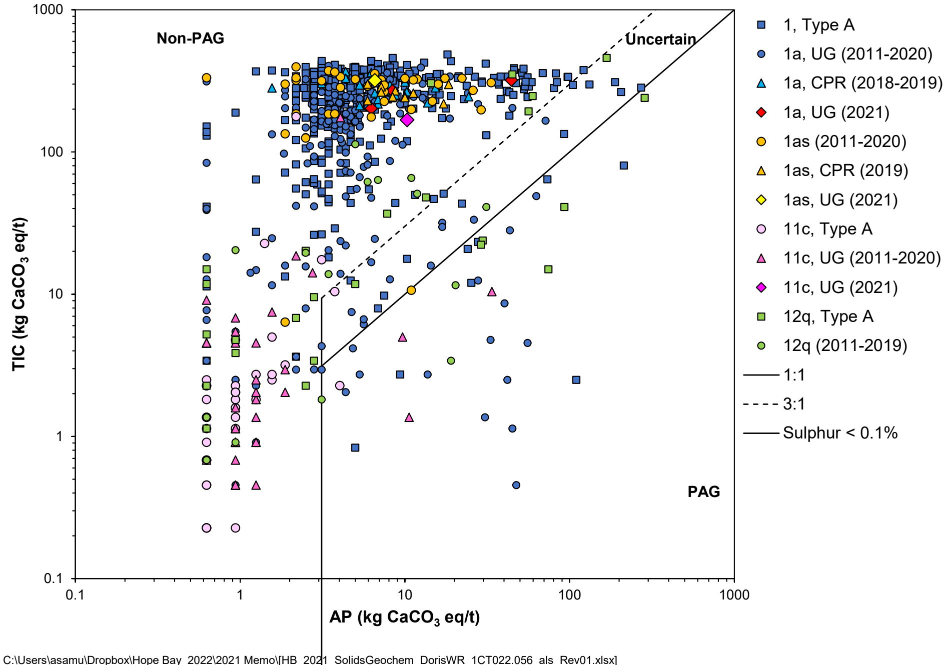


Figure 3-10: ARD Classifications by TIC/AP, Doris Waste Rock Samples

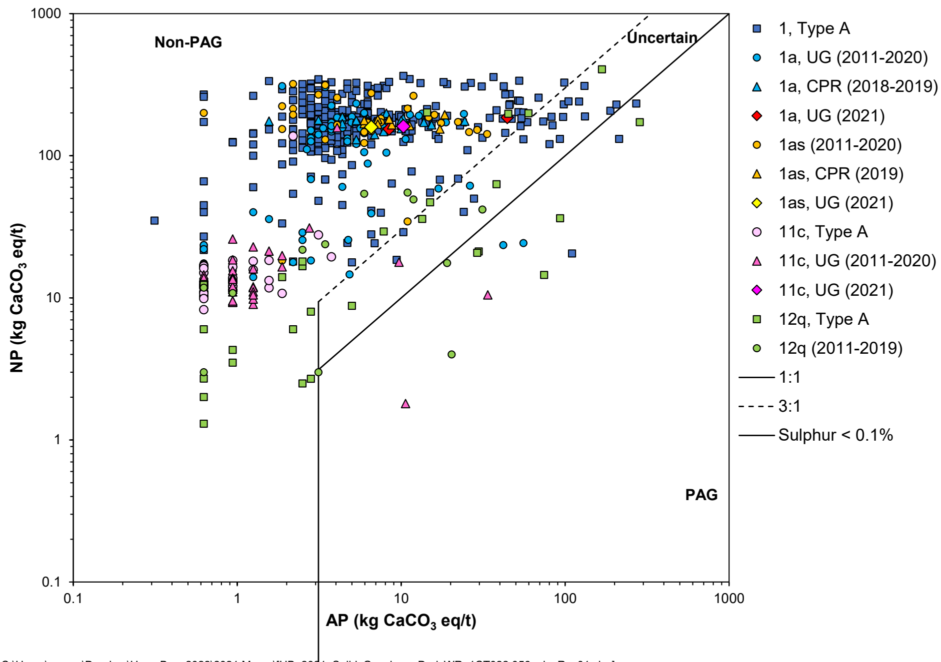


Figure 3-11: ARD Classifications by NP/AP, Doris Waste Rock Samples

4 Summary and Conclusions

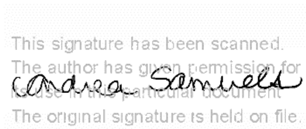
In 2021 a total of 213,926 t of waste rock was produced from mining activities in the Doris mine, of which 133,542 t was kept underground and used as backfill and 80,384 t was placed in the surface waste rock stockpile on Pad T. In addition, approximately 14,000 t of waste rock was removed from the surface waste rock stockpile on Pad T and placed as backfill in stopes of the Doris mine. Doris underground workings in 2021 was geologically described as 95% mafic volcanics with trace sulphide and 1-2% quartz-carbonate veining; 4% sericite altered mafic volcanics with 1% sulphide and 2-5% quartz-carbonate veining; and 1% diabase dyke with 1% sulphide and trace quartz-carbonate veining. The geological inspection conducted by SRK was consistent except for the minor volumes of light brown felsic dyke.

In accordance with the *Waste Rock, Ore and Mine Backfill Management Plan (*TMAC 2019), SRK collected five samples of waste rock from the surface stockpile on Pad T including three samples of mafic metavolcanics (1a), one sample of altered mafic metavolcanics (1as) and one sample of diabase dyke (11c). The results are summarized as follows:

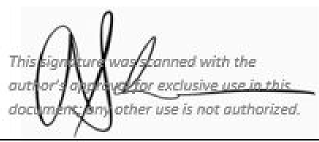
- For mafic metavolcanics samples (1a), total sulphur ranged from 0.20 to 1.42% with a median of 0.27%. The sample with the highest total sulphur had 1% to 2% visible sulphides and was sampled as an end-member representative of a minor proportion (<2%) of waste rock. TIC and Modified NP content was high ranging from 203 to 321 kg $CaCO_3$/t and 154 to 186 kg $CaCO_3$/t, respectively. All samples were classified as non-PAG on the basis of TIC/AP and NP/AP.
- The one sample of altered mafic metavolcanics samples (1as) had a total sulphur content of 0.21%. TIC and Modified NP content was 319 and 159 kg $CaCO_3$/t, respectively. The sample was classified as non-PAG on the basis of TIC/AP and NP/AP.
- The one sample of diabase dyke (11c) had a total sulphur content of 0.33%. TIC and Modified NP content was 168 and 161 kg $CaCO_3$/t, respectively. The sample was classified as non-PAG on the basis of TIC/AP and NP/AP.
- Trace element content was below the screening criteria for all samples except for arsenic, sulphur, and tungsten in the mafic metavolcanics (1a) sample containing 1.4% sulphur. Total metal concentrations for all other samples were less than ten times the average crustal abundance for basalt indicating no appreciable enrichment.
- SFE tests on a sample each of mafic metavolcanics (1a), altered mafic metavolcanics (1as), and diabase (11c) had alkaline pH (7.8 to 8.9). Nitrate concentrations and chloride values ranged from 7.3 to 43 mg/L and 79 to 394 mg/L, respectively and are indicative of blasting and drilling brine residuals present on waste rock surfaces, and possibly naturally saline groundwater that is present in areas of the mine. Two mafic volcanic (1a) waste rock samples collected from Pad T in 2021 were similar to the Type A, UG monitoring and CPR sample sets; one mafic volcanic sample was sampled as an end-member and biased high in sulphur. The sample of altered mafic metavolcanic (1as) collected in 2021 was similar to the previous UG monitoring and CPR sample sets. The diabase (11c) sample collected from Pad T in 2021 was on the upper end of the range of geochemical characteristics (sulphur, arsenic) seen in the Type A and UG waste rock sample sets.

The geological and geochemical inventory of waste rock on Pad T precludes a long-term assessment of the anticipated geochemical behaviour of the waste rock on Pad T with respect to metal leaching and acid rock drainage (ML/ARD). The geochemical behaviour of the waste rock is monitored through the annual seep survey along the downgradient toe of the waste rock and ore stockpile area and routine monitoring of the Pollution Control Pond (PCP). The results of the seepage survey are reported in the accompanying memo (SRK 2022), while results of the routine monitoring program are included in monthly water quality reports prepared by AEM and submitted to the Nunavut Water Board.

Regards,
SRK Consulting (Canada) Inc.

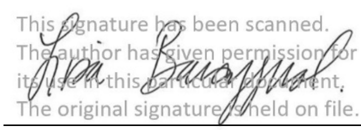


Andrea Samuels, PGeo (BC)
Senior Consultant (Associate Geochemist)



Amanda Schevers, GIT (BC)
Staff Consultant (Geochemistry)

Reviewed by



Lisa Barazzuol, PGeo (NT/NU)
Principal Consultant (Geochemistry)

Attachments:

Attachment A	Pad T Geological Descriptions
Attachment B	Pad T Laboratory Results – Full ABA
Attachment C	Pad T Laboratory Results – Multi-Element Analysis
Attachment D	Pad T Laboratory Results – SFE

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# Attachment A	Pad T Geological Descriptions

Sample ID	Sample Location	Rock Type	Easting	Northing	Sulphide1	Sulph1 %	Sulph1 Texture	Fizz Test (Groundmass)	Fizz Test on Carbonate / Quartz Veins	Carbonate Colour	Carbonate Occurrence	Weathering Intensity	Alteration1	Alteration1 Intensity	Alteration1 Texture	Color of -2mm Fraction	Rock Types	Lith Texture/ Fabric	Geological Description
SRK21-PadT-01	Pad T	1as	433346	7559307				Weak	Moderate	White	Vein	None	Sericite	Stong	Pervasive	Light brown/tan	1as > 9n/p	Equigranular-Foliated	Fine grained light brown/tan sericite altered mafic volcanics, no visible sulphides, weak fizz with moderate to weak fizz on fines, minor carbonate veining with moderate fizz, some felsic/intermediate dyke (9n?) mixed in
SRK21-PadT-02	Pad T	11c	433342	7559262				None	None							Dark greenish black	11c	Equigranular	Fine grained, very dark gray diabase with greenish black fines, slighlty magnetic, no visible sulphides, no alteration or weathering
SRK21-PadT-03	Pad T	1a	433338	7559231	Pyrite	0.1%	Matrix disseminated	None	Moderate	White	Vein	None				Dark gray	1a	Equigranular	Fine grained, dark gray mafic volcanics (1a) with some qtz-carbonate veining with moderate fizz, <0.1% disseminated pyrite, material covered in mud, large scale observations difficult
SRK21-PadT-03-DUP	Pad T	1a	433338	7559231	Pyrite	0.1%	Matrix disseminated	None	Moderate	White	Vein	None				Dark gray	1a	Equigranular	Duplicate of SRK21-PadT-03
SRK21-PadT-04	Pad T	1a	433394	7559304				None	Moderate to Strong	White	Vein		Chlorite	Weak	Pervasive	Dark gray	1a	Equigranular-Foliated	Fine grained, dark gray mafic volcanics (1a) with <1% carbonate veining with moderate to strong fizz, minor chlorite alteration, no visible sulphides
SRK21-PadT-05	Pad T	1a	433210	7559270	Pyrite	1 to 2%	Matrix disseminated & blebby	None	Moderate	White	Vein	None				Gray	1a > 1as	Equigranular-Foliated	From Lower area of Pad T (Low Grade Ore Stockpile) - Fine grained, equigranular to foliated dark gray mafic volcanics (1a) with 10% quartz and 10% sericite altered 1as, 1-2% disseminated pyrite associated with pyrite, no obseravable fizz on matrix, moderate fizz on trace carbonate veinlets

Attachment B Pad T Laboratory Results – Full ABA

Sample ID	Rock Type	Paste pH	Fizz Rating	S(T)	S(SO_4)	S(S-2)	AP from S(T)	AP - from S(S-2)	CO_2	TIC	Mod NP	TIC/AP_S(T)	NP/AP_S(T)	TIC/AP_S(S-2)	NP/AP_S(S-2)
		pH Units	-	wt%	wt%	wt%	kg $CaCO_3$/t	kg $CaCO_3$/t	wt%	kg $CaCO_3$/t	kg $CaCO_3$/t	-	-	-	-
		#N/A	#N/A	0.02	0.01	Calc.	0.6		0.06	1.8	0.1	#N/A	#N/A	#N/A	#N/A
SRK21-PADT-01	1as	8.4	MODERATE	0.21	0.01	0.20	6.6	6.3	14	319	159	49	24	51	25
SRK21-PADT-02	11c	7.7	STRONG	0.33	0.03	0.30	10	9.4	7.4	168	161	16	16	18	17
SRK21-PADT-03	1a	8.3	STRONG	0.2	0.05	0.15	6.3	4.7	8.9	203	168	32	27	43	36
SRK21-PADT-03 DUP	1a	8.3	STRONG	0.23	0.02	0.21	7.2	6.6	7.9	179	163	25	23	27	25
SRK21-PADT-04	1a	8.6	MODERATE	0.27	0.04	0.23	8.4	7.2	12	270	154	32	18	37	21
SRK21-PADT-05	1a	8.2	MODERATE	1.42	0.01	1.41	44	44	14	321	186	7.2	4.2	7.3	4.2

Attachment C Pad T Laboratory Results – Multi-Element Analysis

Sample ID	Rock Type	Ag	Al	As	Au	B	Ba	Bi	Bi	Ca	Cd	Co	Cr	Cu	Fe	Ga	Hg	K	La	Mg
		ppb	%	ppm	ppb	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	%
		2	0.01	0.1	0.2	20	0.5	0.02	0.02	0.01	0.01	0.1	0.5	0.01	0.01	0.1	0.005	0.01	0.5	0.01
SRK21-PADT-01	1as	32	0.33	3	6.4	<20	27	<0.02	<0.02	5.1	0.10	29	25	42	8.2	1.2	<0.005	0.04	4.9	1.4
SRK21-PADT-02	11c	91	3.3	5	215	<20	10	<0.02	<0.02	5.9	0.15	33	25	45	9.9	15	<0.005	0.03	2.5	1.5
SRK21-PADT-03	1a	52	2.8	3	22	<20	6	<0.02	<0.02	5.6	0.11	30	25	33	9.3	13	<0.005	0.03	3.1	1.6
SRK21-PADT-03 DUP	1a	40	2.9	3	4.2	<20	9	<0.02	<0.02	5.5	0.09	30	23	37	9.2	14	<0.005	0.03	3.5	1.6
SRK21-PADT-04	1a	67	1.6	3	10	<20	13	<0.02	<0.02	5.8	0.09	31	22	63	8.8	7.4	0.007	0.07	2.9	1.6
SRK21-PADT-05	1a	248	0.34	74	796	<20	5	0.04	0.04	6.3	0.16	29	32	63	8.3	1.2	<0.005	0.04	1.2	1.5

Sample ID	Rock Type	Mn	Mo	Na	Ni	P	Pb	S	Sb	Sc	Se	Sr	Te	Th	Ti	Tl	U	V	W	Zn
		ppm	ppm	%	ppm	%	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
		1	0.01	0.001	0.1	0.001	0.01	0.02	0.02	0.1	0.1	0.5	0.02	0.1	0.001	0.02	0.1	2	0.1	0.1
SRK21-PADT-01	1as	1750	0.6	0.082	3.8	0.112	4.5	0.16	0.07	10	0.3	44	<0.02	0.7	0.002	<0.02	<0.1	11	0.1	105
SRK21-PADT-02	11c	2000	0.4	0.023	2.2	0.089	9.9	0.29	0.09	21	0.3	72	<0.02	0.4	0.015	<0.02	<0.1	68	<0.1	139
SRK21-PADT-03	1a	2200	0.5	0.020	2.6	0.083	3.1	0.19	0.03	21	0.4	61	<0.02	0.4	0.009	<0.02	<0.1	63	<0.1	130
SRK21-PADT-03 DUP	1a	2080	0.4	0.024	2.5	0.086	5.1	0.17	0.04	20	0.3	59	<0.02	0.4	0.009	<0.02	<0.1	63	<0.1	138
SRK21-PADT-04	1a	2200	0.5	0.031	4.1	0.089	2.3	0.16	<0.02	14	0.3	55	<0.02	0.4	0.006	<0.02	<0.1	34	<0.1	123
SRK21-PADT-05	1a	2150	0.5	0.077	8.0	0.089	3.5	1.31	0.07	12	0.6	41	0.07	0.3	0.001	<0.02	<0.1	12	21	85

Attachment D Pad T Laboratory Results – SFE

Parameter	Units	LOD	SRK21-PadT-01	SRK21-PadT-02	SRK21-PadT-03	SRK21-PadT-03-DUP
			1as	11c	1a	1a
pH	pH Units	N/A	7.8	8.3	8.9	9.0
EC	uS/cm	1	726	1048	529	537
SO4	mg/L	0.5	35	25	19	14
Acidity to pH4.5	mg/L	0.5	<0.5	<0.5	<0.5	<0.5
Acidity to pH8.3	mg/L	0.5	1.8	5.2	2.4	<0.5
Total Alkalinity	mg/L	0.5	13	10	32	31
Bicarbonate	mg/L	0.5	16	13	39	38
Carbonate	mg/L	0.5	<0.5	<0.5	<0.5	<0.5
Hydroxide	mg/L	0.5	<0.5	<0.5	<0.5	<0.5
Dissolved Chloride	mg/L	0.5	158	394	79.2	66.8
Total Ammonia (N)	mg/L	0.005	0.48	2.1	9.6	9.3
Nitrate-N	mg/L	0.02	17	7.4	43	35
Nitrite-N	mg/L	0.005	<0.05	<0.05	<0.05	<0.05
Total Dissolved Solids	mg/L	10	420	920	330	350
Hardness CaCO3	mg/L	0.5	104	469	103	89
Dissolved Aluminum (Al)	mg/L	0.0005	0.11	0.11	0.10	0.18
Dissolved Antimony (Sb)	mg/L	0.00002	0.00020	0.00030	0.00036	0.00039
Dissolved Arsenic (As)	mg/L	0.00002	0.00019	0.00015	0.00056	0.00042
Dissolved Barium (Ba)	mg/L	0.00002	0.011	0.014	0.004	0.004
Dissolved Beryllium (Be)	mg/L	0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Dissolved Bismuth (Bi)	mg/L	0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Dissolved Boron (B)	mg/L	0.05	0.07	0.07	0.42	0.34
Dissolved Cesium (Cs)	mg/L	0.00005	0.00019	0.00031	0.00067	0.00058
Dissolved Cadmium (Cd)	mg/L	0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Dissolved Calcium (Ca)	mg/L	0.05	25	162	28	24
Dissolved Chromium (Cr)	mg/L	0.0001	0.00012	0.00034	0.00029	0.00027
Dissolved Cobalt (Co)	mg/L	0.000005	0.00012	0.00015	0.00013	0.00010
Dissolved Copper (Cu)	mg/L	0.00005	0.00035	0.00029	0.00197	0.00089
Dissolved Lanthanum (La)	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Dissolved Iron (Fe)	mg/L	0.001	0.0097	0.0034	<0.001	0.0016
Dissolved Lead (Pb)	mg/L	0.000005	<0.000005	0.0000054	<0.000005	<0.000005
Dissolved Lithium (Li)	mg/L	0.0005	0.0038	0.0035	0.0027	0.0019
Dissolved Magnesium (Mg)	mg/L	0.05	10	16	7.9	6.8
Dissolved Manganese (Mn)	mg/L	0.00005	0.024	0.208	0.037	0.023
Dissolved Phosphorus (P)	mg/L	0.002	0.0055	0.0037	0.0049	0.0049
Dissolved Molybdenum (Mo)	mg/L	0.00005	0.0009	0.0005	0.0024	0.0019
Dissolved Nickel (Ni)	mg/L	0.00002	0.000034	0.00020	0.000055	0.000044
Dissolved Potassium (K)	mg/L	0.05	6.2	4.1	5.9	4.6
Dissolved Rubidium (Rb)	mg/L	0.00005	0.0062	0.0074	0.0118	0.0099
Dissolved Selenium (Se)	mg/L	0.00004	0.00015	0.00019	0.00018	0.00019
Dissolved Silicon (Si)	mg/L	0.1	0.31	0.29	0.38	0.55
Dissolved Silver (Ag)	mg/L	0.000005	<0.000005	0.0000057	<0.000005	<0.000005
Dissolved Sodium (Na)	mg/L	0.05	89	50	60	49
Dissolved Strontium (Sr)	mg/L	0.00005	0.10	0.32	0.092	0.083
Dissolved Sulphur (S)	mg/L	10	11	<10	<10	<10
Dissolved Tellurium (Te)	mg/L	0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Dissolved Thallium (Tl)	mg/L	0.000002	0.000003	0.000018	0.000013	0.000010
Dissolved Thorium (Th)	mg/L	0.000005	0.0000067	<0.000005	<0.000005	<0.000005
Dissolved Tin (Sn)	mg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Dissolved Titanium (Ti)	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Dissolved Tungsten (W)	mg/L	0.00001	0.00025	0.00034	0.00077	0.00060
Dissolved Uranium (U)	mg/L	0.000002	0.0000021	0.0000029	0.0000062	0.0000026
Dissolved Vanadium (V)	mg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Dissolved Zinc (Zn)	mg/L	0.0001	<0.0001	0.00017	<0.0001	<0.0001
Dissolved Zirconium (Zr)	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Dissolved Mercury (Hg)	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005

Appendix B 2021 Geochemical Monitoring of Waste Rock, Madrid North Mine

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SRK Consulting (Canada) Inc.
1066 West Hastings Street, Suite 2200
Vancouver, BC V6E 3X2
Canada

+1 604 681 4196 office
+1 604 687 5532 fax

vancouver@srk.com
www.srk.com

FINAL

Technical Memo

March 18, 2022

To	Nancy Duquet Harvey, Agnico Eagle Mines Ltd.
From	Amanda Schevers, Lisa Barazzuol, SRK
Cc	Ashley Mathai, Agnico Eagle Mines Ltd.
Subject	2021 Monitoring of Waste Rock, Madrid North Mine
Client	Agnico Eagle Mines Ltd.
Project	1CT022.073

1 Introduction

In 2021, Agnico Eagles Mines (AEM) assumed ownership of the Hope Bay project. In 2019, mining was initiated at Madrid North with the development of the Naartok East Crown Pillar Recovery (NE CPR) in July 2019 and then the decline for the underground mine in December 2019. Mining at Madrid North was halted at the end of March 2020 due to the Covid-19 global pandemic. In 2021, mining including development of the underground decline between January and February. During this period 3,682 t of underground waste rock was produced and placed as backfilled in the NE CPR.

Waste rock monitoring at Madrid North is outlined in Licence 2AM-DOH1335 Amendment No. 2 (NWB 2018), *Waste Rock, Ore and Mine Backfill Management Plan* (TMAC 2019), and *Classification of Waste Rock in Support of Segregating Construction Rock from Naartok East Crown Pillar Recovery, Madrid North, Hope Bay* (SRK 2019). SRK (2019) includes a field classification method and geochemical criteria to classify NE CPR waste rock samples that have a low risk of ML/ARD (non-PAG and with low potential for neutral pH arsenic leaching) and are therefore suitable for construction. SRK (2019) also includes recommendations for operational implementation of the geochemical characterization program. The implementation of SRK (2019), including the sampling program, classification and segregation of run-of-mine waste rock was designed by TMAC as documented in SRK (2020).

This memo documents the geochemical monitoring of Madrid North waste rock in 2021, which included geological inspections of underground waste rock during development of the decline and geochemical monitoring of underground waste rock placed as backfill along the western side of the NE CPR.

Other geochemical monitoring activities in 2021 associated with Madrid North waste rock include an annual seep survey along the downgradient toe of the waste rock pad and routine monitoring of the Madrid North contact water pond (CWP). Results of the routine monitoring program of the CWP are included in monthly water quality reports prepared by AEM and submitted to the NWB.

2 Methods

2.1 Geological Inspection

2.1.1 Underground

AEM site geologists inspect and document the fronts and back of the blast face and maintain internal records of these inspections. Protocols for geological inspections are documented in TMAC (2019).

2.1.2 Waste Rock as Backfill

In August 2021, SRK geochemist Amanda Schevers, GIT (BC) completed a geological inspection of waste rock removed from the underground decline in 2021 and placed as backfill along the western edge of the NE CPR, as denoted by AEM. AEM also indicated construction rock excavated from the Portal Pad was also placed in the same area as the underground waste rock. Construction rock excavated from the Madrid North Portal Pad was waste rock sourced from the NE CPR that was geologically logged as mafic metavolcanics with sediments (1aj/1oj) and sedimentary units (5, SRK 2021b). Consequently, SRK inspected approximately 90% of the stockpile and did not inspect the area adjacent to the pit that was not safe to access.

The objective of the inspection was to document the geological composition of waste rock, to examine for signs of sulphide oxidation and weathering and to collect samples for geochemical characterization of waste rock for comparison with baseline geochemical characterization (TMAC 2019). The inspection was carried out by walking over and around the extent of the stockpile and logging the rock types and geochemical characteristics (i.e. sulphide and carbonate content) of the waste rock.

2.2 Sample Collection and Geochemical Test Work Program

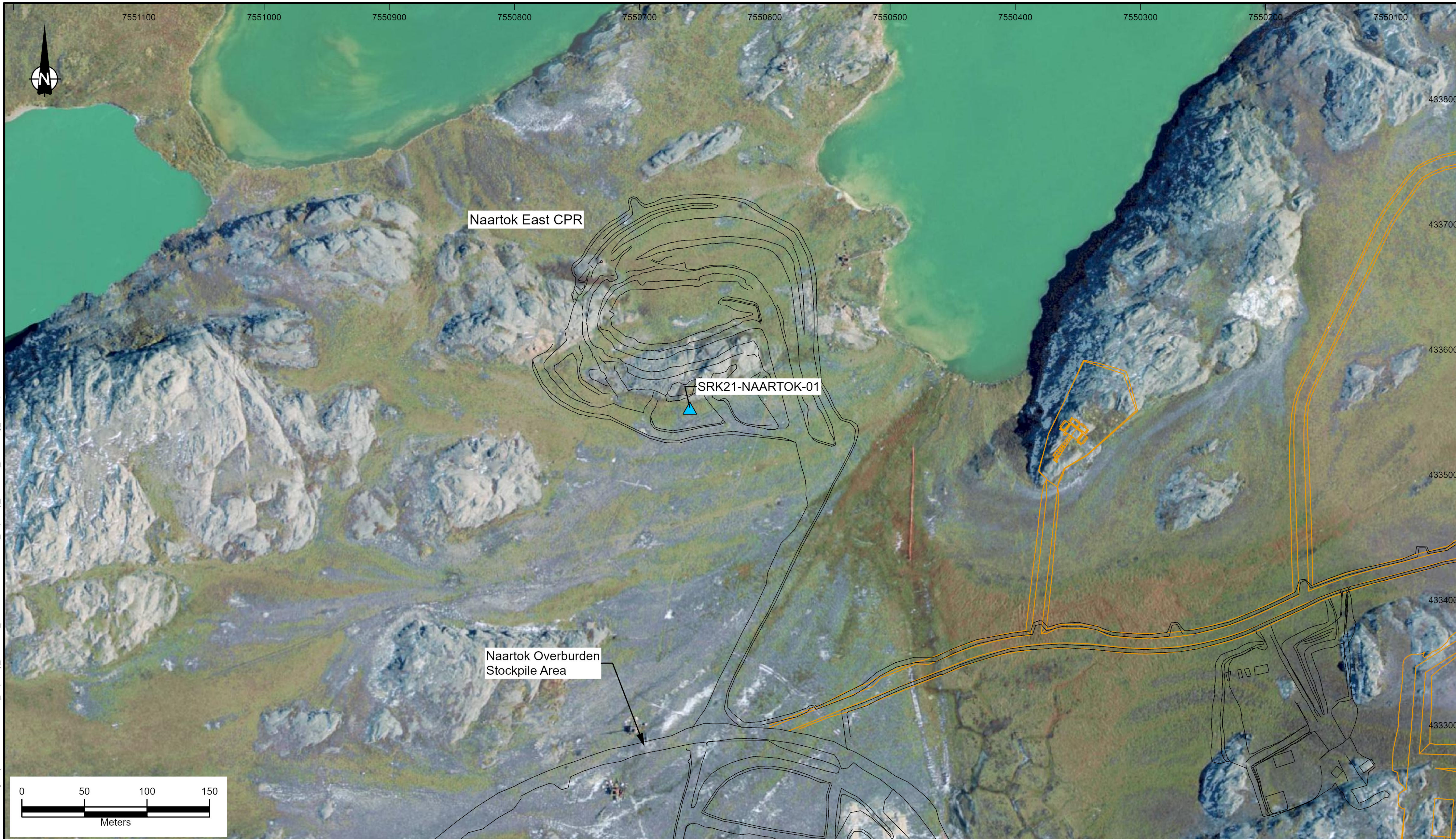
2.2.1 Underground

The geochemical sampling and testing frequency of the underground waste rock is a minimum of one sample per 20,000 tonnes of rock. AEM did not collect a sample during development of the underground because less than 20,000 t of waste rock was produced.

2.2.2 Waste Rock as Backfill

As per the Waste Rock, Ore and Mine Backfill Management Plan (TMAC 2019), SRK collected one sample of waste rock from the surface stockpile placed in the NE CPR. Sample selection was based on the range of rock types identified during the geological inspection.

SRK collected one sample that included the sieved coarse fraction (screened to -1 cm) and a finer fraction (screened to -2 mm) for rinse tests. SRK visually described the samples for rock type, sulphide content (quantity, type, and occurrence), and carbonates (fizz test with 10% HCl, type, and occurrence). Rinse tests involved mixing a one-to-one ratio of distilled water and solids and measuring the resulting pH and electrical conductivity (EC).



Legend

- 2021 Waste Rock Sample
- Existing As-Built Infrastructure
- Design Infrastructure (not constructed)

srk consulting

SRK JOB NO.: CAPR000606-007076

LAYOUT: Geochemical Monitoring

AGNICO EAGLE

Naartok East CPR

Hope Bay Gold Project

Geochemical Monitoring of Waste Rock at Naartok East CPR

DATE:	APPROVED:	FIGURE:
March 2022	AJS	01

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2.3 Analytical Methods

One sample was shipped to Bureau Veritas (BV) in Burnaby, BC by SRK for the following analysis (on the coarse -1 cm fraction):

- Total sulphur by Leco;
- Sulphate by HCl leach;
- TIC by Leco furnace to directly measure CO_2 gas evolved from HCl treatment of the sample;
- Modified Sobek NP (MEND 1991); and
- Elemental analysis by aqua regia digestion followed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) determination of 9 major elements (e.g., aluminum, calcium, magnesium, sodium, potassium, iron, sulphur) and 28 trace elements (e.g., arsenic, zinc, copper, cadmium, lead).

2.4 Data Interpretation

The ratio of TIC to acid potential (AP) provides a measure of the acid rock drainage (ARD) potential of the sample. On the basis of sulphide (calculated as the difference between total sulphur and sulphate) and total sulphur content being at near parity, total sulphur was used to calculate AP. Samples are classified as non-potentially ARD generating (non-PAG) when TIC/AP ratios are greater than 3, as PAG when TIC/AP ratios are less than 1 and as having an uncertain potential for ARD when TIC/AP ratios are between 1 and 3. For the sample, interpretations of ratios of NP to AP were the same as TIC to AP.

2.5 Quality Assurance and Quality Control

All results, including BV's internal quality assurance and quality control (QA/QC) program, were reviewed by SRK for quality assurance. In addition to BV's QA/QC program, SRK followed internal QA/QC procedures as outlined in the SRK Expectations for Laboratory Geochemical Data Quality (2019) which have been agreed upon with the laboratories that SRK uses. Table 2-1 presents a summary of the QA/QC checks for the waste rock sample collected from the NE CRP area by SRK, including the assessment of duplicate and blank samples and standard reference materials. SRK determined all data to be acceptable.

Table 2-1: Summary of QA/QC Results

QC Test	SRK QC Criteria	Results
	paste pH	
Pulp Duplicate (n=1)	For any samples, +/- 0.5 difference pH unit	Passed
Standard Reference Material (n=1)	Within specified tolerance ranges.	Passed
	Total C and TIC	
Method Blank (n=1) for TIC	<2X detection limit (DL)	Passed
Pulp Duplicate (n=1) for TIC	For samples > 10X the detection limit (DL), % RPD within +/-20%	Passed
Standard Reference Material (n=1) for TIC	Within specified tolerance ranges.	Passed
	Total S & Total Sulphate	
Method Blank (n=1) for Total S and SO4	<2X detection limit (DL)	Passed
Sulphur balance (total S > sulphate S) (n=1)	For samples > 10X the detection limit (DL), Total Sulphur should be greater than Total Sulphate, if not the % difference should be within +/-20%	Passed
Pulp Duplicate (n=1) for SO4	For samples > 10X the detection limit (DL), % RPD within +/-20%	Passed
Standard Reference Material (n=1) for Total S and SO4	Within specified tolerance ranges.	Passed
	Modified NP	
Method Blank (n=1)	within -2.50 to 2.50 NP Kg CaCO3/t	Passed
NP consistent with paste pH (n=1)	Negative NP has paste pH <= 5	Passed
Pulp Duplicate (n=1) for NP and Fizz test	% RPD better than +/-15% for NP>20 kg/t, % RPD better than +/-20% for NP>10 kg/t, Difference within +/-5kg/t for NP<10 kg/t. Fizz test rating is the same.	Passed
Fizz test rating with NP (n=1)	Max NP does not exceed fizz test rating	Passed
Standard Reference Material (n=1) for NP	Within specified tolerance ranges.	Passed
	Modified NP and TIC	
Comparison between Modified NP and TIC (n=1)	Check for trends/co-relation	NP > TIC
	Total S-Leco and S-ICP	
Comparison between Total S-Leco and S-ICP (n=1)	For samples >10X detection limit (DL), % RPD within +/-20%	Total S > S-ICP
	Trace Elements (Aqua Regia Digestion with ICP Finish)	
Method Blank (n=1)	<2X detection Limit (DL)	Passed
Pulp Duplicate (n=1)	For samples >10X detection limit (DL), % RPD within +/-20%, For ICP metal scan, it is acceptable for 10% of parameters to be outside of this criterion.	Passed
Standard Reference Material (n=1)	Within specified tolerance ranges.	Passed.

3 Results and Discussion

3.1 Geological Inspection

3.1.1 Underground

Based on geological inspections of the decline by AEM, waste rock was logged as 99% mafic metavolcanics (1) with the balance (1%) logged as quartz-carbonate veining.

3.1.2 Backfill

The majority (99%) of waste rock was chloritic green mafic metavolcanics (1a) with lesser (1%) quartz-carbonate veining (12). The mafic metavolcanics were unoxidized, dark blackish green and weakly foliated with <1% medium-grained disseminated pyrite, no fizz on the groundmass, and moderate fizz on rare <0.5 cm white quartz-carbonate veins. The absence of sedimentary units suggests that the source of waste rock inspected was from the underground mine and was not the NE CPR waste rock excavated from the Portal Pad.

3.2 Rinse Tests

The rinse test on the sieved -2 mm fraction indicated values of pH and EC values of 9.1 and 390 µS/cm, respectively (Table 3-1). The rinse EC value is within the range of values of Portal Pad rock (5th to 95th percentile values of 90 to 320 uS/cm, n=10; SRK 2021b) and Doris underground waste rock (e.g. 87 to 6,700 uS/cm, SRK 2021a and 2022).

Table 3-1: Rinse Test Results, NE CPR Samples

Dominant Rock Type[1]	Sample ID	Rinse pH	Rinse EC
		s.u.	µS/cm
1a	SRK21-NAARTOK-01	9.1	390

Source: https://srk.sharepoint.com/sites/NA1CT022.073/Deliverables/!080_Deliverables/2021 Doris Madrid Annual Report/Madrid WR/Working Files/[1CT022.073_MadridWR-REV0.xlsx]

Note:

[1] 1a = mafic metavolcanic, 1as = altered mafic metavolcanics

3.3 ABA

A summary of ABA data is presented in Table 3-2 and complete results are presented in Attachment 1. Results for the one sample of mafic metavolcanic (1a) are summarized as follows:

- Paste pH was 8.5.

- Total sulphur content was 0.20% which is within the range of total sulphur from Portal Pad construction rock (5th and 95th percentile levels of total sulphur 0.13 and 0.52%, respectively) (SRK 2021b).
- Sulphate content was just above the detection limit (0.01%). Sulphide sulphur, calculated as the difference between total sulphur and sulphate, was at near parity with total sulphur (0.17%).
- Modified NP and TIC values were both 130 kg $CaCO_3$/t.
- Classified as non-PAG on the basis of NP/AP and TIC/AP.

Table 3-2: Summary of ABA Analyses, Madrid North WRSA Samples

Dominant Rock Type[1]	Sample ID	Paste pH	Total S	SO4	AP	TIC	Modified NP	TIC/AP	NP/AP
		s.u.	%	%	kg $CaCO_3$/t	kg $CaCO_3$/t	kg $CaCO_3$/t	-	-
1a	SRK21-NAARTOK-01	8.5	0.20	0.03	6.3	130	130	21	21

Source: \\srk.ad\dfs\NA\VAN\Projects\01_SITES\Hope.Bay\1CT022.056_2020 Geochem Compliance\2020 Annual Reports\Doris Madrid Annual Report\Madrid WR\HB_2020_SolidsGeochem_MadridWR_1CT022.056_rtc_jce_Rev00.xlsx

Notes

3.4 Trace Element Analysis

Selected trace element content for the mafic metavolcanic sample is presented in with complete laboratory results presented in Attachment 1. Results were compared to ten times average crustal abundance for basalt (Price 1997) as an indicator of enrichment. Selenium could not be assessed because the detection limit is equal to the screening criterion and concentrations were below the detection limit or within the range of analytical error.

All parameters were less than ten times the average crustal abundance for basalt indicating no appreciable enrichment. Arsenic content (7.1 ppm) was within the range of arsenic content for Portal Pad construction rock (5th and 95th values of 3.9 and 35 ppm, respectively, SRK 2021b).

Table 3-3: Summary of Elemental Analyses, NE CPR

Parameter	Unit	Detection Limit	SRK21-NAARTOK-01	10x Average Crustal Abundance*
			1a[1]	
Ag	ppm	0.1	0.22	1.1
Au	ppm	0.5	0.0093	0.04
As	ppm	0.1	7.1	20
Ba	ppm	0.5	8.9	3,300
Ca	%	0.01	5.5	76
Cd	ppm	0.1	0.090	2.2
Co	ppm	0.1	44	480
Cr	ppm	0.5	260	1,700
Cu	ppm	0.1	110	870
Fe	%	0.01	6.9	87
Hg	ppm	0.005	<0.005	0.09
Mg	%	0.01	3.2	46
Mn	ppm	1	1,600	15,000
Mo	ppm	0.01	0.4	15
Ni	ppm	0.1	100	1,300
P	%	0.001	0.033	1
Pb	ppm	0.01	2	60
S	%	0.05	0.17	0.3
Sb	ppm	0.1	0.03	2
Sr	ppm	1	25	4,650
U	ppm	0.1	<0.1	10
V	ppm	2	190	2,500
W	ppm	0.1	0.3	7
Zn	ppm	0.1	92	1,050

Source: https://srk.sharepoint.com/sites/NA1CT022.073/Deliverables/!080_Deliverables/2021 Doris Madrid Annual Report/Madrid WR/Working Files/[1CT022.073_MadridWR-REV0.xlsx]

Notes:

* Numbers bolded and underlined exceed 10 times the average crustal abundance for basaltic rocks from Price (1997)

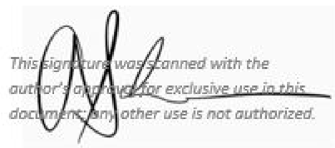
[1] 1a = mafic metavolcanic

4 Summary and Conclusions

In 2021, mining at the Madrid North underground mine occurred for one month during which 3,682 t of waste rock was produced from the decline and placed as backfill in a stockpile on the west side of the Naartok East CPR. AEM's geological inspections of the underground indicated waste rock was 99% mafic metavolcanics (1) with the balance (1%) logged as quartz-carbonate veining. SRK's geological inspection of the stockpile of backfill in NE CPR indicated the majority (99%) of waste rock was geologically logged as mafic metavolcanics (1a) and minor (1%) quartz-carbonate veining.

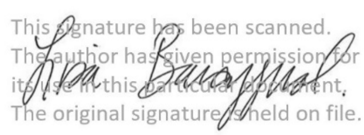
SRK collected one sample of the mafic metavolcanic (1a) from the stockpile at the NE CPR for geochemical characterization. Rinse tests and paste pH indicate the sample was non-acidic. Total sulphur was 0.20% with most sulphur present as sulphide (0.17%). TIC and Modified NP were 130 kg $CaCO_3$/t and the sample was classified as non-PAG. The sample was not classified as enriched compared to the screening criterion. The stockpile also contained saline construction rock that was removed from the Portal Pad in 2021, however on the basis of geological inspection and the absence of sedimentary units (1aj/1oj/5), the sample is interpreted to be underground rock.

Regards,
SRK Consulting (Canada) Inc.



Amanda Schevers, GIT (BC)
Staff Consultant (Geochemistry)

Reviewed by



Lisa Barazzuol, PGeo (NT/NU)
Principal Consultant (Geochemistry)

Attachments:

Attachment 1 Geochemical Data, Waste Rock Sample from Naartok East, CPR

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The opinions expressed in this document have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. While SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

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Attachment 1 Geochemical Data, Waste Rock Sample from Naartok East, CPR

Sample ID	Sample Location	Material Source Area	Sample Type	Dominant Rock Type	Easting	Northing	Sampling Rationale	Sulphid	Sulph %	Fizz Test (Groundmass)	Fizz Test on Carbonate +- Quartz Veins	Carbonate Color	Carbonate Occurrence	Weathering Intensity	Secondary Min	Color of -2mm Fraction	Rock Types	Geological Description	Rinse pH	Rinse EC (uS/cm)
SRK21-Naartok-01	NE CPR	UG	WR	1a	433554	7550660	Characterize underground waste rock	Pyrite	0.5	None	Moderate	White	Vein	None	N/A	brownish gray	1a	Fine grained blackish green mafic volcanics (1a), with trace carbonate veins with moderate fizz, fines have strong fizz, <1% blebby pyrite, some areas with weak sericite and chlorite alteration	9.1	393

Sample ID	Paste pH	Total S	SO_4	Sulphide Sulphur (by diff.)	AP - Tot S	AP - S2	Fizz Rating	CO_2	TIC	Mod NP	TIC/AP TotS	NP/AP TotS
	pH Units	wt%	wt%	wt%	kg $CaCO_3$/t	kg $CaCO_3$/t		wt%	kg $CaCO_3$/t	kg $CaCO_3$/t	Tot S	Tot S
SRK21-Naartok-01	8.52	0.20	0.03	0.17	6.3	5.3	Strong	9	127	132	20	21

Sample ID	As	Co	Ni	Zn	Mo	Cu	Pb	Ag	Mn	Fe	U	Au	Th	Sr	Cd	Sb	Bi	V	Ca
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	%
SRK21-Naartok-01	7.1	43.7	103	92.4	0.4	110	2.03	218	1610	6.94	-0.1	9.3	0.7	24.7	0.09	0.03	-0.02	189	5.47

Sample ID	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Hg	Sc	Tl	S	Ga	Se	Te	Bi
	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
SRK21-Naartok-01	0.033	3.2	259	3.23	8.9	0.196	-20	3.68	0.01	0.04	0.3	-5	15.8	0.02	0.17	10.3	0.6	-0.02	-0.02

Appendix C 2021 Hope Bay Quarry and Construction Rock Monitoring

Data are pending, memo will be reported in an Addendum

Appendix D 2021 Hope Bay Waste Rock, Ore and Infrastructure Seep Monitoring

SRK Consulting (Canada) Inc.
1066 West Hastings Street, Suite 2200
Vancouver, BC V6E 3X2
Canada

+1 604 681 4196 office
+1 604 687 5532 fax

vancouver@srk.com
www.srk.com

FINAL

Technical Memo

March 25, 2022

To	Nancy Duquet Harvey, Agnico Eagle Mines Ltd.
From	Amanda Schevers and Lisa Barazzuol, SRK
Cc	Ashley Mathai, Agnico Eagle Mines Ltd.
Subject	2021 Seepage Monitoring of Doris and Madrid Waste Rock, Ore, and Infrastructure
Client	Agnico Eagle Mines Ltd.
Project	1CT022.073

1 Introduction

As part of the verification, monitoring, and management plans for the Hope Bay Project (the Project), Agnico Eagle Mines (AEM) monitors seepage at the downstream toe of mine infrastructure, pads, roads, and waste rock. Water Licence 2AM-DOH1335 Amendment No. 2 (Nunavut Water Board 2018) is the permit that governs mining activities at the Doris and Madrid areas of the Project. The 2021 seepage monitoring program was completed by AEM in accordance with conditions outlined in Part D Item 18 of Water Licence 2AM-DOH1335 Amendment No. 2, Quarry Management and Monitoring Plan (TMAC 2017), and Waste Rock, Ore, and Backfill Management Plan, Hope Bay Project, Nunavut (TMAC 2019).

In 2021, AEM conducted a seepage survey of the waste rock at Doris and Madrid (Attachment 1). The seepage survey at Doris included the waste rock influenced area (WRIA) defined as the toe of the waste rock stockpile on Pad T, waste rock and ore stockpile on Pad I that includes the upstream embankment of the pollution control pond (PCP) embankment immediately downstream of Pad I and surrounding embankments, and toe of the access road located down-gradient of the Doris waste rock stockpiles. At Madrid North the seepage survey included the Waste Rock Storage Area (WRSA) Pad and the downstream berm of the Madrid Contact Water Pond (CWP). In addition to the seepage survey, AEM conducted routine water quality sampling of waste rock drainage from the Madrid CWP and three water management sumps.

The scope of the 2021 construction rock seepage survey included the following areas, with rationale stated in parentheses (SRK 2021): Madrid North Overburden Stockpile (saline seepage quality), Madrid North Portal Pad (saline seepage quality) and Madrid Shop laydown (seepage not observed in

2020) and Doris access road to the vent raise (seepage not observed since 2019, which was the first year of monitoring).

This memo documents the results of the 2021 waste rock and construction rock seepage monitoring survey and routine monitoring of waste rock drainage from Madrid North WRSA. Geochemical monitoring and characterization of construction rock is documented in SRK (2022) and includes monitoring of quarry rock.

2 Methods

2.1 Seepage Survey and Sample Collection

AEM conducted the 2021 freshet seepage survey between June 14 to 25 and monitoring of waste rock drainage from the Madrid North WRSA at the Madrid CWP and Sumps on July 7, August 4, and September 6 (Table 2-1, Attachment 1).

Seepage survey locations were established where seepage was observed or suspected by examining the toes of the waste rock stockpile, infrastructure, roadways, and berms. Samples were collected and field measurements were taken at locations where water was observed flowing into and out of construction rock material; this included seepage where precipitation runoff and snowmelt came into contact with rock along the roadways, building pads, and berms. Electrical conductivity (EC), pH, temperature, oxidation-reduction potential (ORP), and flow rates (where possible) were measured at each of these locations at the time of monitoring.

AEM collected a total of 34 samples with 20 freshet seepage samples, six monthly samples from within the Contact Water Pond (sample locations MMS-1N and MMS-1S), and eight samples from the three water management sumps downstream of the Madrid WRSA. At each station, the chemical and physical properties of seepage water were measured, and samples were taken for laboratory analysis. The three reference sites, located in the undisturbed tundra and not subject to mine influences, were not sampled in 2021.

Table 2-1: Summary of 2021 seepage survey

Mine Area	Material Source	Sample Area	No. of Samples
Doris	Waste Rock Stockpiles (at Pad T)[1]	Toe of the waste rock stockpiles on Pad T	0
		Embankment immediately downstream of the waste rock and ore stockpile on Pad I and upstream of the pollution control pond (PCP)	3
		Toe of the access roads located down-gradient of the Doris waste rock stockpiles	2
Madrid North	Quarry D & NE CRP Waste Rock	Overburden Stockpile	4
	NE CPR Waste Rock	Portal Pad	4
	Waste Rock Stockpiles (at WRSA)	WRSA Pad Seepage	1
		Sump 1, 2 and 3[2]	8
		Contact Water Pond (CWP)[2,3]	6
		Outside CWP Berm	4
		Inside CWP Berm	2

Notes: See Attachment 1 for surveyed areas in 2021

[1] Referred to as Waste Rock Influenced Area (WRIA) in text.

[2] Routine water quality samples.

[3] Collected from stations MMS-1N and MMS-1S (Figure 1-4 in Attachment 1).

One duplicate sample and one field blank were collected and submitted for laboratory analysis as part of SRK's recommended quality assurance/quality control (QA/QC) program.

AEM submitted a total of 38 samples (including a duplicate and field blank) to ALS Environmental Labs in Burnaby, BC. All samples were analyzed for pH, EC, sulphate, alkalinity, ammonia, bromide, chloride, fluoride, nitrate, nitrite, phosphorus, sulphate, and total suspended sediments (TSS). For Doris, Madrid North Overburden Stockpile, Portal Pad, and Madrid WRSA freshet seepage samples (WRP-01, CWP-01, and CWP-02) total dissolved solids (TDS), acidity, and dissolved metals were also analyzed. For the remainder of the Madrid CWP and Sump samples, total metals were analyzed as per the Water Licence. Cyanate was analyzed for Doris samples and total cyanide was analyzed for Madrid North Sump samples, and select CWP samples (MMS-1, MMS1-S, MMS1-N, MMS1-OUTSIDE and MMS1-OUTSIDE2). All samples were filtered and preserved in the field, as required.

2.2 Quality Assurance / Quality Control

SRK conducted a QA/QC review of all data with results detailed in Table 2-2. Data passed all QC checks except for the following:

- Field EC versus lab EC for September samples at MMS-1N and MMS-1S, which failed with RPD values of 77% and 97%, respectively. Based on review of the field notes and values of field and lab EC, SRK concluded that the samples IDs for the field data or the sample bottles were mixed up. SRK was unable to identify and resolve the sample IDs with the data.
- Sample YL2100679-006 (SEEP-DUP) cyanate had 61% RPD, however could not be assessed because one sample had a concentration within ten times the detection limit (0.005 mg/L) and other was slightly higher than ten times the detection limit. The difference is attributed analytical uncertainty and results were accepted.

SRK deemed the data to be acceptable except for the September samples at MMS-1N and MMS-1S. Data for the September samples at MMS-1N and MMS-1S are documented in Table 3-2, but the data were excluded from the figures and interpretation.

Table 2-2: QA/QC Summary

QC Test	SRK QC Criteria	Results
	Physical Test[1]	
Field Blank	Minimum criteria is <2X DL, will accept <5X DL	Passed (n=1)
Method Blank	<2X DL	All passed. (n=5) for Total Dissolved Solids; (n=8) for Total Suspended Solids; (n=7) for Conductivity and Total Alkalinity; (n=3) for Acidity (as CaCO3)
Field Duplicate	For samples >10X DL should be within +/-30% RPD	Passed (n=1)
Pulp Duplicate	For samples >10X DL should be within +/-20% RPD	All passed. (n=5) for Total Dissolved Solids; (n=8) for Total Suspended Solids; (n=7) for Conductivity; (n=6) for Total Alkalinity; (n=3) for Acidity (as CaCO3) and (n=5) for pH
Field pH vs. Lab pH	Difference should not be greater than 1 pH unit	All passed. (n=31)
Field EC vs Lab EC	For samples > 10X the detection limit (DL), % RPD should be within +/-30%	All samples passed except Sept samples at MMS-1N and MMS-1S (n=33). Field and lab EC failed for two samples (RPD of 77% and 97%). Based on review of the field notes and the lab samples passing QC checks, SRK concluded that the field data were reversed between or bottles were mislabeled. This error could not be resolved. Data are presented in tables but excluded from the figures and interpretation.

QC Test	SRK QC Criteria	Results
Laboratory Control Sample and Certified Reference Material	Within specified tolerance ranges.	All passed. (n=5) for Total Dissolved Solids; (n=8) for Total Suspended Solids; (n=7) for Conductivity, (n=7) for Total Alkalinity; (n=3) for Acidity (as CaCO3); (n=5) for pH
Anions and Nutrients[2]		
Field Blank	Minimum criteria is <2X DL, will accept <5X DL	(n=1)
Method Blank	<2X DL	All passed. (n=7) for Total Ammonia, Chloride, Nitrate (as N), Nitrite (as N), Sulfate, Bromide, Fluoride; (n=3) for Total Phosphorus; (n=1) for Cyanate
Field Duplicate	For samples >10X DL should be within +/-30% RPD	(n=1) for Total Ammonia, Br, Cl, F, NO3, NO2, Total Phosphorus, Sulfate (as SO4) and Cyanate. YL2100679-006 (SEEP-DUP) Cyanate had 61% RPD, however could not be assessed because one sample had concentration <10X DL and other was slightly higher than >10x DL. The difference is attributed analytical uncertainty and results were accepted.
Pulp Duplicate	For samples >10X DL should be within +/-20% RPD	All passed. (n=7) for Total Ammonia, Chloride, Nitrate (as N), Nitrite (as N), Sulfate, Bromide, Fluoride; (n=3) for Total Phosphorus; (n=1) for Cyanate
Ion Balance	EC>100 uS/cm, % difference should be within +/-10%	All passed (n=16)
Standard Reference Materials	Within specified tolerance ranges.	All passed, (n=7) for Total Ammonia, Chloride, Nitrate (as N), Nitrite (as N), Sulfate, Bromide, Fluoride; (n=3) for Total Phosphorus; (n=1) for Cyanate
Trace Metals by ICP-MS		
Field Blank	Minimum criteria is <2X DL, will accept <5X DL	All passed (n=1) for dissolved metals
Method Blank	<2X DL	All passed, (n=3) for dissolved metals and (n=4) for total metals
Field Duplicate	For samples >10X DL should be within +/-30% RPD	(n=1) for Dissolved Metals
Pulp Duplicate	For samples >10X DL should be within +/-20% RPD	All passed, (n=3) for dissolved metals and (n=4) for total metals
Total vs Dissolved Metals	Total Metals>Dissolved metals. Total Metals should be greater than Dissolved Metals, if not the % difference should be within +/-20%. ALS would use 10X DL, Maxxam would use 5X DL	All samples were only analyzed for either total or dissolved metals,
Standard Reference Materials	Within specified tolerance ranges.	All passed, (n=3) for dissolved metals and (n=4) for total metals

QC Test	SRK QC Criteria	Results
	Hg-CVAAS	
Field Blank	Minimum criteria is <2X DL, will accept <5X DL	Passed, (n=1) for dissolved metals
Method Blank	<2X DL	All passed, (n=4) for dissolved metals and (n=4) for total metals
Field Duplicate	For samples >10X DL should be within +/-30% RPD	Passed, (n=1) for dissolved metals
Pulp Duplicate	For samples >10X DL should be within +/-20% RPD	All passed, (n=4) for dissolved metals and (n=4) for total metals
Standard Reference Materials	Within specified tolerance ranges.	All passed, (n=4) for dissolved metals and (n=4) for total metals

Source: https://srk.sharepoint.com/sites/NA1CT022.073/Internal/!020_Project_Data/!2021_Raw_Lab_Files/[!HopeBay_2021_Seepage_QAQC_Summary_Table_Rev00_mlt.xlsx]

Notes:

[1] Conductivity, pH, Hardness (as CaCO3), Total Suspended Solids, Total Dissolved Solids,

[2] Total Alkalinity, Total Ammonia, Unionized Ammonia, Br, Cl, F, NO_3, NO_2, SO_4

3 Results

Attachment 1 presents location maps of the seepage samples, surveyed areas, and of the as-built alignment of the Doris and Madrid mine areas. A complete set of field observations and measurements is provided in Attachment 2. Attachment 3 contains the laboratory water chemistry results.

3.1 Doris Waste Rock Influenced Area

Table 3-1 presents field and lab data for the Doris seepage samples.

Five samples from the Doris WRIA were submitted for laboratory analysis (Table 3-1). 21DC-01, 21DC-02, and 21DC-03 were sampled along the embankment immediately downstream of Pad I and upstream of the PCP. Prior to 2015, the Pad I stockpile was composed of waste rock and after this period TMAC placed ore on top of the waste rock stockpile. Accordingly, seepage from DC-01 to DC-03 were considered contact water from the stockpile on Pad I. Seepage stations 21DC-04 and 21DC-05 were sampled along the downstream toe of the access road located down-gradient of the Doris waste rock stockpiles.

Table 3-1: Summary of Select Laboratory Results of 2021 Doris Waste Rock Influenced Area (WRIA) Seepage Samples

Station ID	Date	Field pH	Lab pH	Field EC	Lab EC	ORP	TDS	Total Alkalinity	Total Ammonia	Cl	NO_3	NO_2	SO_4	Ca	Mg	K	Na	Cyanate	Al	As	Cd	Co	Cu	Fe	Mn	Mo	Ni	Se	Zn
		s.u.	s.u.	µS/cm	µS/cm	mV	mg/L	mg $CaCO_3$/L	mg N/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
21DC-01	25-Jun-21	8.1	7.5	2,200	2,100	140	1,500	140	4.4	250	15	1.3	530	100	41	23	280	2.7	0.0072	0.004	0.000028	0.034	0.41	4.1	0.12	0.012	0.051	0.0043	0.0049
21DC-02	25-Jun-21	8.1	7.5	2,200	2,100	190	1,400	130	4.4	250	15	1.2	530	100	43	23	290	1.8	0.0076	0.0042	0.000030	0.034	0.44	4.1	0.11	0.013	0.052	0.0042	0.0054
21DC-03	25-Jun-21	8.0	7.5	2,200	2,100	200	1,300	130	4.5	250	16	1.2	530	99	44	24	300	2.3	0.0076	0.0042	0.000028	0.035	0.45	4.1	0.11	0.013	0.053	0.0043	0.012
21DC-04	25-Jun-21	7.7	7.9	5,600	4,200	150	3,400	88	30	1,100	63	0.11	180	350	65	27	340	11	0.0056	0.0014	0.00019	0.0019	0.0062	0.011	0.42	0.0059	0.0036	0.0023	0.0059
21DC-05	25-Jun-21	7.9	7.9	5,400	4,100	140	3,500	90	30	1,100	64	0.097	170	360	65	27	340	10	0.0062	0.0015	0.00021	0.0022	0.0060	0.012	0.49	0.0060	0.0041	0.0026	0.0084

Source: https://srk.sharepoint.com/sites/NA1CT022.073/Deliverables/!080_Deliverables/2021 Doris Madrid Annual Report/Seepage/Working Files/[1CT022.073_2021_Master_Compilation_Seepage_Rev01_mlt_bdd_ajs.xlsx]

Notes: Trace elements refer to dissolved metal concentrations

3.1.1 Field Data

Field pH ranged from 7.7 to 8.1 for all samples. Field EC values for samples collected along the access road (DC-04 and DC-05) were approximately twice those collected at the embankment downstream of Pad I (DC-01 to DC-03), with average values of 5,500 and 2,200 µS/cm, respectively.

3.1.2 Laboratory Data

The laboratory pH values ranged from 7.5 to 7.9 and laboratory EC values were roughly equivalent to field values.

Sulphate concentrations for seepage at stations DC-04 and DC-05 (170 and 180 mg/L) were lower than seepage from samples DC-01 to DC-03 (530 mg/L).

The major ion chemistry for samples DC-01 to DC-03 differed from DC-04 and DC-05. For DC-01 to DC-03, major cation chemistry was dominated by sodium (280 to 300 mg/L) with lesser calcium (99 to 100 mg/L), while major anion chemistry was dominated by sulphate (530 mg/L), chloride (250 mg/L), and alkalinity (130 to 140 mg/L as $CaCO_3$) with notable levels of nitrate (15 to 16 mg/L as N). For DC-04 and DC-05 the cation chemistry was dominated by calcium (350 and 360 mg/L) and sodium (340 mg/L), while major anion chemistry was dominated by chloride (1,100 mg/L), sulphate (170 and 180 mg/L) and nitrate (63 and 64 mg/L as N). The higher concentrations of calcium, magnesium, manganese, and strontium from DC-04 and DC-05 suggests dissolution of carbonates.

Concentrations at DC-04 and DC-05 were higher for chloride (1,100 mg/L), ammonia (30 mg/L), nitrate (~63 mg/L) and cyanate (~10 mg/L) compared to DC-01 to DC-03 (250 mg/L chloride, ~4.4 mg/L ammonia, ~15 mg/L nitrate, and 1.4 to 2.3 mg/L cyanate). Stations DC-04 and DC-05 are located further from waste rock than DC-01 to DC-03 suggesting a loading source for chloride, ammonia, and nitrate that is not waste rock.

Seepage samples DC-01 to DC-03 had higher metal concentrations than samples DC-04 and DC-05 for the following parameters: arsenic (ranging from 0.0040 to 00042 mg/L and three times higher), cobalt (0.034 to 0.035 mg/L and 1 order of magnitude higher), molybdenum (0.012 to 0.013 mg/L and one order of magnitude higher), and nickel (0.051 to 0.053 mg/L and one order of magnitude higher). At DC-01 to DC-03, the higher concentrations of iron (4.1 mg/L) suggest the presence of colloids in the sample with concentrations of copper and zinc likely related to iron (oxy)hydroxides because leaching of these parameters were not indicated by kinetic test work (SRK 2015). Cadmium and manganese concentrations were higher at DC-04 and DC-05 (0.00019 and 0.00021 mg/L and one order of magnitude higher and 0.42 and 0.49 mg/L and 4 times greater, respectively) compared to DC-01 to DC-03. Concentrations for aluminum, selenium, and zinc were roughly equivalent for all samples.

All seepage from waste rock and at toe of the road is intercepted by water management collection systems and pumped to the Tailings Impoundment Area.

3.2 Madrid North

3.2.1 Waste Rock Storage Area

Table 3-2 presents a summary of the freshet seepage survey and monthly monitoring data at the Madrid North WRSA (Attachment 1, Figure 1-2). The freshet seepage survey included one sample collected downstream of the WRSA pad near Sump 1, four samples collected downstream of the CWP berm, and two samples collected upstream of the CWP berm. The purpose of the upstream and downstream seepage samples collected at the CWP berm was to confirm the water quality of the seepage observed flowing from the berm that was suspected by AEM to be drainage from the CWP. Monthly monitoring stations included the two stations within the CWP and Sumps 1 to 3. As discussed in Section 2.2, data for the two samples collected from the CWP in September are documented in Table 3-2 but have been excluded from the figures and data interpretation.

Background

Waste Rock Management

Of the 101,126 t of waste rock present at WRSA, most waste rock originated from NE CPR (83,968 t). Approximately, 17,158 t of waste rock from the decline of the Madrid North underground mine was also placed at the WRSA. A small volume of briny waste rock from the Madrid North portal pad was also placed on the WRSA in 2020. Waste rock at the WRSA was geochemically classified as non-PAG and placed in two stockpiles (SRK 2021c). The stockpiles at the WRSA include:

1. A smaller stockpile located directly upstream of the contact water pond (CWP) that contains oxide rock. The oxide rock is ore hosted in mafic volcanics with sediments (1aj) from NE CPR that could not operationally be segregated from waste rock.
2. A larger stockpile located adjacent to Sumps 1 to 3 that contains a mixture of waste rock from NE CPR and the underground mine (the latter as indicated by rinse tests).

Water Management

Water management at the Madrid North WRSA includes three water collection sumps and the Madrid North contact water pond. The water collection sumps collect drainage from the WRSA that does not report directly to the CWP. Runoff/seepage water from WRSA which reports to the sumps is transferred to the contact water pond, therefore water chemistry at the CWP is influenced by waste rock seepage draining to CWP and the collection sumps. Discharge of effluent onto tundra from the contact water pond is in accordance with the effluent quality limits provided in the Water License. Water that does not meet these criteria is transferred to the TIA via water truck.

In 2020, TMAC identified that water from the CWP was bypassing the liner at the downstream berm of the CWP (NT-NU Report submitted by TMAC on June 15, 2020). Overburden was placed near the liner contact to remediate the bypass; however, seepage has subsequently been observed by AEM.

Table 3-2 presents a summary of the freshet seepage survey and monthly monitoring data at the Madrid North WRSA (Attachment 1, Figure 1-2). The freshet seepage survey included one sample collected downstream of the WRSA pad near Sump 1, four samples collected downstream of the CWP berm, and two samples collected upstream of the CWP berm. The purpose of the upstream and downstream seepage samples collected at the CWP berm was to confirm the water quality of the seepage observed flowing from the berm that was suspected by AEM to be drainage from the CWP.

Table 3-2: Summary of Select Laboratory Results of 2021 Seepage Samples, Madrid North Waste Rock at Madrid North WRSA

Monitoring Program	Area	Station ID	Date	Field pH	Lab pH	Field EC	Lab EC	ORP	TSS	Total Alkalinity	Total Ammonia	Cl	NO_3	NO_2	SO_4	Ca	Mg	K	Na	Al	As	Cd	Co	Cu	Fe	Mn	Mo	Ni	Se	Zn
				s.u.	s.u.	µS/cm	µS/cm	mV	mg/L	mg $CaCO_3$/L	mg N/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Freshet Seepage Survey	WRSA Pad Seepage near Sump	21-WRP-01	19-Jun-21	8.2	8.1	700	650	170	4.0	81	0.46	86	4.1	0.018	74	27	9.4	4.5	83	0.039	0.067	0.0000052	0.00018	0.0016	0.014	0.0044	0.0039	0.0035	0.0033	0.0022
	CWP Berm (Downstream)	21-CWP-01	18-Jun-21	7.5	7.8	1,700	1,600	190	3.0	52	1.0	410	2.3	0.037	58	180	19	9.9	91	0.0059	0.12	0.000023	0.00058	0.0014	0.010	0.15	0.0022	0.0038	0.0014	0.0024
		21-CWP-02	19-Jun-21	7.9	8.0	2,100	2,000	140	5.0	75	1.4	510	2.8	0.046	99	200	24	13	130	0.0086	0.25	0.000015	0.00092	0.0026	0.010	0.10	0.004	0.014	0.0025	0.0012
		MMS1-OUTSIDE	18-Jun-21	7.5	7.8	1,700	1,600	170	3.0	57	1.0	410	2.4	0.044	59	160	20	9.8	90	*0.074*	*0.12*	*0.000027*	*0.00074*	*0.0017*	*0.13*	*0.17*	*0.002*	*0.0046*	*0.0013*	*0.0050*
		MMS1-OUTSIDE 2	18-Jun-21	--	8.0	--	1,900	--	20	73	1.4	490	2.6	0.042	95	190	25	13	130	*0.22*	*0.26*	*0.000022*	*0.0013*	*0.0034*	*0.35*	*0.12*	*0.004*	*0.016*	*0.0024*	*0.0030*
	CWP Berm (Upstream)	MMS1	14-Jun-21	7.8	7.5	1,300	1,200	200	14	30	0.77	320	1.8	0.028	42	140	14	7.3	60	*0.66*	*0.22*	*0.000029*	*0.0015*	*0.003*	*1.0*	*0.055*	*0.0021*	*0.017*	*0.0013*	*0.0057*
			18-Jun-21	7.8	7.8	1,600	1,500	150	11	39	0.99	410	2.1	0.035	53	160	18	9.2	78	*0.21*	*0.23*	*0.000036*	*0.0012*	*0.0021*	*0.25*	*0.051*	*0.0023*	*0.015*	*0.0014*	*0.0097*
Routine Monitoring	Contact Water Pond (CWP)	MMS-1N	7-Jul-21	7.4	7.9	3,800	3,800	120	74	160	2.3	970	3.3	0.12	390	230	64	24	430	*2.4*	*0.076*	*0.000082*	*0.0065*	*0.012*	*4.6*	*0.96*	*0.0069*	*0.023*	*0.0053*	*0.014*
			4-Aug-21	8.1	8.1	4,100	3,900	130	7.5	220	0.36	960	1.7	0.037	380	210	78	22	440	*0.36*	*0.035*	*0.00006*	*0.0044*	*0.011*	*0.53*	*0.93*	*0.0051*	*0.015*	*0.0017*	*0.0060*
			6-Sep-21[1]	8.1	8.0	4,100	1,800	140	39	93	0.23	400	1.1	0.020	150	99	22	7.3	130	*1.3*	*0.027*	*0.00011*	*0.0046*	*0.0067*	*2.2*	*0.21*	*0.0012*	*0.013*	*0.00074*	~~*0.0076*~~
		MMS-1S	7-Jul-21	7.5	7.8	5,100	4,900	180	7.0	88	0.74	1,500	5.8	0.087	180	540	76	16	260	*0.068*	*0.045*	*0.00038*	*0.0061*	*0.0054*	*0.22*	*0.49*	*0.00078*	*0.013*	*0.0034*	*0.016*
			4-Aug-21	7.4	7.8	4,400	4,100	100	3.0	130	0.37	1,200	3.9	0.042	230	420	65	18	290	*0.015*	*0.047*	*0.00058*	*0.010*	*0.0084*	*0.023*	*0.25*	*0.00075*	*0.016*	*0.0026*	*0.030*
			6-Sep-21[1]	7.9	8.2	1,500	4,400	130	19	240	0.40	1,000	1.3	0.038	420	210	89	28	510	*0.46*	*0.054*	*0.000038*	*0.0045*	*0.008*	*0.79*	*0.93*	*0.0053*	*0.029*	*0.0013*	*0.0060*
	Sump 1, WRSA	MMS1-S1	7-Jul-21	7.5	7.8	1,200	1,100	150	3.0	150	0.40	180	2.7	0.069	140	58	17	7.7	130	*0.12*	*0.0083*	*0.000071*	*0.0029*	*0.014*	*0.21*	*0.32*	*0.0016*	*0.0024*	*0.0029*	*3.4*
			4-Aug-21	6.8	7.2	1,700	1,600	84	3.0	150	0.15	330	1.8	0.071	190	99	22	7.2	190	*0.074*	*0.0031*	*0.00015*	*0.0065*	*0.016*	*0.14*	*1.6*	*0.00052*	*0.0051*	*0.0023*	*4.3*
			6-Sep-21	7.0	7.8	1,400	1,500	88	3.0	190	0.30	250	0.34	0.019	160	99	23	7.1	140	*0.071*	*0.0023*	*0.00012*	*0.0049*	*0.016*	*0.48*	*1.5*	*0.00073*	*0.0054*	*0.0013*	*4.5*
	Sump 2, WRSA	MMS1-S2	7-Jul-21	8.0	7.9	240	240	170	3.0	110	0.030	16	0.069	0.0029	3.8	20	14	2.8	12	*2.6*	*0.0019*	*0.000013*	*0.0014*	*0.039*	*1.2*	*0.091*	*0.00052*	*0.0086*	*0.00023*	*4.4*
			4-Aug-21	7.8	7.9	470	430	-30	3.1	170	0.088	27	0.082	0.0068	16	36	22	3.5	16	*1.4*	*0.0024*	*0.000025*	*0.0032*	*0.044*	*0.66*	*0.23*	*0.0012*	*0.0080*	*0.00029*	*14*
			6-Sep-21	7.5	7.8	1,000	1,100	120	3.0	87	0.034	270	0.10	0.0050	18	42	70	3.5	31	*0.078*	*0.0018*	*0.000013*	*0.0010*	*0.017*	*0.14*	*0.11*	*0.00053*	*0.0042*	*0.00022*	*4.3*
	Sump 3, WRSA	MMS1-S3	7-Jul-21	7.9	7.6	2,100	2,400	180	5.4	180	1.9	620	3.3	0.064	170	70	75	16	260	*0.28*	*0.092*	*0.000050*	*0.0089*	*0.018*	*0.62*	*0.90*	*0.0034*	*0.023*	*0.0014*	*18*
			4-Aug-21	7.7	8.1	1,500	1,400	130	3.0	230	1.6	210	4.2	0.0064	110	28	20	14	210	*0.75*	*0.15*	*0.000017*	*0.0020*	*0.016*	*0.85*	*0.088*	*0.0078*	*0.0069*	*0.0022*	*5.2*

Source: https://srk.sharepoint.com/sites/NA1CT022.073/Deliverables/!080_Deliverables/2021 Doris Madrid Annual Report/Seepage/Working Files/[1CT022.073_2021_Master_Compilation_Seepage_Rev01_mlt_bdd_ajs.xlsx]

Notes:

Dissolved metals available for samples 21-WRP-01, 21-CWP-01 and 21-CWP-02. Italicized and underlined values denote total metal concentrations.

Data coloured blue were excluded from interpretation because TSS, iron and/or aluminum concentrations suggested the presence of sediment in the samples that may result in dissolved trace element concentrations being overestimated.

[1]Results reported but data is not included in interpretation for reasons discussed in Section 2.2.

Field Data

Field pH for all samples from the Madrid WRSA ranged from 7.0 to 8.2 except for one sample collected from Sump 1 (west of the WRSA) in August 2021 that had a value of 6.8. ORP results from Sump 2 (-30 mV) indicated reducing conditions in August and all other samples indicate oxidizing conditions (84 to 200 mV). Values of field EC varied spatially and are summarized as follows:

- Berm of CWP seepage samples (June): Upstream values were 1,300 and 1,600 µS/cm and were lower than downstream values (1,700 to 2,100 µS/cm).
- CWP routine monitoring (July and August): Values ranged from 3,800 to 5,100 µS/cm from July to August. Between July and August, values of field EC increased slightly for station MMS-1N (3,800 to 4,100 µS/cm) and decreased at MMS-1S (5,100 to 4,400 µS/cm), respectively.
- Sump 1, Sump 2 and Sump 3 (July to September): All values ranged from 1,000 to 2,100 µS/cm except samples at Sump 2 collected in July and August that had values <500 µS/cm.
- Pad of WRSA near Sump 1 (June): the one seepage sample had a value of 700 µS/cm.

Laboratory Data

Laboratory pH for all Madrid WRSA samples ranged from 7.2 to 8.1. Lab and field EC values were at near parity.

Figure 3-1 presents a Piper Plot of the major ion chemistry for the Madrid North WRSA samples and is summarized as follows:

- Berm of CWP (June): The upstream and downstream samples had equivalent major ion composition that was also equivalent with samples from MMS-1S. Major cations were dominated by calcium (140 to 200 mg/L) and sodium (60 to 130 mg/L) while chloride (320 to 510 mg/L) was the dominant anion.
- CWP (July to August): Major ion chemistry of CWP samples were classified into the following two groups:
  - MMS-1N cations were dominated by sodium (430 and 440 mg/L) with lesser calcium (210 and 230 mg/L) while major anions were dominated by chloride (960 and 970 mg/L) with lesser sulphate (380 and 390 mg/L). The major ion composition was roughly equivalent to samples from Sump 1.
  - MMS-1S cations were dominated by calcium (420 and 540 mg/L) with lesser sodium (260 and 290 mg/L) and chloride (1,200 and 1,500 mg/L). The dominance and elevated concentrations of calcium and chloride suggests are indicative of residual drilling brine from underground waste rock. The equivalent major ion compositions at MMS-1S and CWP berms seepage and higher concentrations at MMS-1S suggests that concentrations in seepage downstream of the berm can have seasonal variability.
  - The sump and WRSA pad samples are summarized as follows:

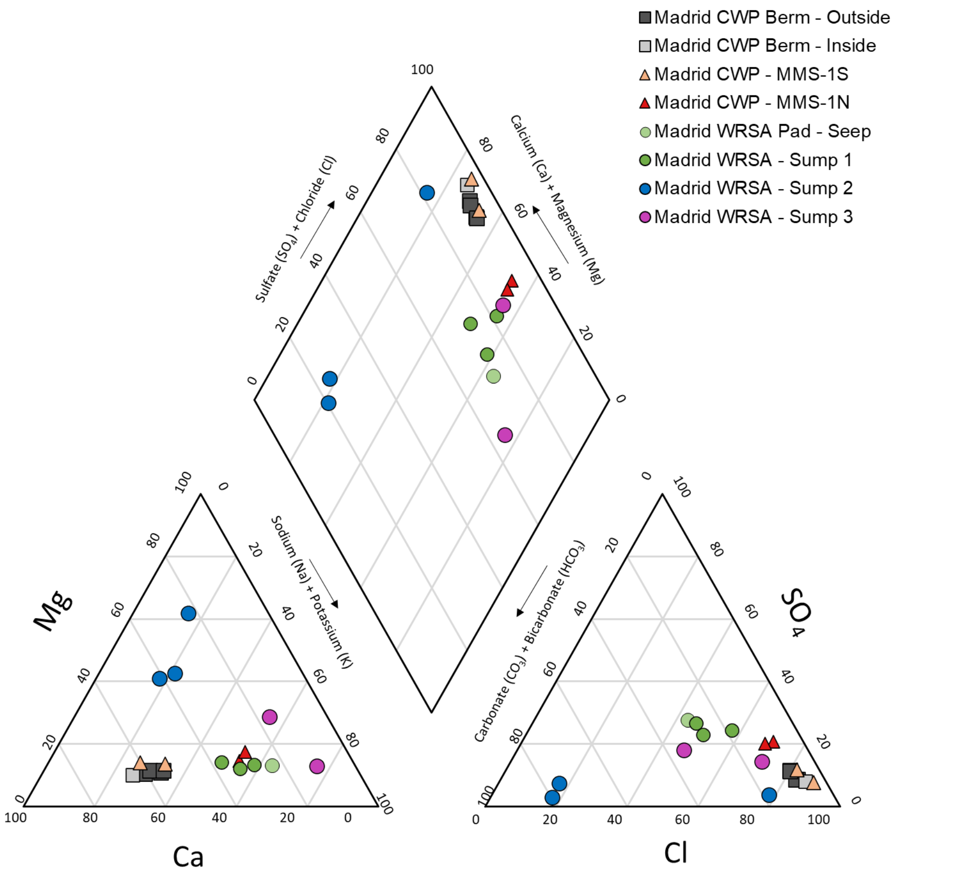
  - Sump 2 (July to September): Major cations were dominated by calcium (20 to 42 mg/L), magnesium (14 and 70 mg/L), and sodium (12 and 31 mg/L), while major anions were dominated by total alkalinity (110 to 170 mg/L) with lesser chloride (16 to 27 mg/L), except for the September sample which was dominated by chloride (270 mg/L) with lesser total alkalinity (87 mg/L). The composition of major ions varied between the samples (ex. Sump 2 had a higher proportion of magnesium compared the calcium and sodium, Figure 3-1).
  - Sump 1, seepage at pad of WRSA near Sump 1, Sump 1, and Sump 3 (July only): Major cations were dominated by sodium (83 to 260 mg/L) with lesser calcium (27 to 100 mg/L), while major anions were dominated by chloride (86 to 616 mg/L) and total alkalinity (81 to 190 mg/L). The composition of major ions suggests the seepage station collected at the base WRSA pad has the same drainage source as Sump 1. Notably the sump samples have lower chloride concentrations than CWP samples.
  - Sump 3 (August): Major cations were dominated by sodium (210 mg/L), while major anions were dominated by total alkalinity (230 mg/L) and chloride (210 mg/L).

Chloride and nitrogen nutrient concentrations can be indicators of residual drilling brines and explosives present on the surfaces of underground waste rock (SRK 2021c) are summarized as follows:

- Chloride is a tracer of drilling brines used for mining at the Madrid North underground mine but not the NE CPR. Chloride is geochemically conservative and therefore can be used as an indicator of underground mine waste rock drainage flow at the WRSA. A summary of concentrations in decreasing order are summarized as follows:
  - CWP (July to August): Chloride concentrations were 960 and 970 from MMS-1N and 1,200 and 1,500 mg/L from MMS-1S, with concentrations higher at MMS-1S.
  - Berm of CWP (June): Concentrations on the upstream and downstream side of the CWP berm were similar with values ranging from 320 to 510 mg/L.
  - Sump 3: Chloride concentrations decreased from 620 mg/L in July to 210 mg/L in August.
  - Sump 1: Chloride concentrations ranged from 180 to 330 mg/.
  - Sump 2: Chloride concentrations were 16 mg/L and 270 mg/.
  - Seepage near Sump 1: Chloride was 86 mg/L.
- Chloride concentrations suggest contact water from underground waste rock is draining to Sump 1 and Sump 3. Another potential source of chloride loadings could be the briny waste rock from the Portal Pad that was placed at the WRSA in 2020.
- Ammonia and nitrate concentrations are summarized as follows:
  - CWP berm (June): concentrations of ammonia and nitrate were slightly higher in seepage downstream of the CWP berm (1.0 to 1.4 mg/L and 2.3 to 2.6 mg/L, respectively) compared to seepage upstream of the berm (0.77 and 0.99 mg/L and 1.8 and 2.1 mg/L, respectively).
  - CWP, Sump1 to 3 and Seepage near Sump 1:

- Ammonia: concentrations of ammonia were highest at Sump 3 (1.6 to 1.9 mg/L) and MMS-1N in July (2.3 mg/L) and were one order of magnitude higher than MMS-1N (August, 0.36 mg/L), MMS-1S (0.37 to 0.74 mg/L), Sump 1 (0.15 to 0.40 mg/L), and seepage near Sump 1, and lowest for samples from Sump 2 (0.030 to 0.088 mg/L).
- Nitrate: concentrations of nitrate were highest at MMS-S1, MMS-1N, Sump 3, seepage near Sump 1, and Sump 1 for July and August (1.7 to 5.8 mg/L) and were one magnitude higher than Sump 1 and Sump 2 in September (0.34 and 0.10 mg/L, respectively), and lowest for Sump 2 in July and August (0.069 and 0.082 mg/L).

- Similar to the chloride concentrations, ammonia and nitrate from blast residues suggest contact water from underground waste rock is draining to Sump 1 and Sump 3.



Source: https://srk.sharepoint.com/sites/NA1CT022.073/Deliverables/!080_Deliverables/2021 Doris Madrid Annual Report/Seepage/Working Files/[1CT022.073_2021_Master_Compilation_Seepage_Rev01_mlt_bdd_ajs.xlsx]

Figure 3-1: Piper Plot for Madrid WRSA Samples

Trace metals data are illustrated in Figure 4-13. Samples with trace element data coloured blue in Table 3-2 have been excluded from data interpretation because concentrations of TSS are greater than 10 mg/L and iron and/or aluminum is greater than 1 mg/L suggesting the presence of sediment in the sample that could result in trace element content being biased high.

Geochemical monitoring of waste rock in stockpiles at the WRSA confirmed the relationship between neutral pH arsenic leaching and solid phase arsenic content and the trace mineral gersdorffite (SRK 2017a and 2021c). Neutral pH metal leaching parameters from the oxidation of the trace sulphide mineral gersdorffite are arsenic, cobalt, and nickel and are summarized as follows:

- Sulphate is an indicator of overall sulphide oxidation. Concentrations are summarized as follows:
  - Sump 2 and all seepage samples (June): the lowest concentrations were observed at these stations, ranging from 3.8 to 99 mg/L.
  - CWP, Sump 1 and Sump 3: concentrations ranged from 110 to 390 mg/L and were ten times higher than the other stations suggesting draining from NE CPR waste rock with higher sulphide content and associated oxidation rates are draining to these collection points. NE CPR waste rock overall has higher sulphide content than the waste rock from the underground decline (SRK 2017a).
- Arsenic concentrations are summarized as follows (in decreasing order):
  - CWP berm seepage (downstream) and Sump 3 (August): concentrations ranged from 0.12 to 0.25 mg/L
  - Seepage near Sump 1, CWP and Sump 3 (July): concentrations ranged from 0.035 to 0.092 mg/L
  - Sump 1 and 2: concentrations ranging from 0.0018 to 0.0083 mg/L.
- Cobalt concentrations are summarized as follows (in decreasing order):
  - CWP, Sump 1, 2, and 3: concentrations ranged from 0.001 to 0.010 mg/L.
  - Seepage near Sump 1 and downstream of CWP berm: concentrations were lowest with values ranging from 0.00018 to 0.00092 mg/L.
- Nickel concentrations are summarized as follows (in decreasing order):
  - CWP (July and August), downstream of CWP berm (Jun 19) and Sump 3 (July): concentrations ranged from 0.013 to 0.023 mg/L.
  - Concentrations for all other samples were an order of magnitude lower, with values ranging from 0.0024 to 0.0080 mg/L.
- Manganese concentrations are summarized as follows (in decreasing order):
  - Sump 1: concentrations ranged from 0.32 in July and ~1.5 mg/L in August and September.
  - Downstream of CWP, CWP, Sump 2 and Sump 3 (July): concentrations ranged from 0.1 to 0.93 mg/L.
  - Sump 2 (July) and Sump 3 (August): concentrations of 0.088 and 0.091 mg/L, respectively.

  - Seepage near Sump 1: concentration of 0.0044 mg/L
- Selenium concentrations are summarized as follows:
  - CWP, Sump 1, Sump 3, seepage near Sump 1 and downstream of CWP berm: concentrations ranged from 0.0013 to 0.0034 mg/L.
  - Sump 2: concentrations were lower with values ranging from 0.00022 to 0.00029 mg/L.
- Zinc concentrations are summarized as follows:
  - Sump 1, 2, and 3: concentrations tanged from 3.4 to 28 mg/L. The elevated concentrations may be related to total metal analysis.
  - CWP MMS-1S: concentrations were 0.016 and 0.030 mg/L
  - Seepage near Sump 1, downstream of CWP berm, CWP MMS-1N: concentrations were lowest with values ranging from 0.0012 to 0.0060 mg/L.

Based on HCT studies, waste rock from the NE CPR has a higher potential for metal leaching for sulphate, arsenic, cobalt and nickel than underground waste rock (SRK 2018). Furthermore, based on the results of the geochemical monitoring of NE CPR waste rock, material that had the highest risk of ML/ARD was managed through placement immediately upgradient of the CWP. The results of the drainage monitoring at the WRSA suggest that contact water with a geochemical signature of metal leaching from NE CPR waste rock is draining to the CWP, Sump 3 and to a lesser degree Sump 1.

3.2.2 Infrastructure and Roads

Four samples were collected from the Overburden Stockpile and three samples from the Portal Pad. Table 3-3 presents field and lab data for the Overburden Stockpile and Portal Pad samples.

Field Data

Field parameters are summarized as follows:

- Overburden Stockpile: pH ranged from 7.4 to 8.1 and field EC values ranged from 1,500 to 2,800 μS/cm, except at station 21-OVB-03 that had an EC value of 190 μS/cm.
- Portal Pad: field pH ranged from 7.3 to 8.0 and EC values ranged from 1,200 to 2,000 μS/cm, except at station 21-MAD-02 that had a value of 750 μS/cm.

Laboratory Data

Overburden Stockpile

Overburden Stockpile seepage chemistry is summarized as follows:

- Laboratory pH ranged from 7.6 to 8.1 for all samples. EC values ranged from 1,200 to 2,400 μS/cm except for sample 21-OVB-03 with a value of 200 μS/cm. Laboratory and field data were at near parity.

- The major cation chemistry was dominated by sodium (220 mg/L) and calcium (150 and 160 mg/L) at stations 21-OVB-01 and 21-OVB-02, sodium for 21-OVB-04 (170 mg/L) and calcium for 21-OVB-03 (24 mg/L). Major anions were dominated by chloride in samples 21-OVB-01 and 21-OVB-02 (620 and 640 mg/L, respectively), chloride and sulphate for sample 21-OVB-04 (210 and 170 mg/L, respectively), and total alkalinity for sample 21-OVB-03 (74 mg/L). There was a positive relationship between EC and chloride concentrations.
- Nutrient concentrations ranged from 0.11 to 0.62 mg/L as N (ammonia), 0.08 to 1.7 mg/L (nitrate), and 0.0038 to 0.0436 mg/L as N (nitrite) (Figure 4-13). There was a positive relationship between EC and ammonia concentrations that was not observed for nitrate or nitrite.
- Manganese concentrations were one order of magnitude higher for samples 21-OVB-01 and 21-OVB-02 (0.22 and 0.34 mg/L, respectively) compared to samples 21-OVB-03 and 21-OVB-04 (0.036 and 0.019 mg/L, respectively).
- Cobalt, nickel, and zinc concentrations were the same order of magnitude for all samples and ranged from 0.00018 to 0.0011 mg/L, 0.0012 to 0.0048 mg/L, and 0.0012 to 0.0035 mg/L, respectively.
- The seepage chemistry for 20-OVB-03 does not represent contact water of the Overburden Stockpile.

Portal Pad

Portal pad seepage chemistry is summarized as follows:

- Laboratory pH ranged from 7.9 to 8.1 for all samples. EC values ranged from 1,100 to 1,900 µS/cm except for sample 21-MAD-02 with a value of 750 µS/cm.
- The major cation chemistry was dominated by calcium (71 to 190 mg/L) and sodium (33 to 110 mg/L). Major anions were dominated by chloride (110 and 210 mg/L) and total alkalinity (120 and 180 mg/L) for samples 21-MAD-02 and 21-MAD-03, while samples 21-MAD-01 and 21-MAD-04 were dominated by chloride (440 and 510 mg/L, respectively).
- Seepage at stations 21-MAD-03 and 21-MAD-04 had the highest concentrations of ammonia (0.85 and 1.1 mg/L, respectively) and nitrate (5.0 and 0.12 mg/L, respectively compared to stations 21-MAD-01 and 21-MAD-02 with ammonia and nitrate concentrations of 0.23 and 0.20 mg/L and 0.059 and 0.005 mg/L, respectively.
- Arsenic, cobalt and nickel concentrations ranged from 0.00098 to 0.019 mg/L, 0.00036 to 0.0036 mg/L and 0.0015 to 0.0077 mg/L, respectively. There was no clear relationship between concentrations between these parameters.
- Manganese and zinc concentrations ranged from 0.10 to 0.47 mg/L and 0.0043 to 0.0082 mg/L, respectively.

Table 3-3: Summary of Select Laboratory Results of 2021 Seepage Samples, Madrid North Infrastructure and Roads

Area	Station ID	Date	Field pH	Lab pH	Field EC	Lab EC	ORP	TDS	Total Alkalinity	Total Ammonia	Cl	NO_3	NO_2	SO_4	Ca	Mg	K	Na	Al	As	Cd	Co	Cu	Fe	Mn	Mo	Ni	Se	Zn
					µS/cm	µS/cm	mV	mg/L	mg $CaCO_3$/L	mg N/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Overburden Stockpile	21-OVB-01	21-Jun-21	7.5	7.6	2,800	2,400	150	1,900	110	0.62	640	0.88	0.036	100	150	55	12	220	0.0077	0.0022	0.000025	0.00077	0.0029	0.029	0.22	0.0015	0.0047	0.00028	0.0028
	21-OVB-02	21-Jun-21	7.4	7.7	2,800	2,300	140	1,900	100	0.51	620	0.87	0.023	110	160	49	12	220	0.014	0.0027	0.000042	0.0011	0.0037	0.044	0.34	0.0021	0.0048	0.00034	0.0035
	21-OVB-03	21-Jun-21	7.7	7.9	190	200	120	130	74	0.11	13	0.082	0.0038	5.4	24	3.7	1.6	9.1	0.023	0.0020	0.000005	0.00026	0.0055	0.034	0.036	0.00038	0.0017	0.00013	0.0022
	21-OVB-04	21-Jun-21	8.1	8.0	1,500	1,200	140	740	79	0.12	210	1.7	0.015	170	31	22	9.0	170	0.019	0.0014	0.000005	0.00018	0.0057	0.012	0.019	0.0051	0.0012	0.00043	0.0012
Portal Pad	21-MAD-01	17-Jun-21	7.2	7.9	1,800	1,700	190	1,500	60	0.23	440	0.059	0.0050	80	120	57	6.5	96	0.0092	0.00098	0.000012	0.00036	0.0015	0.033	0.10	0.00019	0.0015	0.00060	0.0043
	21-MAD-02	17-Jun-21	7.4	7.9	780	750	150	510	180	0.20	110	0.005	0.0010	19	82	14	6.2	33	0.019	0.0035	0.000023	0.00087	0.0031	0.029	0.43	0.00043	0.0028	0.00024	0.0078
	21-MAD-03	17-Jun-21	8.0	8.1	1,200	1,100	160	650	120	0.85	210	5.0	0.049	78	71	17	8.1	110	0.014	0.019	0.0000098	0.00082	0.0038	0.028	0.10	0.0069	0.0077	0.0016	0.0059
	21-MAD-04	17-Jun-21	7.3	7.9	2,000	1,900	100	1,900	86	1.1	510	0.12	0.014	68	190	49	8.3	95	0.0074	0.0012	0.000051	0.0036	0.0025	0.22	0.47	0.00043	0.0040	0.00046	0.0082

Source: https://srk.sharepoint.com/sites/NA1CT022.073/Deliverables/!080_Deliverables/2021 Doris Madrid Annual Report/Seepage/Working Files/[1CT022.073_2021_Master_Compilation_Seepage_Rev01_mlt_bdd_ajs.xlsx]

4 Comparison to Previous Surveys

4.1 Doris Waste Rock Influenced Area

As previously noted, the stockpile on Pad I is composed of Doris ore mined by TMAC that has been placed on top of the waste rock stockpile in 2015. Waste rock mined by AEM has been placed on Pad T since 2015.

Table 4-1 compares the results of samples collected in 2021 from the waste rock influenced area at Doris with a statistical summary of historical seepage samples collected from the WRIA between 2011 and 2020. Table 4-1 presents the historical data as 5^{th}, 50^{th}, and 95^{th} percentile statistics, with concentrations below the detection limit assumed to be equal to the detection limit.

Table 4-1: Comparison of analytical results between 2021 survey data and 5th, 50th, and 90th percentile of 2011 to 2020 survey data

Area	Sample ID	Field pH	Lab pH	Field EC	Lab EC	Total Hardness	TDS	Total Ammonia	Cl	NO_3	SO_4	Al	As	Cd	Cu	Fe	Pb	Ni	Se	Zn
		s.u.	s.u.	µS/cm	µS/cm	mg $CaCO_3$/L	mg/L	mg N/L	mg/L	mg N/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Waste Rock Influenced Area	21DC-01	8.1	7.5	2,200	2,100	420	1,500	4.4	250	15	530	0.0072	0.0040	0.000028	0.41	4.1	***0.00005***	0.051	0.0043	0.0049
	21DC-02	8.1	7.5	2,200	2,100	430	1,400	4.4	250	15	530	0.0076	0.0042	0.000030	0.44	4.1	***0.00005***	0.052	0.0042	0.0054
	21DC-03	8.0	7.5	2,200	2,100	430	1,300	4.5	250	16	530	0.0076	0.0042	0.000028	0.45	4.1	0.000057	0.053	0.0043	0.012
	21DC-04	7.7	7.9	5,600	4,200	1,100	3,400	30	1,100	63	180	0.0056	0.0014	0.00019	0.0062	0.011	***0.00005***	0.0036	0.0023	0.0059
	21DC-05	7.9	7.9	5,400	4,100	1,200	3,500	30	1,100	64	170	0.0062	0.0015	0.00021	0.0060	0.012	***0.00005***	0.0041	0.0026	0.0084
	2011-2020 P05	7.1	7.6	550	430	130	240	0.78	67	2.3	16	0.0060	0.00071	0.0000092	0.0036	0.010	***0.00005***	0.00061	0.00023	***0.001***
	2011-2020 P50	8.0	7.9	2,100	2,500	540	1,600	9.4	480	25	100	0.0096	0.0023	0.000063	0.011	0.038	0.000084	0.0033	0.0014	0.0018
	2011-2020 P95	8.3	8.1	9,600	1,2000	4,000	10,000	72	3,700	220	320	0.024	0.0073	0.0033	3.6	6.9	0.00025	0.08	0.0051	0.012
	2011-2020 n[1]	30	35	29	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35

Sources: https://srk.sharepoint.com/sites/FS208/Internal/!Databases/Geochemistry/Seepage/Doris-Madrid seepage compilation/[1CT022.037_2019_Doris-MadridSeep_rev04_jce_dwm_bdd.xlsx]

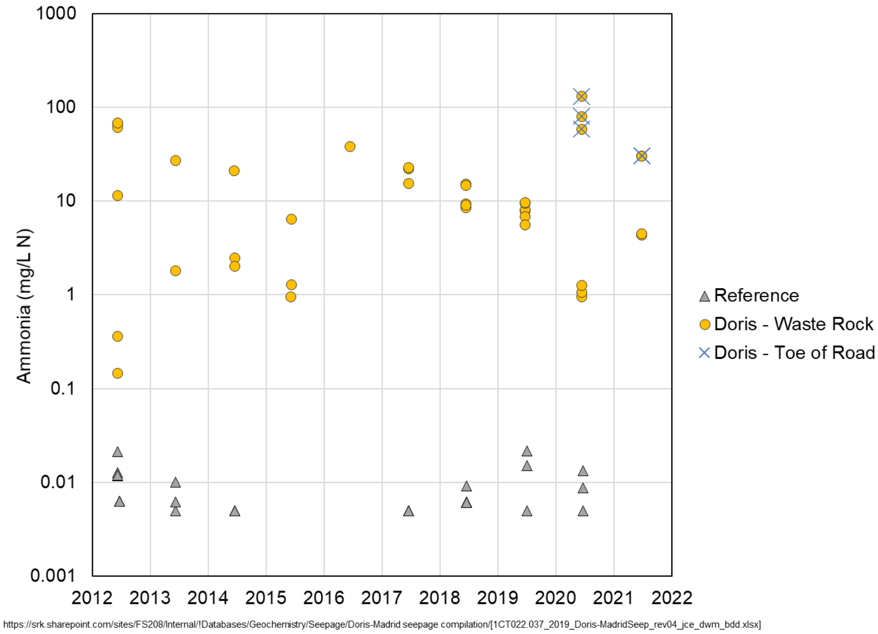
Notes: Bold italicized values are present at less than analytical detection.

[1] n = number of samples

Ammonia, Nitrate, and Chloride

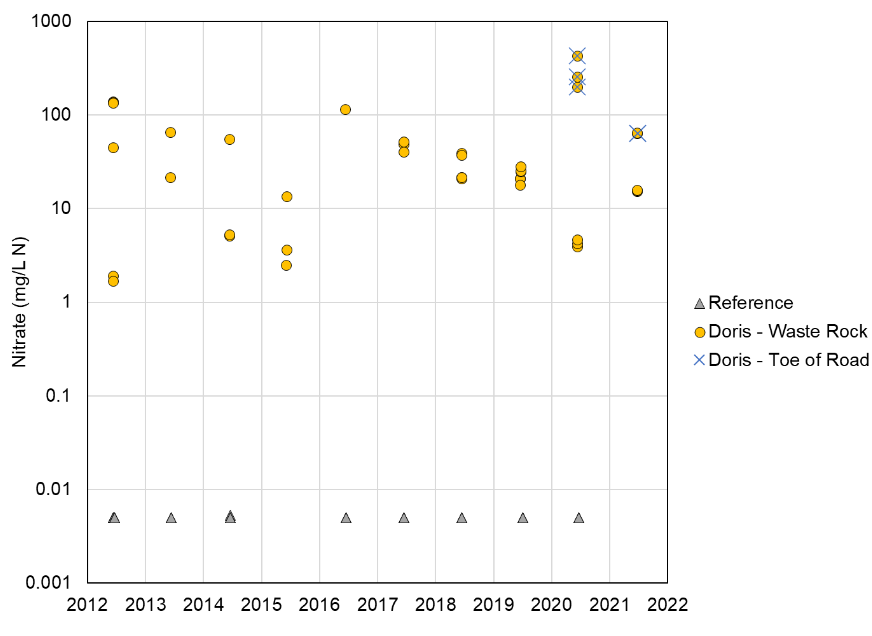
Trends in ammonia, nitrate and chloride are indicative of flushing of residual salts from drilling brines (chloride) and explosives (ammonia, nitrate, and nitrite) from the surfaces of waste rock in the stockpile on Pad I (Figure 4-1 to Figure 4-3). A summary of the seepage data is summarized as follows:

- 2012 to 2015: the peak in concentrations represents the initiation of mining at Doris with subsequent decrease in concentrations corresponding to the flush of soluble products during a period of no mining.
- 2016: increase in concentrations coincides with the re-initiation of mining and recontouring of the waste rock stockpile, the latter which resulted in a flush of existing residual drilling brine and explosives from the stockpile. After 2015, concentrations of residual salts and explosives decreased because new material (ore) placed on Pad I had a short residence time.
- 2012 to 2019: seepage chemistry at the toe of Pad I indicated waste rock contact water while the seepage at the toe of the access road was had a waste rock signature but more dilute than seepage samples collected from the toe of Pad I.
- 2020: seepage chemistry along the toe of the access road contained higher levels of chloride, ammonia and nitrate suggesting that a loading source that was not waste rock. Madrid ore placed on Pad I was exclusively sourced from Madrid NECPR was concluded to not be the source because the surface mining methods do not use drilling brines and have a lower powder factor than underground mining.
- 2021:
  - Toe of the access road: ammonia, nitrate and chloride concentrations continued to be higher than seepage at the toe of Pad I but lower than samples from the toe of the road collected in 2020. This trend suggests the continued presence of an additional loading source.
  - Waste rock contact water at the toe of Pad I: ammonia and nitrate exhibited decreasing trends between 2015 and 2020 with an increase observed in 2021. Chloride concentrations decreased between 2015 and 2021.



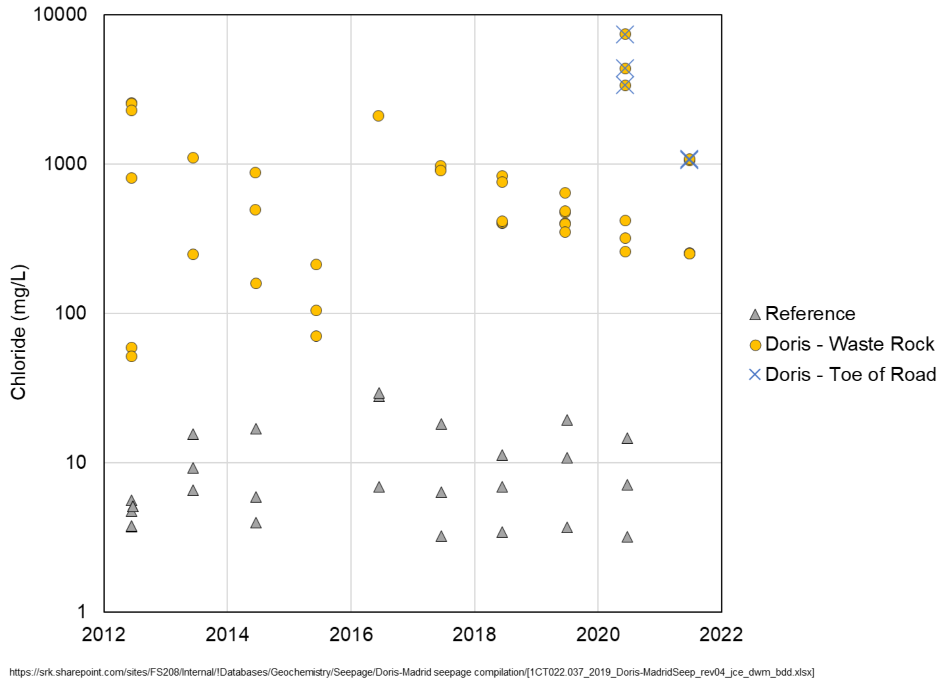
*Note: Toe of access road samples only identified since 2020.

Figure 4-1: Ammonia Seepage Monitoring Data, Waste Rock Influenced Area and Reference Areas



*Note: Toe of access road samples only identified since 2020.

Figure 4-2: Nitrate Seepage Monitoring Data, Waste Rock Influenced Area and Reference Areas



Note: Toe of access road samples only identified since 2020.

Figure 4-3: Chloride Seepage Monitoring Data, Waste Rock Influenced Area and Reference Areas

Sulphate and Trace Elements

Figure 4-4 to Figure 4-12 present temporal trends of sulphate, manganese, arsenic, cobalt, nickel, cadmium, zinc, copper, and iron. Sulphate is presented in the context of sulphide oxidation. Arsenic, cobalt, and nickel are presented in the context of neutral pH metal leaching parameters for Madrid North rock. Manganese, cadmium, and zinc are discussed because concentrations at the toe of the road have been higher in seepage at the toe of the road compared to the toe of Pad I, suggesting a source other than waste rock. Copper and iron are discussed because concentrations in the seepage at the toe of the stockpile of Pad I increased since 2020.

Historically, sulphate concentrations in seepage at the toe of the access road were lower than at the toe of the stockpile on Pad I, however in 2020 sulphate concentrations were higher at the toe of the access road. In 2021, sulphate concentrations at the toe of Pad I were higher than at the toe of the road, with the former exhibiting an increasing trend since 2015 (Figure 4-4). As discussed in SRK (2020), prior to 2015, Pad I was used for the waste rock stockpile and increasing trends in sulphate are attributed to the placement of Doris ore on Pad I that is enriched in sulphide and with higher release rates compared to Doris waste rock (SRK 2015a). The increase in sulphate in seepage at the toe of the access road may be related to the placement of Madrid ore at Doris camp starting in Fall 2019. Madrid ore is stockpiled on the west side of Pad T and then moved to Pad I to be processed through the mill with Doris ore. Madrid and Doris ore have an average sulphur concentration of 1.5% and 1.0%, respectively (SRK 2017a and 2015b). SRK's humidity cell test program demonstrated that sulphate leaching rates were higher for samples of Madrid ore (average stable rate of 13 mg/kg/week, n=3; SRK 2015a) compared to Doris ore (average stable rate of 3.2 mg/kg/week, n=4; SRK 2015b).

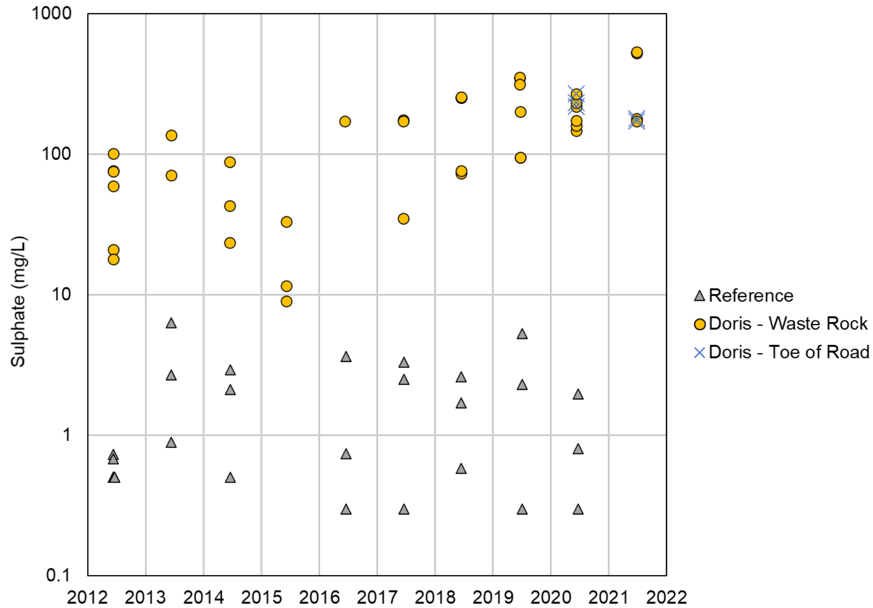
Arsenic, cobalt, and nickel concentrations exhibited the same trend as sulphate, in that concentrations are higher in seepage at the toe of Pad I except in 2020 when they were higher in seepage at the toe of the road. Cobalt and nickel concentrations have been relatively stable since 2017 while arsenic concentrations have decreased with anomalously low values for all parameters in 2020.

Manganese and cadmium concentrations at the toe of the access road were lower than in 2020 but consistent with 2020 were higher than concentrations from the toe of Pad I (Figure 4-8 and Figure 4-9). The higher manganese concentrations from the access road suggest a different source. Sources of manganese leaching at Doris pad could include ore and/or detoxified tailings. A review of humidity cell test (HCT) data indicated that selected samples of ore from Doris Central (HC-36, HC-45, HC-52 and HC-54) and Madrid (Naartok East) (HC-26) had maximum manganese loading rates (0.014 to 0.038 mg/kg/week) that were higher than other Doris and Madrid waste rock and ore HCTs but that overall stable rates were roughly equivalent for all HCT samples (SRK 2017a and 2015b). Detoxified tailings are temporarily stored at the Doris pad. HCT data indicated higher stable manganese loading rates for Doris and Madrid detoxified tailings, with stable rates of 0.091 and 0.26 mg/kg/week, respectively. Assuming 1,000 tonnes of detoxified tailings and using the base case source term inputs documented in SRK (2017b), contact water estimates for sulphate and manganese are 326 and 0.22 mg/L, respectively, which are within the range of concentrations indicated by the 2021 seepage samples (TL-11) that represent contact water from detoxified tailings placed as backfill in underground stopes (SRK 2022).

Zinc concentrations at the toe of the access road have decreased since 2020. In 2020, zinc concentrations were higher at the toe of the road however in 2021, concentrations are near equivalent between stations (Figure 4-10). HCT data for cadmium and zinc were below or within levels of analytical detection for all samples (SRK 2017a and 2015b). Barrel tests, which are primarily samples of waste rock with selected samples of mixed ore and waste rock, indicated a higher initial flush with higher concentrations ranging from 0.0001 to 0.0002 mg/L for waste rock types intersected at NE CPR followed by a decreasing trend with concentrations currently <0.0001 mg/L. Barrel zinc concentrations have oscillated between approximately 0.001 and 0.01 mg/L over the 11-year period operation, with no evident trends. The underground seepage survey has indicated 5th to 95th percentile concentrations of cadmium and zinc of 0.0001 to 0.035 mg/L and 0.02 to 2 mg/L, respectively.

Copper and iron were higher than in 2020. Previous elevated concentrations of iron were interpreted to be represent colloids or TSS within the sample. This interpretation is supported by the high concentrations of dissolved iron (4.1 mg/L) in 2021.

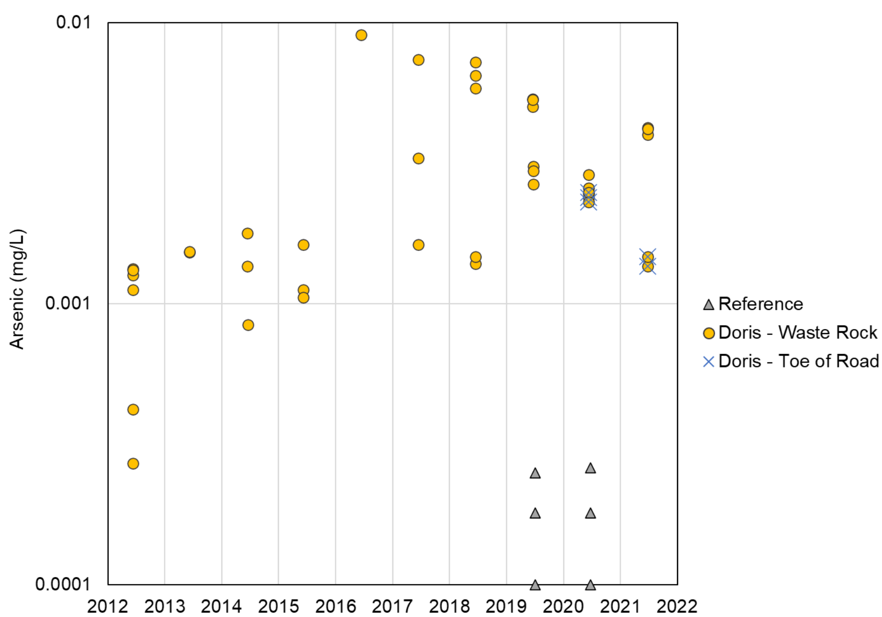
All drainage from the Doris camp pad, including seepage captured in the collection sumps downstream of the toe of the access road, is pumped to the sediment control pond (SCP) prior to transfer to the TIA. In 2021, water from the SCP accounted for 1.4% of total inflow volumes entering the TIA and 0.4% of the total volume stored in the TIA.



https://srk.sharepoint.com/sites/FS208/Internal/!Databases/Geochemistry/Seepage/Doris-Madrid seepage compilation/[1CT022.037_2019_Doris-MadridSeep_rev04_jce_dwm_bdd.xlsx]

Note: Toe of access road samples only identified since 2020.

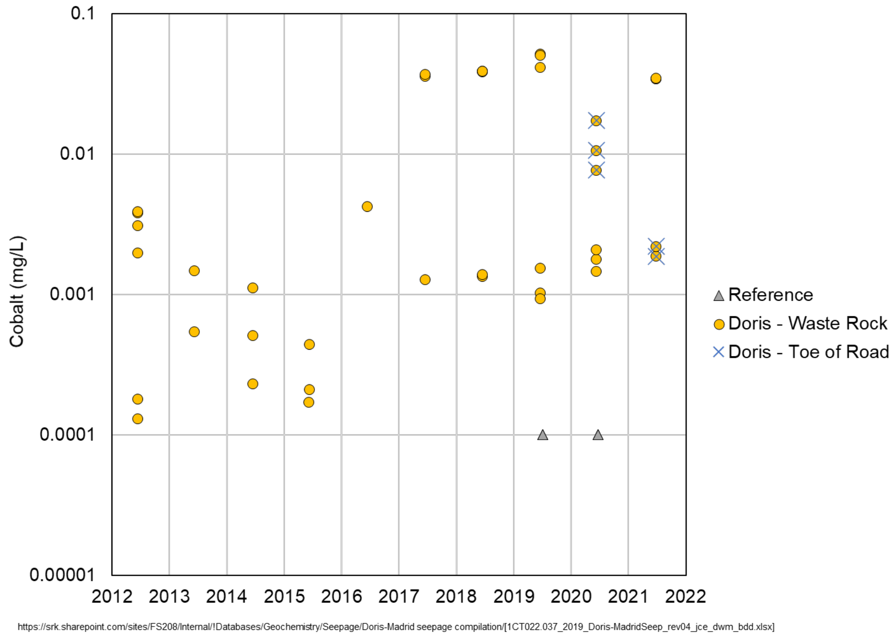
Figure 4-4: Sulphate Seepage Monitoring Data, Waste Rock Influenced Area and Reference Areas



https://srk.sharepoint.com/sites/FS208/Internal/!Databases/Geochemistry/Seepage/Doris-Madrid seepage compilation/[1CT022.037_2019_Doris-MadridSeep_rev04_jce_dwm_bdd.xlsx]

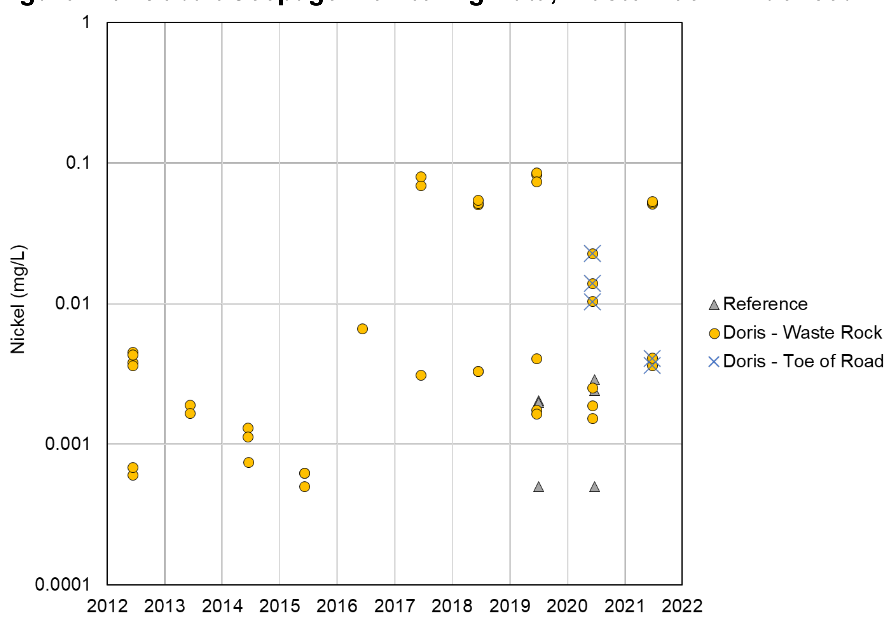
Note: Toe of access road samples only identified since 2020.

Figure 4-5: Arsenic Seepage Monitoring Data, Waste Rock Influenced Area and Reference Areas



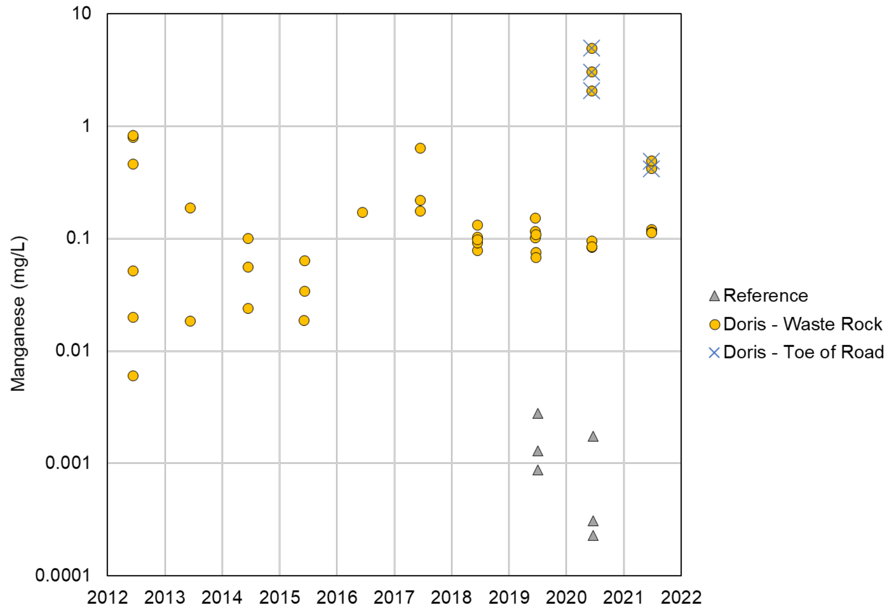
Note: Toe of access road samples only identified since 2020.

Figure 4-6: Cobalt Seepage Monitoring Data, Waste Rock Influenced Area and Reference Areas



Note: Toe of access road samples only identified since 2020.

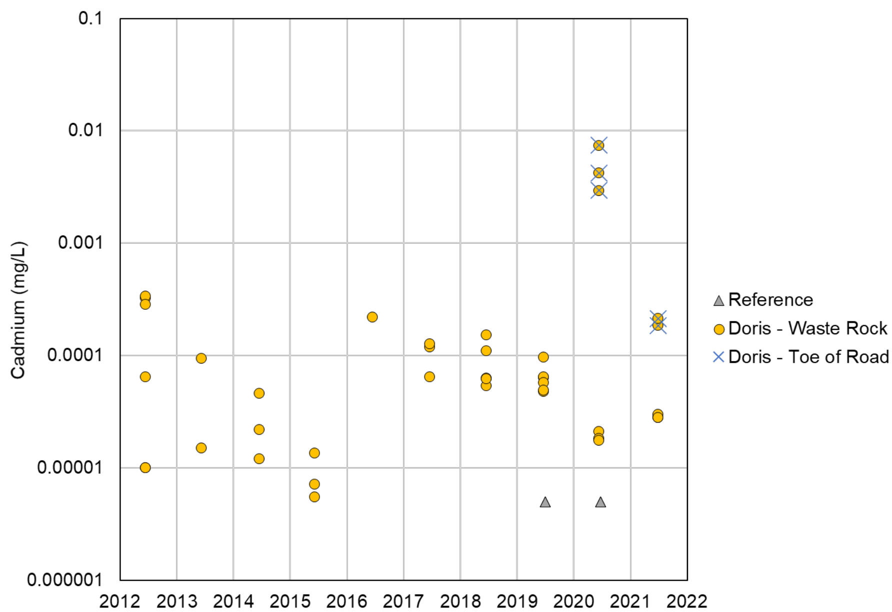
Figure 4-7: Nickel Seepage Monitoring Data, Waste Rock Influenced Area and Reference Areas



https://srk.sharepoint.com/sites/FS208/Internal/!Databases/Geochemistry/Seepage/Doris-Madrid seepage compilation/[1CT022.037_2019_Doris-MadridSeep_rev04_jce_dwm_bdd.xlsx]

Note: Toe of access road samples only identified since 2020.

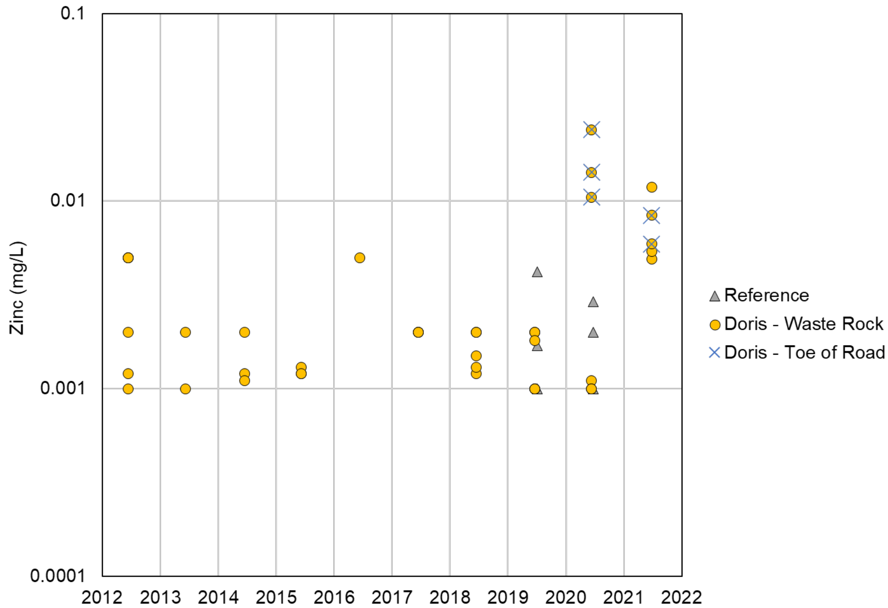
Figure 4-8: Manganese Seepage Monitoring Data, Waste Rock Influenced Area and Reference Areas



https://srk.sharepoint.com/sites/FS208/Internal/!Databases/Geochemistry/Seepage/Doris-Madrid seepage compilation/[1CT022.037_2019_Doris-MadridSeep_rev04_jce_dwm_bdd.xlsx]

Note: Toe of access road samples only identified since 2020.

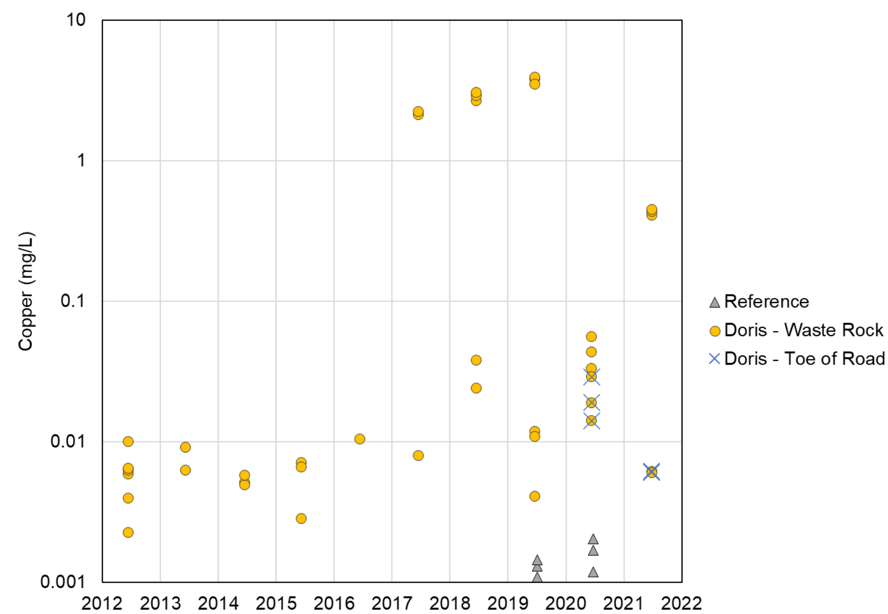
Figure 4-9: Cadmium Seepage Monitoring Data, Waste Rock Influenced Area and Reference Areas



https://srk.sharepoint.com/sites/FS208/Internal/!Databases/Geochemistry/Seepage/Doris-Madrid seepage compilation/[1CT022.037_2019_Doris-MadridSeep_rev04_jce_dwm_bdd.xlsx]

Note: Toe of access road samples only identified since 2020.

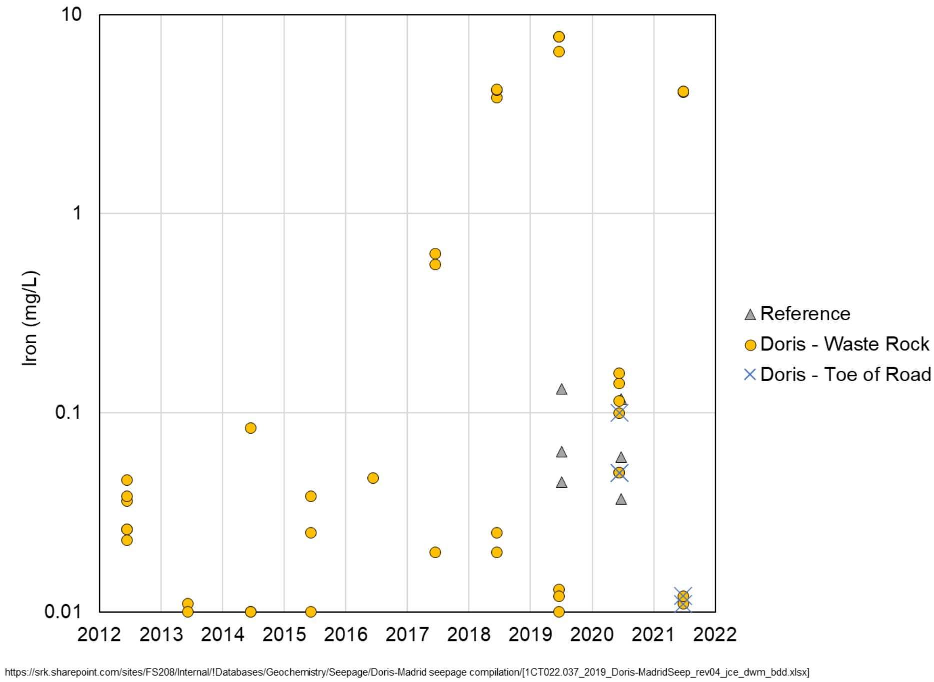
Figure 4-10: Zinc Seepage Monitoring Data, Waste Rock Influenced Area and Reference Areas



https://srk.sharepoint.com/sites/FS208/Internal/!Databases/Geochemistry/Seepage/Doris-Madrid seepage compilation/[1CT022.037_2019_Doris-MadridSeep_rev04_jce_dwm_bdd.xlsx]

Note: Toe of access road samples only identified since 2020.

Figure 4-11: Copper Seepage Monitoring Data, Waste Rock Influenced Area and Reference Areas



Note: Toe of access road samples only identified since 2020.

Figure 4-12: Iron Seepage Monitoring Data, Waste Rock Influenced Area and Reference Areas

4.2 Madrid North

4.2.1 Waste Rock Storage Area

Figure 4-13 and Figure 4-14 provides a comparison of selected parameters for Madrid North WRSA samples from 2020 and 2021. In 2020, briny rock placed on the Portal Pad was removed and sent to the Madrid WRSA and in 2021 reclamation of the Portal Pad was conducted, and material was transferred to the NE CPR.

- A summary of the Madrid North WRSA results from 2020 and 2021 is as follows:
- Field pH values from 2020 and 2021 are similar with values typically ranging from 7.3 to 8.3 in 2020 and 7.0 to 8.2 in 2021, except for Sump 1 with the lowest field pH values (6.7 and 6.8 in 2020 and 2021, respectively).
- In 2020, field EC values increased from June to September at all locations where multiple samples were collected and varied spatially. In contrast, field EC values from 2021 varied both spatially and temporally.
- Major cation chemistry was dominated by calcium and sodium except for selected samples at Sump 2. Concentrations at all sample locations remained relatively stable, except at Sump 3 and station MMS-1S (within the CWP) where median concentrations were higher in 2021, for example at Sump 3, median concentrations of calcium and sodium increased from 14 to 49 mg/L and 90 to 240 mg/L, respectively). Major anions chemistry was dominated by chloride

and sulphate in 2020 and 2021 except for samples from Sump 2. Chloride and sulphate concentrations increased from 2020 to 2021 at Sump 3 and MMS-1S and sulphate only at Sump 1. The increased major ions at Sump 3 and MMS-1S possibly suggests a buildup of residual salts at these stations.

- There were no other notable year over year trends in seepage chemistry that suggested preferential drainage of contact water from the underground and NE CPR waste rock to the sumps.

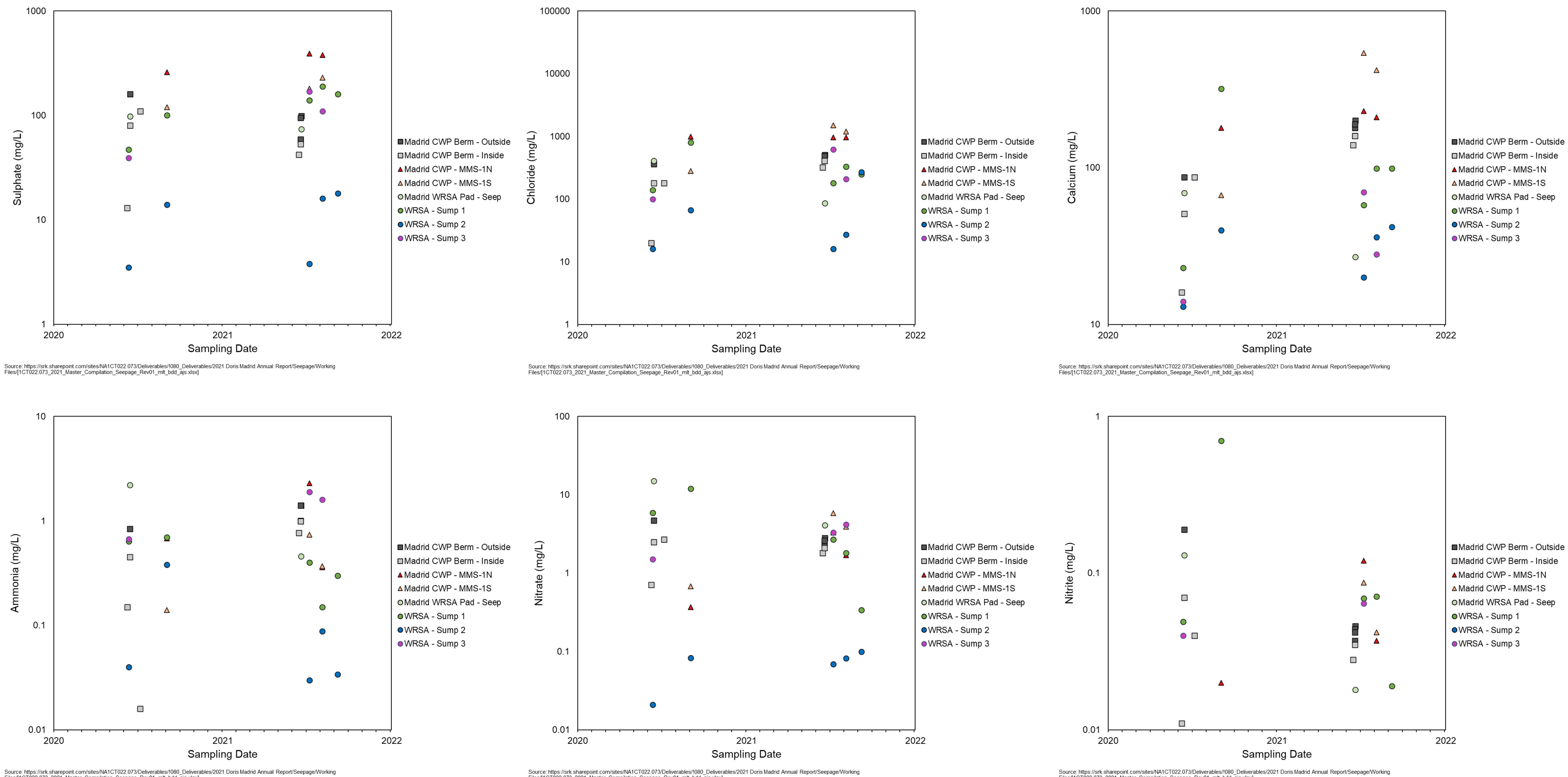


Figure 4-13: Time Series Plots Sulphate, Chloride, Calcium, Ammonia, Nitrate, and Nitrite, Madrid North Waste Rock Storage Area

Notes: Two seepage samples downstream of the CWP berm and the seepage near Sump 1 are dissolved metals whereas the remainder of the samples are total metals.

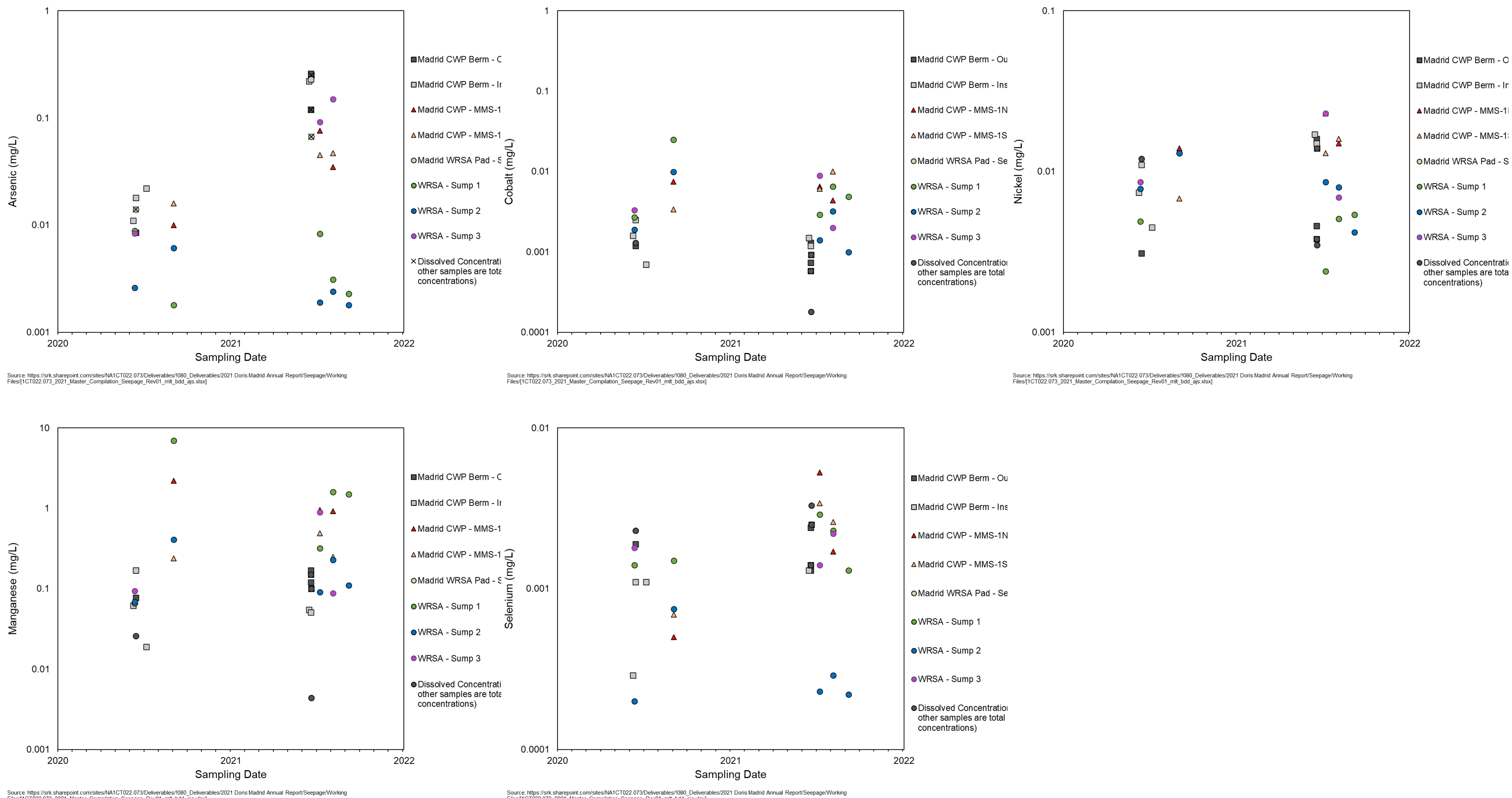


Figure 4-14: Time Series Plots of Arsenic, Cobalt, Nickel, Manganese, and Selenium, Madrid North Waste Rock Storage Area

Notes: Two seepage samples downstream of the CWP berm and the seepage near Sump 1 are dissolved metals whereas the remainder of the samples are total metals.

4.2.2 Infrastructure and Roads

Table 4-2, Figure 4-15, Figure 4-16, and Figure 4-17 provides a comparison of selected parameters for Overburden Stockpile and Portal Pad seepage samples from 2020 and 2021.

Overburden Stockpile

In 2020 seepage samples from the Overburden Stockpile indicated elevated EC, major ions, ammonia, cobalt, manganese, nickel, and zinc. An investigation of the potential source of loadings from the Overburden Stockpile concluded that seepage chemistry was likely a result of the thawing of saline interstitial porewater that had the chemical signature of seawater with localized pockets having concentrations higher than seawater that were conceptually related to cryoconcentration. In addition, overburden porewater was characterized by elevated concentrations of dissolved iron, cobalt, manganese, and nickel (SRK 2021e).

Overall, seepage from the Overburden Stockpile in 2021 was characterized by lower concentrations than 2020 and is summarized as follows[1]:

- Seepage from the Overburden Stockpile in 2021 was characterized by lower concentrations of EC and most major ions, whereby EC, sulphate, calcium, and potassium were one order of magnitude lower than 2020 samples and chloride, magnesium and sodium were up to two orders of magnitude lower. Figure 4-17 indicates that the major ion composition of 2021 samples was relatively uniform and distinctive from 2020 seepage samples.
- Ammonia and phosphorus concentrations in 2021 were two orders of magnitude lower than in 2020.
- Concentrations of dissolved trace elements were lower in 2021 with levels one or two orders of magnitude lower for antimony, cadmium, cobalt, iron, lead, manganese, molybdenum, nickel, selenium, and zinc. Notably, arsenic concentrations were roughly equivalent.

The significant decrease in concentrations of major ions and trace elements in seepage within one year validates the conceptual geochemical model that the source loading to seepage chemistry in 2020 was the thawing and draining of frozen saline porewater from the Overburden Stockpile, however seepage samples collected in 2021 were from a different location than 2020 samples. SRK (2021e) indicated that some overburden in the Stockpile was not saline.

[1] The seepage chemistry for 20-OVB-03 does not represent contact water of the Overburden Stockpile and accordingly this sample is not presented in Table 4-2, Table 3-3, Figure 4-15, and Figure 4-16.

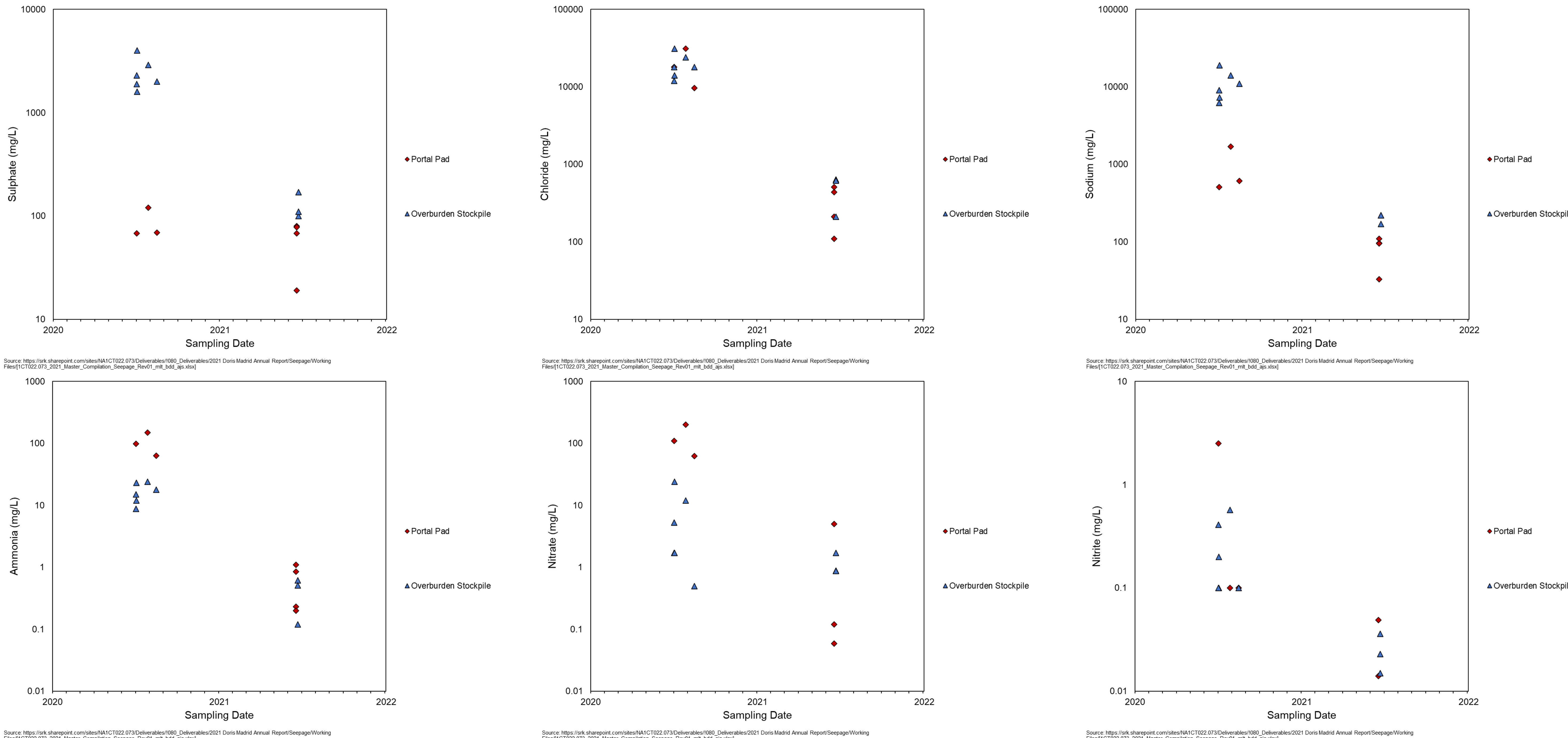


Figure 4-15: Time Series Plots Sulphate, Chloride, Sodium, Ammonia, Nitrate, and Nitrite, Madrid North Infrastructure and Roads

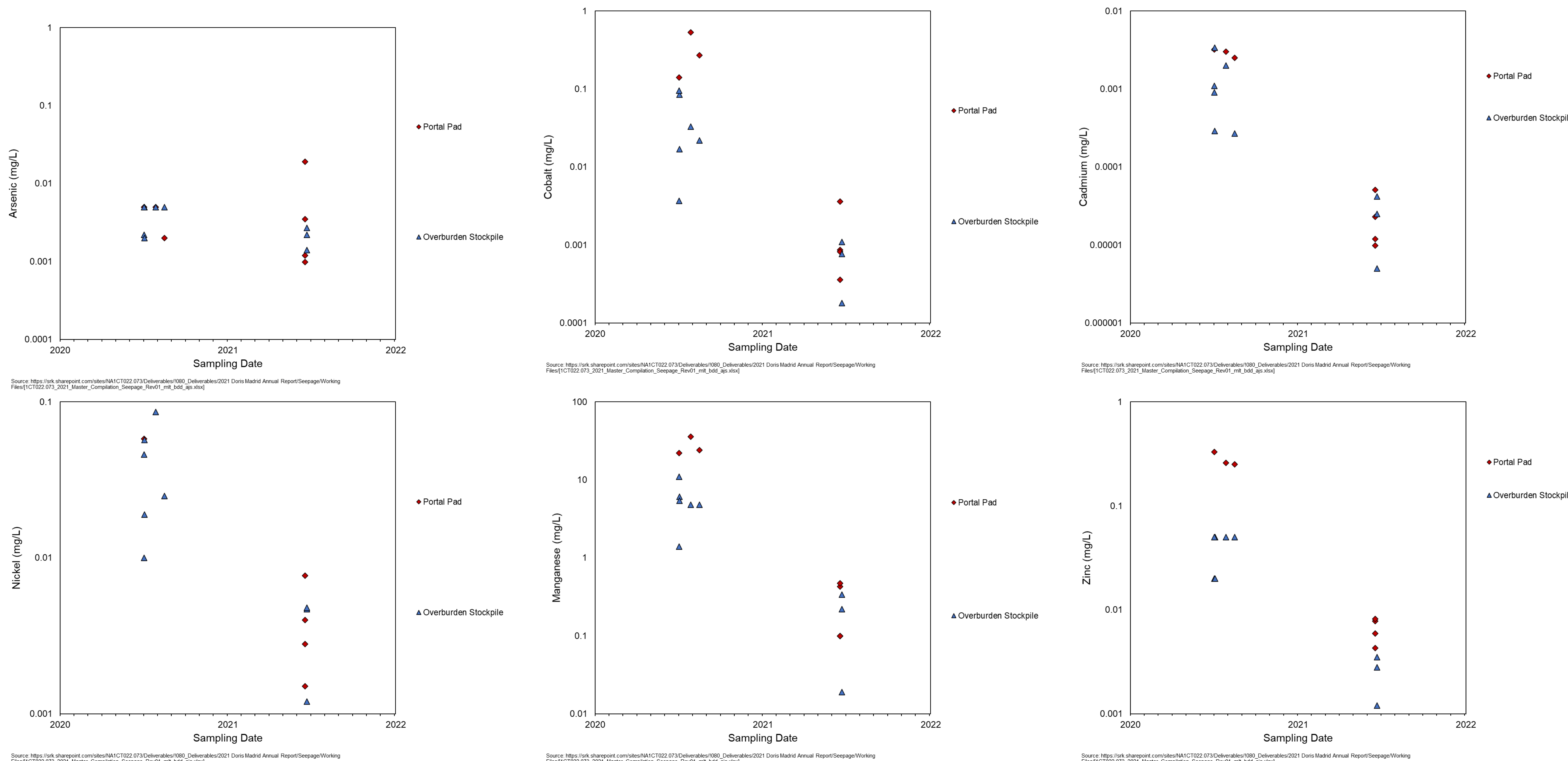
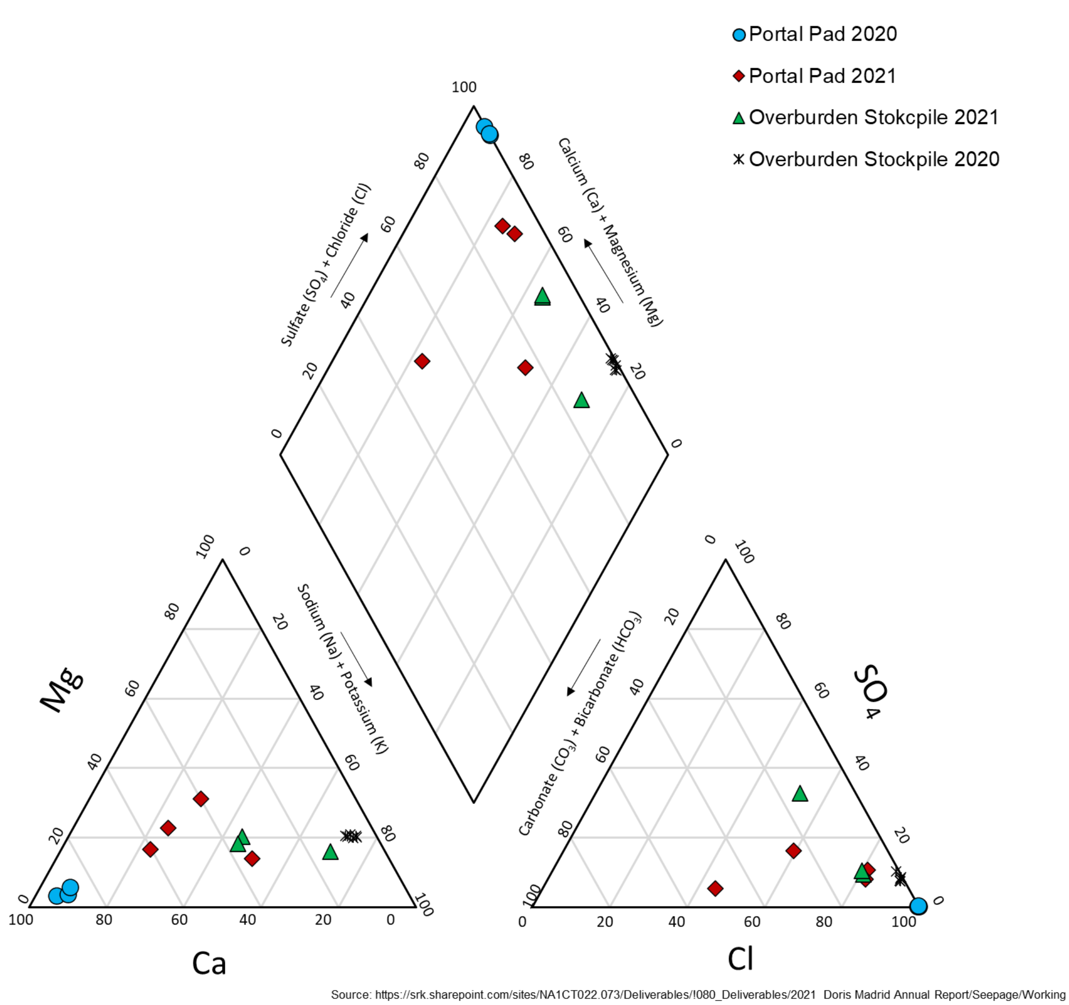


Figure 4-16: Time Series Plots Arsenic, Cobalt, Cadmium, Nickel, Manganese, and Zinc, Madrid North Infrastructure and Roads.



Source: https://srk.sharepoint.com/sites/NA1CT022.073/Deliverables/!080_Deliverables/2021 Doris Madrid Annual Report/Seepage/Working Files/[1CT022.073_2021_Master_Compilation_Seepage_Rev01_mlt_bdd_ajs.xlsx]

Figure 4-17: Piper Plot for 2020 and 2021 Overburden Stockpile and Portal Pad Seepage Samples

Portal Pad

The 2020 seepage survey of the Portal Pad indicated saline seepage (EC >35,000 µS/cm) dominated by calcium and chloride (Figure 4-17), elevated concentrations of cadmium (0.0025 to 0.0032 mg/L), cobalt (0.14 to 0.53 mg/L), manganese (210 to 460 mg/L), nickel (0.058 to 0.24 mg/L), and zinc (0.25 and 0.33 mg/L) and for one sample, a pH of 4.9 (SRK 2021e). Notably zinc was never identified as a metal leaching concern in geochemical baseline studies of waste rock. An investigation of the portal pad concluded that conceptually the source loads were not due to weathering of waste rock but accelerated rates of metal leaching in the presence of high ionic strength drilling brine (SRK 2021b). Furthermore, the acidic pH was attributed to organic acids in the active layer and/or release of acidity from ion exchange between seepage and tundra.

Between the 2020 and 2021 seepage surveys, AEM remediated the Portal Pad by removing areas of the Pad that were saline with disposal within the NE CPR. Accordingly, the results of the 2021 seepage survey are an indicator of the reclamation activities. The 2021 Portal Pad seepage chemistry in the context of reclamation activities is summarized as follows:

- All seepage observed in 2021 was non-acidic.
- EC values (780 to 2,000 µS/cm) were lower by one order of magnitude compared to 2020.
- Concentrations of calcium (71 to 190 mg/L) and chloride (110 to 510 mg/L) were lower by one order of magnitude compared to 2020. Sulphate concentrations (68 to 120 mg/L), which are an indicator of sulphide oxidation, were notably equivalent between years.
- Nitrogen nutrients, which are present in or residuals of explosives, were present at significantly lower concentrations in 2021, including ammonia (two orders of magnitude lower), nitrate (three to five orders of magnitude lower) and nitrite (up to two orders of magnitude lower).
- Trace element concentrations were lower including dissolved cadmium (one to two orders of magnitude), cobalt (two orders of magnitude), iron (three to four orders of magnitude), manganese (one order of magnitude), nickel (one order of magnitude), selenium (one order of magnitude) and zinc (one order of magnitude).

The results of the 2021 Portal Pad seepage survey indicates that reclamation activities have improved seepage chemistry.

Table 4-2: Comparison of Select Laboratory Results of 2020 and 2021 Seepage Samples, Madrid North Infrastructure and Roads

Area	Year	Station ID	Date	Field pH	Lab pH	Field EC	Lab EC	ORP	Total Alkalinity	Total Ammonia	Cl	NO3	NO2	SO4	Ca	Mg	K	Na	Al	As	Cd	Co	Cu	Fe	Mn	Mo	Ni	Se	Zn
						µS/cm	µS/cm	mV	mg $CaCO_3$/L	mg N/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Overburden Stockpile	2021	21-OVB-01	21-Jun-21	7.5	7.6	2,800	2,400	150	110	0.62	640	0.88	0.036	100	150	55	12	220	0.0077	0.0022	0.000025	0.00077	0.0029	0.029	0.22	0.0015	0.0047	0.00028	0.0028
		21-OVB-02	21-Jun-21	7.4	7.7	2,800	2,300	140	100	0.51	620	0.87	0.023	110	160	49	12	220	0.014	0.0027	0.000042	0.0011	0.0037	0.044	0.34	0.0021	0.0048	0.00034	0.0035
		21-OVB-04	21-Jun-21	8.1	8.0	1,500	1,200	140	79	0.12	210	1.7	0.015	170	31	22	9	170	0.019	0.0014	0.000005	0.00018	0.0057	0.012	0.019	0.0051	0.0012	0.00043	0.0012
	2020	20-OVB-01	2-Jul-20	6.8	7.3	--	31,000	220	160	8.8	12,000	1.7	0.41	1,900	610	960	200	6,200	0.02	0.0022	0.0011	0.0037	0.0067	0.2	1.4	0.0044	0.01	0.001	0.02
		20-OVB-02	3-Jul-20	7.0	7.2	--	81,000	230	220	23	31,000	24	0.2	4,000	1,500	2,900	590	19,000	0.05	0.005	0.0034	0.085	0.012	0.5	6.1	0.0064	0.057	0.0037	0.05
		20-OVB-03	27-Jul-20	6.9	6.8	--	63,000	86	270	24	24,000	12	0.57	2,900	1,000	2,000	450	14,000	0.05	0.005	0.002	0.033	0.01	15	4.8	0.028	0.086	0.0027	0.05
		20-OVB-03	15-Aug-20	6.8	7.7	--	55,000	69	320	18	18,000	0.5	0.1	2,000	660	1,600	330	11,000	0.05	0.005	0.00027	0.022	0.01	8.4	4.8	0.018	0.025	0.0025	0.05
		20-OVB-03A	3-Jul-20	7.1	7.2	--	37,000	82	290	12	14,000	1.7	0.1	1,600	450	1,100	260	7,300	0.02	0.002	0.00029	0.017	0.004	0.26	5.4	0.011	0.019	0.001	0.02
		20-NUN-01	2-Jul-20	7.1	7.3	--	44,000	190	180	15	18,000	5.3	0.1	2,300	840	1,400	280	9,100	0.05	0.005	0.00091	0.096	0.019	0.5	11	0.0056	0.046	0.0025	0.05
Portal Pad	2021	21-MAD-01	17-Jun-21	7.2	7.9	1,800	1,700	190	60	0.23	440	0.059	0.005	80	120	57	6.5	96	0.0092	0.00098	0.000012	0.00036	0.0015	0.033	0.1	0.00019	0.0015	0.0006	0.0043
		21-MAD-02	17-Jun-21	7.4	7.9	780	750	150	180	0.2	110	0.005	0.001	19	82	14	6.2	33	0.019	0.0035	0.000023	0.00087	0.0031	0.029	0.43	0.00043	0.0028	0.00024	0.0078
		21-MAD-03	17-Jun-21	8.0	8.1	1,200	1,100	160	120	0.85	210	5	0.049	78	71	17	8.1	110	0.014	0.019	9.8E-06	0.00082	0.0038	0.028	0.1	0.0069	0.0077	0.0016	0.0059
		21-MAD-04	17-Jun-21	7.3	7.9	2,000	1,900	100	86	1.1	510	0.12	0.014	68	190	49	8.3	95	0.0074	0.0012	0.000051	0.0036	0.0025	0.22	0.47	0.00043	0.004	0.00046	0.0082
	2020	20-MAD-01	2-Jul-20	6.0	6.6	--	40,000	140	85	98	18,000	110	2.5	68	9100	210	170	510	0.058	0.005	0.0032	0.14	0.01	0.5	22	0.0025	0.058	0.004	0.33
		20-MAD-02	27-Jul-20	5.3	4.9	--	68,000	110	2.5	150	31,000	200	0.1	120	17,000	460	320	1,700	0.26	0.005	0.003	0.53	0.013	490	36	0.0025	0.24	0.0059	0.26
		20-MAD-02	15-Aug-20	5.6	5.6	--	35,000	140	5.1	63	9,700	62	0.1	69	6700	280	130	610	0.099	0.002	0.0025	0.27	0.004	160	24	0.001	0.12	0.0031	0.25

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5 Conclusions and Recommendations

The scope of the 2021 construction rock seepage survey included infrastructure constructed between Fall 2020 and Spring 2021 and areas from the 2020 survey where subsequent monitoring was recommended (SRK 2021). At Doris, the construction seepage survey included the access road to the vent raise. At Madrid North, the construction survey included the Overburden Stockpile, Portal Pad, and Madrid Shop laydown, the latter two which were constructed from NE CPR waste rock. The three reference sites, located in the undisturbed tundra and not subject to mine influences, were not sampled in 2021.

5.1 Doris

5.1.1 Doris Waste Rock Influenced Area

Consistent with previous years, seepage at the waste rock influenced area was characterized according to two groups: i) the downstream toe of the waste rock/ore stockpile on Pad I and ii) toe of the access road. A summary of seepage chemistry data of these two groups is as follows:

- pH for all seepage samples was non-acidic (7.5 to 7.9). EC values were 2,100 µS/cm at the toe of the stockpile and 4,100 and 4,200 µS/cm for samples at the toe of the access road.
- The major ion chemistry differed between the stockpile (21DC-01 to 21DC-03) and road (21DC-04 and 21DC-06) samples. The differences in major ion chemistry for the WRIA sample groups are illustrated in Figure 3-1 and summarized as follows:
  - For the stockpile samples, major cation chemistry was dominated by sodium (280 to 300 mg/L) with lesser calcium (99 to 100 mg/L), while major anion chemistry was dominated by sulphate (530 mg/L), chloride (250 mg/L), and
  - For the access road samples the cation chemistry was dominated by calcium (350 and 360 mg/L) and sodium (340 mg/L), while major anion chemistry was dominated by chloride (1,100 mg/L), sulphate (170 and 180 mg/L) and nitrate (63 and 64 mg/L as N).
- Prior to 2020, seepage at the toe of the road had the chemical signature of waste rock and was more dilute that waste rock contact water, e.g. DC-01 because the seepage was mixed with other flows. Since 2020, the higher chloride and ammonia concentrations in the road seepage samples suggests a loading source other than waste rock.
- A comparison of seepage trace element concentrations is summarized as follows:
  - Higher for stockpile stations: sulphate (530 mg/L), arsenic (ranging from 0.0040 to 00042 mg/L and three times higher), cobalt (0.034 to 0.035 mg/L and one order of magnitude higher), molybdenum (0.012 to 0.013 mg/L and one order of magnitude higher), and nickel (0.051 to 0.053 mg/L and one order of magnitude higher). Trends in these parameters were relatively stable except sulphate, which has been increasing with time.

  - Higher for road stations: cadmium (ranging from 0.00019 and 0.00021 mg/L and one order of magnitude). and manganese concentrations (0.42 and 0.49 mg/L and 4 times greater for manganese).
  - Equivalent: dissolved selenium and zinc were similar for all samples.
- For stockpile seepage, trends for all parameters were either decreasing or stable except for sulphate, which was increasing.
- For the access road seepage, concentrations for all parameters have decreased since 2020.

All drainage from the Doris camp pad, including seepage captured in the collection sumps downstream of the toe of the access road, is pumped to the sediment control pond (SCP) prior to transfer to the TIA. In 2021, water from the SCP accounted for 1.4% of total inflow volumes entering the TIA and 0.4% of the total volume stored in the TIA.

5.2 Madrid North

5.2.1 Waste Rock Storage Area

SFE arsenic concentrations for Madrid North waste rock at WRSA exhibited a positive trend with solid-phase arsenic and sulphur content. SFE arsenic did not have a relationship with gold in WRSA rock suggesting arsenic leaching is not higher for the oxide stockpile containing ore (SRK 2021c).

Water management at the Madrid North WRSA includes three water collection sumps (Sump 1, Sump 2 and Sump 3) and the Madrid North CWP. Water from the sumps is pumped to the contact water pond, therefore water chemistry at the CWP is influenced by waste rock seepage draining to CWP and the collection sumps. Discharge of effluent onto tundra from the CWP is in accordance with the effluent quality limits provided in the Water License. Water that does not meet these criteria is transferred to the TIA via water truck.

The water quality sample set in 2021 included i) one seepage sample collected downstream of the WRSA pad and near Sump 1, ii) monthly water quality samples from the contact water pond (CWP), Sump 1, Sump 2, and Sump 3 and iii) seepage samples collected upstream and downstream of the CWP berm. The purpose of the seepage monitoring upstream and downstream of the CWP berm was to geochemically characterize seepage that is bypassing the CWP.

Selected data did not pass QC checks and dissolved metals data were not available for all samples. Consequently, data interpretation was based on data that was determined to be acceptable to SRK. A summary of the results are as follows:

- All waste rock drainage samples were non-acidic and EC values (240 to 5,100 µS/cm) indicated the temporal and spatial variability at all stations.
- The major ion chemistry for the Madrid North WRSA samples is illustrated in Figure 3-1. As with EC, concentrations of all major ions were variable with time (e.g. sulphate, chloride and calcium as shown in Figure 4-13). The major cation chemistry for most Madrid WRSA samples

was typically dominated by sodium (12 to 440 mg/L) and calcium (20 to 540 mg/L), with concentrations for Sumps 1, 2, and 3 lower than CWP samples. Seepage at Sump 2 was dominated by magnesium (14 to 70 mg/L) and calcium (20 to 42 mg/L) with lesser sodium (12 to 31 mg/L). Seepage near Sump 1 (21-WRP-01) was lower than Sump 1 samples. Major anions for all samples were dominated by chloride (16 to 1,500 mg/L), sulphate (3.8 to 420 mg/L), and alkalinity (39 to 230 mg/L).

- Chloride concentrations ranged from 320 to 510 mg/L for all stations in June except the seepage sample near Sump 1 (86 mg/L).
- The seepage sample near Sump 1 had chloride (86 mg/L) and sulphate (74 mg/L) concentrations that were two times smaller than the nearby sump sample from 18 days prior. The lower concentration suggests that the seepage is less representative of waste rock contact water than the Sump 1.
- There was a temporal decrease in chloride concentrations at Sump 3 (maximum 620 mg/L) and CWP samples MMS1-N and MMS1-S (maximum values of 970 and 1,500 mg/L, respectively) between July and September. Decreases are likely due to increased dilution from inflows to the CWP and reduced loading from underground waste rock that reports to Sump 3. The temporal increase in chloride concentrations at Sump 2 (from 16 mg/L in July to 270 mg/L in September) suggests that a minor loading source from underground waste rock reports directly to this water management collection point.
- In June, concentrations of chloride and sulphate were slightly higher for samples downstream of the CWP berm (410 to 510 mg/L) compared to samples upstream of the CWP berm (320 to 410 mg/L), but overall the chemistry was roughly equivalent.

In 2022, AEM is scheduled to construct a sump downstream of the CWP berm to intercept any CWP bypassing containment.

5.2.2 Infrastructure and Roads

Infrastructure surveyed at Madrid North included the Overburden Stockpile, Madrid North Portal Pad (reclamation activities conducted between 2020 and 201 seepage surveys), and Madrid Shop Laydown (constructed of NE CPR waste rock). Seepage stations were established at the Portal Pad and Overburden Stockpile. A summary of the seepage chemistry is as follows:

- Laboratory pH ranged from 7.2 to 8.1 for all samples. EC values ranged from 1,100 to 2,400 µS/cm except for one Portal Pad sample (21-MAD-02) with a value of 750 µS/cm.
- The major cation chemistry was dominated by calcium (24 to 160 mg/L and 71 to 190 mg/L for Overburden Stockpile and Portal Pad samples, respectively) and sodium (9.1 to 220 mg/L and 33 to 110 mg/L, respectively). Major anions were dominated by chloride in half of the samples with concentrations ranging from 210 to 640 mg/. Two samples, 21-OVB-03 and 21-MAD-02 were dominated by total alkalinity, with chloride concentrations of 13 and 110 mg/L and alkalinity values of 74 and 180 mg $CaCO_3$/t, respectively. Overburden sample 04 was dominated by chloride (210 mg/L) and sulphate (170 mg/L). Overall, seepage sample 21-OVB-

03 contained the lowest concentrations of major ions suggesting this material did not contain saline porewater.

- Nutrient concentrations ranged from 0.11 to 1.1 mg/L as N (ammonia), 0.005 to 5.0 mg/L (nitrate), and 0.001 to 0.049 mg/L as N (nitrite) with no consistent differences between the two areas (Figure 4-13). These nitrogen concentrations are not indicative of blast residues from underground waste rock.
- Cobalt concentrations ranged from 0.00018 to 0.0036 mg/L for all samples.
- Manganese concentrations were higher in Portal Pad samples with values ranging from 0.10 to 0.47 mg/L, compared to Overburden Stockpile samples with values ranging from 0.019 to 0.34 mg/L.
- Nickel concentrations ranged from 0.0012 to 0.0077 mg/L for all samples.
- Zinc concentrations were highest in Portal Pad samples with values ranging from 0.0043 to 0.0082 mg/L, compared to Overburden Stockpile samples with values from 0.0012 to 0.0035 mg/L).

Overall, major ion and dissolved metal concentrations for both the Overburden Stockpile and Portal Pad samples were significantly lower than concentrations quantified in 2020 (SRK 2021e). At the Portal Pad these concentrations confirm the briny waste rock was the source of elevated concentrations as the removal of the material drastically reduced concentrations. Lower concentrations at the Overburden Stockpile suggest much of the saline ice lenses have been flushed through the stockpile.

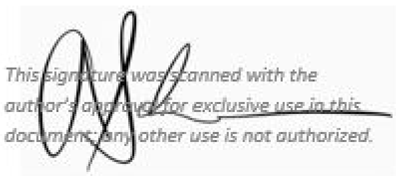
5.3 Recommendations

SRK recommends the following for the 2022 seepage survey:

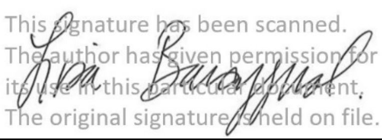
- Routine monitoring of infrastructure, pads, and roads as per the Water Licence and applicable management plans (TMAC 2017b and 2019).
- At Doris:
  - Continued seepage survey monitoring of waste rock at the toe of the stockpiles on Pad T, Pad I and at the toe of the access road.
  - Conduct seepage survey at access road to vent raise.
- At Madrid North:
  - Continued seepage survey monitoring of the waste rock stockpile at the Madrid North WRSA, that includes walking the toes of all stockpiles and the toe of the WRSA pad.
  - One year of seepage monitoring at the Madrid Portal Pad to confirm changes.
  - One year of seepage monitoring at the southern toe of the Overburden Stockpile where saline seepage was observed in 2020.
  - Conduct seepage survey at Madrid Shop Laydown.

– Dissolved metals analysis for all samples collected at the WRSA, including the CWP and Sumps to quantify metal leaching from waste rock at WRSA.
– Monitor seepage samples on the downstream side of the CWP berm at the same frequency as the routine CWP samples (e.g. July to September).

Regards,
SRK Consulting (Canada) Inc.



Amanda Schevers, GIT (BC)
Staff Consultant (Geochemistry)



Lisa Barazzuol, PGeo (NT/NU)
Principal Consultant (Geochemistry)

Attachments:

Attachment 1	Maps of 2021 Seepage Survey Locations
Attachment 2	2021 Field Observations and Measurements
Attachment 3	2021 Laboratory Water Quality Data

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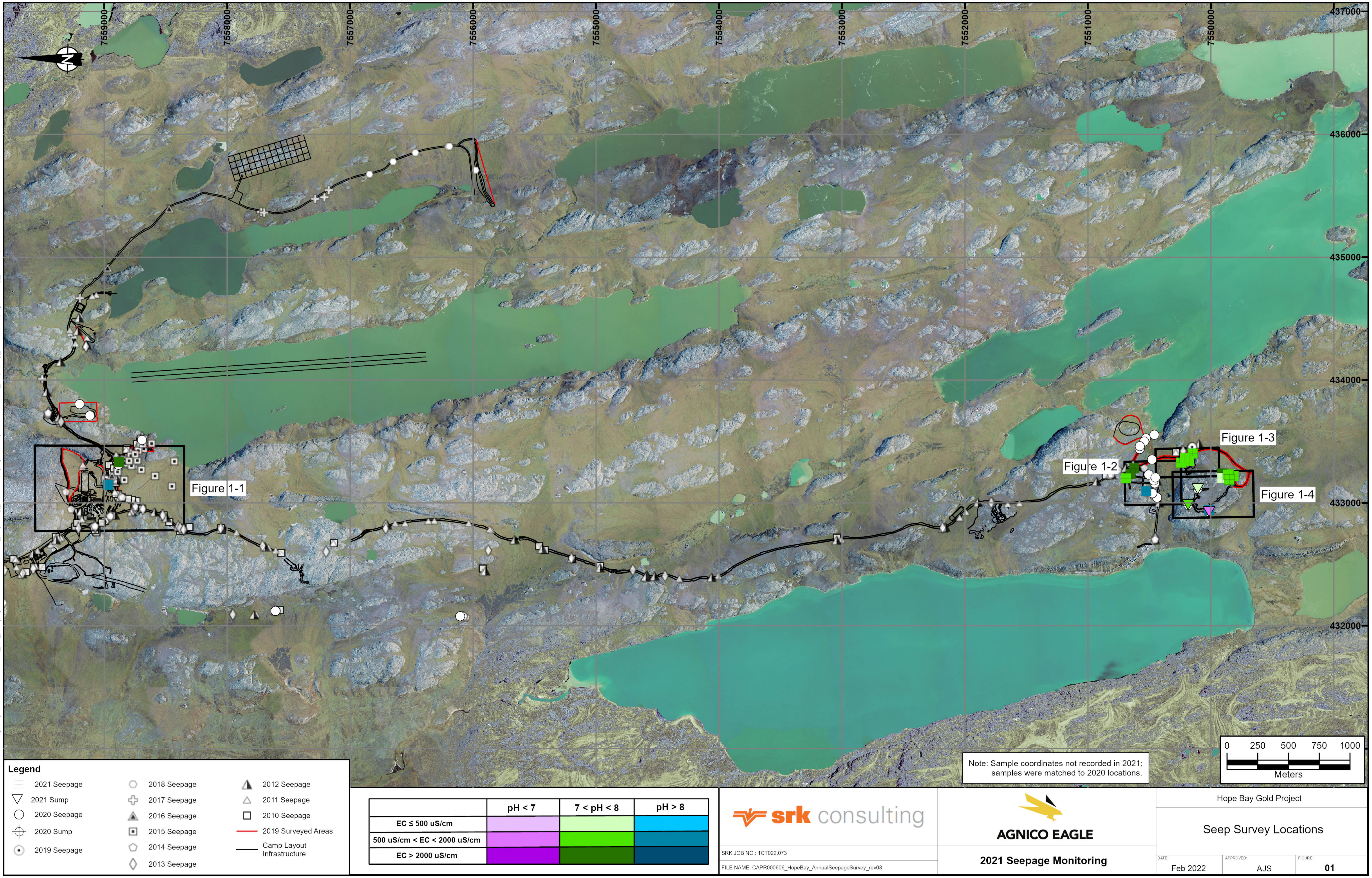
Attachment 1 Maps of 2021 Seepage Survey Locations



	pH < 7	7 < pH < 8	pH > 8
EC ≤ 500 uS/cm			
500 uS/cm < EC < 2000 uS/cm			
EC > 2000 uS/cm			

srk consulting

SRK JOB NO.: 1CT022.073

FILE NAME: CAPR000606_HopeBay_AnnualSeepageSurvey_rev03

AGNICO EAGLE

2021 Seepage Monitoring

Hope Bay Gold Project

Seep Survey Locations

DATE: Feb 2022 | APPROVED: AJS | FIGURE: 01

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Legend

- 2021 Seepage
- 2021 Routine Monitoring Station
- 2020 Seepage
- 2020 Sump
- 2019 Seepage
- 2018 Seepage
- 2017 Seepage
- 2016 Seepage
- 2015 Seepage
- 2014 Seepage
- 2013 Seepage
- 2012 Seepage
- 2011 Seepage
- 2010 Seepage
- 2019 Surveyed Areas
- Camp Layout Infrastructure

	pH < 7	7 < pH < 8	pH > 8
EC ≤ 500 uS/cm			
500 uS/cm < EC < 2000 uS/cm			
EC > 2000 uS/cm			

srk consulting

SRK JOB NO.: 1CT022.073

FILE NAME: CAPR000606_HopeBay_AnnualSeepageSurvey_rev05

AGNICO EAGLE

2021 Seepage Monitoring

Hope Bay Gold Project

Seep Survey Locations

DATE:	APPROVED:	FIGURE:
Feb 2022	AJS	1-1

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Legend

- 2021 Seepage
- 2020 Seepage
- 2020 Sump
- 2019 Seepage
- 2018 Seepage
- 2017 Seepage
- 2016 Seepage
- 2015 Seepage
- 2014 Seepage
- 2013 Seepage
- 2012 Seepage
- 2011 Seepage
- 2010 Seepage
- 2019 Surveyed Areas
- Camp Layout Infrastructure

	pH < 7	7 < pH < 8	pH > 8
EC ≤ 500 uS/cm			
500 uS/cm < EC < 2000 uS/cm			
EC > 2000 uS/cm			

srk consulting

SRK JOB NO.: 1CT022.073

FILE NAME: CAPR000606_HopeBay_AnnualSeepageSurvey_rev03

AGNICO EAGLE

2021 Seepage Monitoring

Hope Bay Gold Project

Seep Survey Locations

DATE:	APPROVED:	FIGURE:
Feb 2022	AJS	1-2

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Legend

- 2021 Seepage
- 2020 Seepage
- 2020 Sump
- 2019 Seepage
- 2018 Seepage
- 2017 Seepage
- 2016 Seepage
- 2015 Seepage
- 2014 Seepage
- 2013 Seepage
- 2012 Seepage
- 2011 Seepage
- 2010 Seepage
- 2019 Surveyed Areas
- Camp Layout Infrastructure

	pH < 7	7 < pH < 8	pH > 8
EC ≤ 500 uS/cm			
500 uS/cm < EC < 2000 uS/cm			
EC > 2000 uS/cm			

srk consulting

SRK JOB NO.: 1CT022.073

FILE NAME: CAPR000606_HopeBay_AnnualSeepageSurvey_rev01

AGNICO EAGLE

2021 Seepage Monitoring

Hope Bay Gold Project

Seep Survey Locations

DATE:	APPROVED:	FIGURE:
Feb 2022	AJS	1-3

Legend

- 2021 Seepage
- 2021 Routine Monitoring Station
- 2020 Seepage
- 2020 Sump
- 2019 Seepage
- 2018 Seepage
- 2017 Seepage
- 2016 Seepage
- 2015 Seepage
- 2014 Seepage
- 2013 Seepage
- 2012 Seepage
- 2011 Seepage
- 2010 Seepage
- 2019 Surveyed Areas
- Camp Layout Infrastructure

	pH < 7	7 < pH < 8	pH > 8
EC ≤ 500 uS/cm			
500 uS/cm < EC < 2000 uS/cm			
EC > 2000 uS/cm			

srk consulting

SRK JOB NO.: 1CT022.073

FILE NAME: CAPR000606_HopeBay_AnnualSeepageSurvey_rev04

AGNICO EAGLE

2021 Seepage Monitoring

Hope Bay Gold Project

Seep Survey Locations

DATE: Feb 2022 | APPROVED: AJS | FIGURE: 1-4

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Attachment 2 2021 Field Observations and Measurements

Region	Area	Report ID	Original Sample ID	Date	Description of Location	Field Measurements												Lab sample collected	Duplicate	Field Blank
						pH	Conductivity	ORP	Water Temperature	Water Colour	Turbidity	t1	t2	t3	Amount	Capture	Flow			
						pH units	µS/cm	mV	°C			sec	sec	sec	mL	%	L/s			
Doris	Waste Rock Influenced Area (WRIA)	21DC-01	21DC-01	2021-06-25	inside PCP at NW edge. Seep flows through base of pond, along edge. Multiple seeps in area. Flows in multiple channels, (unable to measure flow) into central pond. Flow is through some exposed geotextile with some algae on it. Shallow flow.	8.14	2190	143	7.2	Clear	No	-	-	-	-	-	-	Yes	Yes	Yes
		21DC-02	21DC-02	2021-06-25	Small seep flowing from base of roadway inside PCP. Approx. 3m from 21-DC-01 (along NW edge of road). Flow fans out into multiple streams to central pool. Unable to measure flow. Shallow flow with some pooling.	8.12	2230	191	1.7	Clear/light green	No	-	-	-	-	-	-	Yes	No	No
		21DC-03	21DC-03	2021-06-25	Multiple seeps in area. Approx. 3m from 21-DC-03. Flow through base of road in NW corner inside PCP. Flows through multiple channels to central pool. Deeper flow with some pooling.	8.03	2240	199	0.9	Clear	No	0.991	0.997	1.037	30	0	-	Yes	No	No
		21DC-04	21DC-04	2021-06-25	Multiple seeps in area. Seep fans out over tundra, flowing toward ST2S3. Flow roughly 10m from ST2S1. Flow steady, but unable to measure. Flow through base of road.	7.71	5610	152	2.6	Clear	No	-	-	-	-	-	-	Yes	No	No
		21DC-05	21DC-05	2021-06-25	Approx. 3m W of 21-DC-04. Shallow, steady flow fanning out over tundra, flowing toward ST2S3. Algae growing in area. Flow through base of road.	7.93	5430	141	3	Clear	No	-	-	-	-	-	-	Yes	No	No
Madrid	Overburden Stockpile	21-OVB-01	21-OVB-01	2021-06-21	Large rocks; west side of windy road Km8. Madrid area near Drills.	7.48	2760	154	6.5	clear	No	6.52	4.42	4.4	-	-	-	Yes	No	No
		21-OVB-02	21-OVB-02	2021-06-21	large rocks; seep located where two roads connect; west side of windy road; Geo 5 location	7.42	2800	144	5.3	clear	No	2.3	2.5	2	-	-	-	Yes	No	No
		21-OVB-03	21-OVB-03	2021-06-21	North end of OVB pad, flowing North. Flow through base of road, shallow and small. Difficult to accurately measure flow. Flow through small-medium sized material.	7.73	193	118	4	clear/ light yellow	No	5.656	5.347	5.523	-	-	-	Yes	No	No
		21-OVB-04	21-OVB-04	2021-06-21	seep directly out of OVB pad, through OVB, 25m close to south western edge of OVB pad. Flow steady	8.14	1489	141	2.8	clearish	No	3.005	2.81	3.18	-	-	-	Yes	No	No
	Portal Pad	21-MAD-01	21-MAD-01	2021-06-17	water clear SE of pad flow coming out of road; cocomat down in area	7.22	1823	190	32	clear	No	5.828	6.214	4.388	3-3.5 depths	-	-	Yes	No	No
		21-MAD-02	21-MAD-02	2021-06-17	Edge of old waste rock storage area; coco matting present/upstream; mixture size rock; seep steady but shallow; less flow today	7.39	781	149	6.6	cloudy	No	-	-	-	-	-	-	Yes	No	No
		21-MAD-03	21-MAD-03	2021-06-17	NE cornder of Madrid Pad; Mixture rock sizes; foamy red/brown on top of water	7.99	1180	160	5	cloudy clear	No	-	-	-	-	-	-	Yes	No	No
		21-MAD-04	21-MAD-04	2021-06-17	Midpoint of original roadway to lower laydown; strong flow through base of small to medium sized rock at base of roadway; ground around area satured with pooling.	7.28	1990	102	9.5	Clear	No	-	-	-	-	-	-	Yes	No	No
	WRSA Pad Seepage near Sump 1	21-WRP-01	21-WRP-01	2021-06-19	Southend by Madrid Sump MMS1-1. Road edge flows through large boulders.	8.21	704	174	0.5	Clear	No	-						Yes	No	No
	Seepage Outside the CWP Berm	21-CWP-01	21-CWP-01	2021-06-18	Roughly centre contact water pond/ bank edge. Snow directly upstream bank in between 2 outcrops, grey precipitate on tundra	7.5	1689	193	2.4	Clear	No	-	-	-	-	-	-	Yes	No	No
		21-CWP-02	21-CWP-02	2021-06-19	Downstream inside ____ snow drift beside it	7.9	2110	135	0.1	Clear	No	-	-	-	-	-	-	Yes	No	No
		MMS1-OUTSIDE	MMS1-OUTSIDE	2021-06-18		7.45	1715	165	2.4	-	-	-	-	-	-	-	-	Yes	No	No
		MMS1-OUTSIDE 2	MMS1-OUTSIDE 2	2021-06-18		-	-	-	-	-	-	-	-	-	-	-	-	Yes	No	No
	Inside the Contact Water Pond (CWP)	MMS-1	MMS-1	2021-06-14		7.77	1291	198	7.2	-	-	-	-	-	-	-	-	Yes	No	No
			MMS1-INSIDE	2021-06-18		7.80	1622	145	5.8	-	-	-	-	-	-	-	-	Yes	No	No
		MMS-1N	MMS-1N	2021-07-07		7.43	3770	124	8.3	-	-	-	-	-	-	-	-	Yes	No	No
			MMS-1N	2021-08-04		8.06	4110	129	8.9	-	-	-	-	-	-	-	-	Yes	No	No
			MMS1-N	2021-09-06		8.1	4100	140	0	-	-	0	0	0	0	0	0	0	0	0
		MMS-1S	MMS-1S	2021-07-07		7.47	5070	177	15.4	-	-	-	-	-	-	-	-	Yes	No	No
			MMS-1S	2021-08-04		7.38	4400	103	8.5	-	-	-	-	-	-	-	-	Yes	No	No
			MMS1-S	2021-09-06		7.9	1500	130	0	-	-	0	0	0	0	0	0	0	0	0
	Sump 1, WRSA	MMS1-S1	MMS1-S1	2021-07-07		7.45	1179	150	4.9	-	-	-	-	-	-	-	-	Yes	No	No
			MMS1-S1	2021-08-04		6.76	1717	84	6.4	-	-	-	-	-	-	-	-	Yes	No	No
			MMS1-S1	2021-09-06		6.99	1406	88	3.9	-	-	-	-	-	-	-	-	Yes	No	No
	Sump 2, WRSA	MMS1-S2	MMS1-S2	2021-07-07		8.04	244	167	8.2	-	-	-	-	-	-	-	-	Yes	No	No
			MMS1-S2	2021-08-04		7.8	467	-29	4.3	-	-	-	-	-	-	-	-	Yes	No	No
			MMS1-S2	2021-09-06		7.49	1029	122	4.7	-	-	-	-	-	-	-	-	Yes	No	No
	Sump 3, WRSA	MMS1-S3	MMS1-S3	2021-07-07		7.91	2130	183	8.2	-	-	-	-	-	-	-	-	Yes	No	No
			MMS1-S3	2021-08-04		7.72	1453	130	6	-	-	-	-	-	-	-	-	Yes	No	No

Attachment 3 2021 Laboratory Water Quality Data

Region	Area	Report ID	Sample ID	Lab pH	Lab EC	ORP	Total Hardness	TSS	TDS	Acidity	Total Alkalinity	Ammonia	Cl	F	NO3
				s.u.	µS/cm	mV	mg CaCO3/L	mg/L	mg/L	mg CaCO3/L	mg CaCO3/L	mg N/L	mg/L	mg/L	mg /L
Doris	Doris WR Influenced Area	21DC-01	21DC-01	7.46	2120	143	422	7.9	1450	13.1	135	4.4	254	0.2	15.3
		21DC-02	21DC-02	7.46	2090	191	430	7.7	1390	12.1	132	4.37	251	0.2	15.4
		21DC-03	21DC-03	7.49	2100	199	428	4.7	1340	10.8	131	4.46	251	0.2	15.6
		21DC-04	21DC-04	7.91	4150	152	1130	3.1	3380	9.2	88.1	30.2	1060	0.4	63.4
		21DC-05	21DC-05	7.93	4080	141	1160	3	3520	8.9	90.3	30.2	1080	0.4	63.7
Madrid	Overburden Stockpile	21-OVB-01	21-OVB-01	7.61	2410	154	606	18.8	1920	4	108	0.62	636	0.2	0.877
		21-OVB-02	21-OVB-02	7.66	2320	144	610	16.6	1860	4.5	104	0.506	620	0.2	0.868
		21-OVB-03	21-OVB-03	7.92	195	118	75.7	5.4	132	2	74	0.107	12.9	0.037	0.0819
		21-OVB-04	21-OVB-04	7.98	1220	141	167	31.2	742	2	79.1	0.123	207	0.137	1.71
	Portal Pad	21-MAD-01	21-MAD-01	7.87	1710	190	534	29.4	1460	3.1	60.4	0.233	443	0.1	0.0593
		21-MAD-02	21-MAD-02	7.87	749	149	262	26	514	5.7	179	0.199	113	0.054	0.005
		21-MAD-03	21-MAD-03	8.11	1110	160	248	14.2	654	2	120	0.854	209	0.1	5.03
		21-MAD-04	21-MAD-04	7.93	1940	102	670	4.8	1880	3.7	86.1	1.06	512	0.2	0.115
	WRSA Pad Seepage near Sump 1	21-WRP-01	21-WRP-01	8.11	647	174	107	4	336	2	81	0.455	86.1	0.094	4.1
	Seepage Outside the CWP Berm	21-CWP-01	21-CWP-01	7.77	1590	193	520	3	1520	2.7	52	1.02	410	0.1	2.34
		21-CWP-02	21-CWP-02	7.98	1960	135	590	5	1820	3.4	74.7	1.39	507	0.2	2.78
		MMS1-OUTSIDE	MMS1-OUTSIDE	7.84	1590	165	490	3.0	--	--	56.8	1.02	414	0.1	2.39
		MMS1-OUTSIDE 2	MMS1-OUTSIDE 2	7.98	1940	-	585	20.0	--	--	72.5	1.43	493	0.1	2.59
	Inside the Contact Water Pond (CWP)	MMS-1	MMS-1	7.53	1220	198	408	13.6	--	--	30.2	0.766	324	0.1	1.76
			MMS1-INSIDE	7.75	1530	145	482	11.4	--	--	38.7	0.994	405	0.1	2.12
		MMS-1N	MMS-1N	7.88	3770	124	831	73.8	--	--	162	2.29	970	0.4	3.33
			MMS-1N	8.05	3870	129	851	7.5	--	--	219	0.362	959	0.4	1.72
			MMS1-N	8	1800	140	0	39	0	0	93	0.23	0	0	0
		MMS-1S	MMS-1S	7.79	4920	177	1650	7	--	--	88.2	0.743	1510	0.4	5.81
			MMS-1S	7.8	4120	103	1300	3	--	--	126	0.368	1160	0.4	3.85
			MMS1-S	8.2	4400	130	0	19	0	0	240	0.4	0	0	0
	Sump 1, WRSA	MMS1-S1	MMS1-S1	7.81	1110	150	214	3	--	--	147	0.403	177	0.1	2.69
			MMS1-S1	7.19	1640	84	340	3	--	--	147	0.153	325	0.1	1.84
			MMS1-S1	7.75	1480	88	340	3	--	--	190	0.304	248	0.1	0.338
	Sump 2, WRSA	MMS1-S2	MMS1-S2	7.85	242	167	106	3	--	--	105	0.03	16.3	0.215	0.0692
			MMS1-S2	7.91	429	-29	180	3.1	--	--	169	0.0879	27.2	0.216	0.0822
			MMS1-S2	7.79	1090	122	395	3	--	--	87.4	0.0337	266	0.1	0.103
	Sump 3, WRSA	MMS1-S3	MMS1-S3	7.63	2440	183	485	5.4	--	--	182	1.87	616	0.4	3.29
			MMS1-S3	8.14	1380	130	149	3	--	--	226	1.63	214	0.242	4.17

Dissolved Metals

Region	Area	Report ID	Sample ID	NO2	Total P	SO4	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Doris	Doris WR Influenced Area	21DC-01	21DC-01	1.34	0.0224	528	0.0072	0.00117	0.004	0.0195	0.0001	0.00005	0.375	0.000028	101
		21DC-02	21DC-02	1.21	0.0224	525	0.0076	0.0012	0.00423	0.0199	0.0001	0.00005	0.359	0.00003	101
		21DC-03	21DC-03	1.21	0.0224	532	0.0076	0.00118	0.00418	0.0208	0.0001	0.00005	0.369	0.0000283	98.8
		21DC-04	21DC-04	0.106	0.0224	178	0.0056	0.00052	0.00136	0.0554	0.0001	0.00005	0.195	0.000185	346
		21DC-05	21DC-05	0.0969	0.0224	172	0.0062	0.00057	0.00147	0.0584	0.0001	0.00005	0.2	0.000214	357
Madrid	Overburden Stockpile	21-OVB-01	21-OVB-01	0.0357	0.0224	102	0.0077	0.00015	0.0022	0.0357	0.0001	0.00005	0.118	0.0000248	153
		21-OVB-02	21-OVB-02	0.0227	0.0224	111	0.0138	0.00015	0.00266	0.044	0.0001	0.00005	0.116	0.0000424	163
		21-OVB-03	21-OVB-03	0.0038	0.0224	5.42	0.0233	0.0001	0.00202	0.00563	0.0001	0.00005	0.018	0.000005	24.2
		21-OVB-04	21-OVB-04	0.015	0.0224	174	0.019	0.00013	0.00139	0.00651	0.0001	0.00005	0.138	0.000005	31.1
	Portal Pad	21-MAD-01	21-MAD-01	0.005	0.0224	80.2	0.0092	0.0001	0.00098	0.043	0.0001	0.00005	0.026	0.0000124	120
		21-MAD-02	21-MAD-02	0.001	0.0224	18.6	0.0186	0.00011	0.00352	0.0265	0.0001	0.00005	0.062	0.0000226	82.3
		21-MAD-03	21-MAD-03	0.0491	0.0224	78.1	0.014	0.00039	0.0189	0.0146	0.0001	0.00005	0.22	0.0000098	71.3
		21-MAD-04	21-MAD-04	0.0141	0.0224	67.8	0.0074	0.0001	0.0012	0.0674	0.0001	0.00005	0.038	0.000051	187
	WRSA Pad Seepage near Sump 1	21-WRP-01	21-WRP-01	0.0177	0.0224	74.3	0.0386	0.00106	0.0669	0.00603	0.0001	0.00005	0.112	0.0000052	27.4
	Seepage Outside the CWP Berm	21-CWP-01	21-CWP-01	0.0371	0.0407	58.4	0.0059	0.00119	0.117	0.0334	0.0001	0.00005	0.091	0.0000225	177
		21-CWP-02	21-CWP-02	0.0456	0.0224	99.1	0.0086	0.00239	0.252	0.0308	0.0001	0.00005	0.142	0.000015	197
		MMS1-OUTSIDE	MMS1-OUTSIDE	0.0443	0.0224	58.5	-	-	-	-	-	-	-	-	-
		MMS1-OUTSIDE 2	MMS1-OUTSIDE 2	0.0422	0.0224	94.8	-	-	-	-	-	-	-	-	-
	Inside the Contact Water Pond (CWP)	MMS-1	MMS-1	0.0277	0.0224	41.7	-	-	-	-	-	-	-	-	-
			MMS1-INSIDE	0.0354	0.0224	52.7	-	-	-	-	-	-	-	-	-
		MMS-1N	MMS-1N	0.115	0.0224	388	-	-	-	-	-	-	-	-	-
			MMS-1N	0.0365	0.0224	381	-	-	-	-	-	-	-	-	-
			MMS1-N	0	0	0	-	-	-	-	-	-	-	-	-
		MMS-1S	MMS-1S	0.0872	0.0224	177	-	-	-	-	-	-	-	-	-
			MMS-1S	0.0424	0.0224	227	-	-	-	-	-	-	-	-	-
			MMS1-S	0	0	0	-	-	-	-	-	-	-	-	-
	Sump 1, WRSA	MMS1-S1	MMS1-S1	0.0694	0.0224	139	-	-	-	-	-	-	-	-	-
			MMS1-S1	0.0712	0.0224	188	-	-	-	-	-	-	-	-	-
			MMS1-S1	0.0193	0.0224	156	-	-	-	-	-	-	-	-	-
	Sump 2, WRSA	MMS1-S2	MMS1-S2	0.0029	0.0224	3.77	-	-	-	-	-	-	-	-	-
			MMS1-S2	0.0068	0.0224	16.2	-	-	-	-	-	-	-	-	-
			MMS1-S2	0.005	0.0224	17.9	-	-	-	-	-	-	-	-	-
	Sump 3, WRSA	MMS1-S3	MMS1-S3	0.0637	0.0224	170	-	-	-	-	-	-	-	-	-
			MMS1-S3	0.0064	0.0224	112	-	-	-	-	-	-	-	-	-

Region	Area	Report ID	Sample ID	Cs	Cr	Co	Cu	Fe	Pb	Li	Mg	Mn	Hg	Mo	Ni
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Doris	Doris WR Influenced Area	21DC-01	21DC-01	0	0.00178	0.0341	0.411	4.09	0.00005	0.0068	41.3	0.12	0.0000174	0.0124	0.0509
		21DC-02	21DC-02	0	0.00182	0.0344	0.435	4.12	0.00005	0.0062	43.1	0.114	0.0000079	0.0129	0.0521
		21DC-03	21DC-03	0	0.00186	0.0346	0.449	4.12	0.000057	0.0061	44.1	0.113	0.0000067	0.0126	0.0533
		21DC-04	21DC-04	0	0.0005	0.00187	0.00615	0.011	0.00005	0.0085	65.1	0.417	0.000005	0.00586	0.00363
		21DC-05	21DC-05	0	0.0005	0.0022	0.00604	0.012	0.00005	0.009	64.9	0.488	0.000005	0.00595	0.00408
Madrid	Overburden Stockpile	21-OVB-01	21-OVB-01	0	0.0005	0.00077	0.00293	0.029	0.00005	0.0078	54.5	0.224	0.000005	0.00147	0.00468
		21-OVB-02	21-OVB-02	0	0.0005	0.00108	0.00367	0.044	0.00005	0.0084	49.2	0.34	0.000005	0.00212	0.00481
		21-OVB-03	21-OVB-03	0	0.0005	0.00026	0.00547	0.034	0.00005	0.0019	3.72	0.0364	0.000005	0.00038	0.00172
		21-OVB-04	21-OVB-04	0	0.0005	0.00018	0.00565	0.012	0.00005	0.0043	21.8	0.0191	0.000005	0.00512	0.00122
	Portal Pad	21-MAD-01	21-MAD-01	0	0.0005	0.00036	0.00151	0.033	0.00005	0.0089	56.9	0.101	0.000005	0.000186	0.0015
		21-MAD-02	21-MAD-02	0	0.0005	0.00087	0.00312	0.029	0.00005	0.0024	13.8	0.425	0.0000069	0.000429	0.00276
		21-MAD-03	21-MAD-03	0	0.0005	0.00082	0.00376	0.028	0.00005	0.0022	17.1	0.103	0.000005	0.00692	0.00767
		21-MAD-04	21-MAD-04	0	0.0005	0.00356	0.00247	0.216	0.00005	0.0073	49.2	0.47	0.000005	0.000426	0.00401
	WRSA Pad Seepage near Sump 1	21-WRP-01	21-WRP-01	0	0.0005	0.00018	0.00156	0.014	0.00005	0.0012	9.44	0.00435	0.000005	0.00394	0.00353
	Seepage Outside the CWP Berm	21-CWP-01	21-CWP-01	0	0.0005	0.00058	0.00135	0.01	0.00005	0.0051	18.9	0.149	0.000005	0.00217	0.00384
		21-CWP-02	21-CWP-02	0	0.0005	0.00092	0.00256	0.01	0.00005	0.0075	23.7	0.101	0.000005	0.00404	0.0138
		MMS1-OUTSIDE	MMS1-OUTSIDE	-	-	-	-	-	-	-	-	-	-	-	-
		MMS1-OUTSIDE 2	MMS1-OUTSIDE 2	-	-	-	-	-	-	-	-	-	-	-	-
	Inside the Contact Water Pond (CWP)	MMS-1	MMS-1	-	-	-	-	-	-	-	-	-	-	-	-
			MMS1-INSIDE	-	-	-	-	-	-	-	-	-	-	-	-
		MMS-1N	MMS-1N	-	-	-	-	-	-	-	-	-	-	-	-
			MMS-1N	-	-	-	-	-	-	-	-	-	-	-	-
			MMS1-N	-	-	-	-	-	-	-	-	-	-	-	-
		MMS-1S	MMS-1S	-	-	-	-	-	-	-	-	-	-	-	-
			MMS-1S	-	-	-	-	-	-	-	-	-	-	-	-
			MMS1-S	-	-	-	-	-	-	-	-	-	-	-	-
	Sump 1, WRSA	MMS1-S1	MMS1-S1	-	-	-	-	-	-	-	-	-	-	-	-
			MMS1-S1	-	-	-	-	-	-	-	-	-	-	-	-
			MMS1-S1	-	-	-	-	-	-	-	-	-	-	-	-
	Sump 2, WRSA	MMS1-S2	MMS1-S2	-	-	-	-	-	-	-	-	-	-	-	-
			MMS1-S2	-	-	-	-	-	-	-	-	-	-	-	-
			MMS1-S2	-	-	-	-	-	-	-	-	-	-	-	-
	Sump 3, WRSA	MMS1-S3	MMS1-S3	-	-	-	-	-	-	-	-	-	-	-	-
			MMS1-S3	-	-	-	-	-	-	-	-	-	-	-	-

Region	Area	Report ID	Sample ID	P	K	Rb	Se	Si	Ag	Na	Sr	S	Te	Tl	Th
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Doris	Doris WR Influenced Area	21DC-01	21DC-01	0.341	22.8	0	0.00431	2.56	0.00416	283	0.398	210	0	0.00001	0
		21DC-02	21DC-02	0.338	22.7	0	0.00417	2.47	0.00443	288	0.397	204	0	0.00001	0
		21DC-03	21DC-03	0.35	23.5	0	0.00434	2.55	0.00443	296	0.397	210	0	0.00001	0
		21DC-04	21DC-04	0.05	26.8	0	0.00225	1.98	0.000014	343	1.12	70.4	0	0.000059	0
		21DC-05	21DC-05	0.05	26.7	0	0.00256	2.01	0.00001	344	1.2	73.3	0	0.000063	0
Madrid	Overburden Stockpile	21-OVB-01	21-OVB-01	0.059	11.5	0	0.000275	2.72	0.00001	221	0.731	37.5	0	0.00001	0
		21-OVB-02	21-OVB-02	0.05	11.5	0	0.000335	2.62	0.00001	220	0.701	40.6	0	0.00001	0
		21-OVB-03	21-OVB-03	0.05	1.6	0	0.000126	2.21	0.00001	9.14	0.0724	1.95	0	0.00001	0
		21-OVB-04	21-OVB-04	0.05	9	0	0.000429	1.48	0.00001	173	0.137	61.6	0	0.00001	0
	Portal Pad	21-MAD-01	21-MAD-01	0.05	6.5	0	0.000599	3.38	0.00001	95.6	0.226	27.7	0	0.00001	0
		21-MAD-02	21-MAD-02	0.061	6.21	0	0.00024	2.92	0.00001	32.5	0.102	6.81	0	0.00001	0
		21-MAD-03	21-MAD-03	0.05	8.06	0	0.0016	2.09	0.00001	113	0.171	29.3	0	0.00001	0
		21-MAD-04	21-MAD-04	0.05	8.33	0	0.00046	3.53	0.00001	94.8	0.276	24.4	0	0.00001	0
	WRSA Pad Seepage near Sump 1	21-WRP-01	21-WRP-01	0.05	4.54	0	0.00326	0.958	0.00001	83.4	0.0595	25.8	0	0.00001	0
	Seepage Outside the CWP Berm	21-CWP-01	21-CWP-01	0.05	9.92	0	0.0014	0.901	0.00001	90.7	0.31	20.8	0	0.00001	0
		21-CWP-02	21-CWP-02	0.05	12.6	0	0.00246	1.29	0.00001	127	0.378	35.4	0	0.000011	0
		MMS1-OUTSIDE	MMS1-OUTSIDE	-	-	-	-	-	-	-	-	-	-	-	-
		MMS1-OUTSIDE 2	MMS1-OUTSIDE 2	-	-	-	-	-	-	-	-	-	-	-	-
	Inside the Contact Water Pond (CWP)	MMS-1	MMS-1	-	-	-	-	-	-	-	-	-	-	-	-
			MMS1-INSIDE	-	-	-	-	-	-	-	-	-	-	-	-
		MMS-1N	MMS-1N	-	-	-	-	-	-	-	-	-	-	-	-
			MMS-1N	-	-	-	-	-	-	-	-	-	-	-	-
			MMS1-N	-	-	-	-	-	-	-	-	-	-	-	-
		MMS-1S	MMS-1S	-	-	-	-	-	-	-	-	-	-	-	-
			MMS-1S	-	-	-	-	-	-	-	-	-	-	-	-
			MMS1-S	-	-	-	-	-	-	-	-	-	-	-	-
	Sump 1, WRSA	MMS1-S1	MMS1-S1	-	-	-	-	-	-	-	-	-	-	-	-
			MMS1-S1	-	-	-	-	-	-	-	-	-	-	-	-
			MMS1-S1	-	-	-	-	-	-	-	-	-	-	-	-
	Sump 2, WRSA	MMS1-S2	MMS1-S2	-	-	-	-	-	-	-	-	-	-	-	-
			MMS1-S2	-	-	-	-	-	-	-	-	-	-	-	-
			MMS1-S2	-	-	-	-	-	-	-	-	-	-	-	-
	Sump 3, WRSA	MMS1-S3	MMS1-S3	-	-	-	-	-	-	-	-	-	-	-	-
			MMS1-S3	-	-	-	-	-	-	-	-	-	-	-	-

Region	Area	Report ID	Sample ID	Sn	Ti	W	U	V	Zn	Zr	Al	Sb	As	Ba	Be	Bi
				Total Metals												
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Doris	Doris WR Influenced Area	21DC-01	21DC-01	0.0001	0.0003	0	0.00124	0.00162	0.0049	0.0002	-	-	-	-	-	-
		21DC-02	21DC-02	0.0001	0.0003	0	0.00117	0.00174	0.0054	0.0002	-	-	-	-	-	-
		21DC-03	21DC-03	0.0001	0.0003	0	0.00117	0.00176	0.0119	0.0002	-	-	-	-	-	-
		21DC-04	21DC-04	0.0001	0.0003	0	0.000874	0.0005	0.0059	0.0002	-	-	-	-	-	-
		21DC-05	21DC-05	0.0001	0.0003	0	0.000873	0.00051	0.0084	0.0002	-	-	-	-	-	-
Madrid	Overburden Stockpile	21-OVB-01	21-OVB-01	0.0001	0.0003	0	0.000705	0.0005	0.0028	<0.00020	-	-	-	-	-	-
		21-OVB-02	21-OVB-02	0.0001	0.00054	0	0.00077	0.0005	0.0035	<0.00020	-	-	-	-	-	-
		21-OVB-03	21-OVB-03	0.0001	0.00049	0	0.00007	0.0005	0.0022	0.00023	-	-	-	-	-	-
		21-OVB-04	21-OVB-04	0.0001	0.0006	0	0.00145	0.00088	0.0012	<0.00020	-	-	-	-	-	-
	Portal Pad	21-MAD-01	21-MAD-01	0.0001	0.00031	0	0.000031	0.0005	0.0043	<0.00020	-	-	-	-	-	-
		21-MAD-02	21-MAD-02	0.0001	0.00055	0	0.000352	0.0005	0.0078	<0.00020	-	-	-	-	-	-
		21-MAD-03	21-MAD-03	0.0001	0.00039	0	0.000587	0.00092	0.0059	<0.00020	-	-	-	-	-	-
		21-MAD-04	21-MAD-04	0.0001	0.0003	0	0.000128	0.0005	0.0082	<0.00020	-	-	-	-	-	-
	WRSA Pad Seepage near Sump 1	21-WRP-01	21-WRP-01	0.0001	0.0006	0	0.000261	0.00072	0.0022	<0.00020	-	-	-	-	-	-
	Seepage Outside the CWP Berm	21-CWP-01	21-CWP-01	0.0001	0.0003	0	0.000392	0.0005	0.0024	<0.00020	-	-	-	-	-	-
		21-CWP-02	21-CWP-02	0.0001	0.0003	0	0.00105	0.00075	0.0012	<0.00020	-	-	-	-	-	-
		MMS1-OUTSIDE	MMS1-OUTSIDE	-	-	-	-	-	-	-	0.0741	0.00116	0.120	0.0336	0.0001	0.00005
		MMS1-OUTSIDE 2	MMS1-OUTSIDE 2	-	-	-	-	-	-	-	0.222	0.00252	0.257	0.0316	0.0001	0.00005
	Inside the Contact Water Pond (CWP)	MMS-1	MMS-1	-	-	-	-	-	-	-	0.655	0.00127	0.222	0.0198	0.0001	0.00005
			MMS1-INSIDE	-	-	-	-	-	-	-	0.208	0.00142	0.229	0.0262	0.0001	0.00005
		MMS-1N	MMS-1N	-	-	-	-	-	-	-	2.38	0.00195	0.0764	0.0732	0.0002	0.0001
			MMS-1N	-	-	-	-	-	-	-	0.357	0.00097	0.0348	0.0638	0.0002	0.0001
			MMS1-N	-	-	-	-	-	-	-	0	0	0	0	0	0
		MMS-1S	MMS-1S	-	-	-	-	-	-	-	0.0682	0.00029	0.0447	0.109	0.0002	0.0001
			MMS-1S	-	-	-	-	-	-	-	0.0153	0.00028	0.0466	0.0806	0.0002	0.0001
			MMS1-S	-	-	-	-	-	-	-	0	0	0	0	0	0
	Sump 1, WRSA	MMS1-S1	MMS1-S1	-	-	-	-	-	-	-	0.121	0.00058	0.00829	0.02	0.0001	0.0001
			MMS1-S1	-	-	-	-	-	-	-	0.0744	0.00017	0.00305	0.0261	0.0001	0.0001
			MMS1-S1	-	-	-	-	-	-	-	0.0707	0.00025	0.00229	0.0252	0.0001	0.00005
	Sump 2, WRSA	MMS1-S2	MMS1-S2	-	-	-	-	-	-	-	2.59	0.0001	0.00187	0.0388	0.0001	0.0001
			MMS1-S2	-	-	-	-	-	-	-	1.42	0.0005	0.00242	0.0246	0.0005	0.00025
			MMS1-S2	-	-	-	-	-	-	-	0.078	0.0001	0.00182	0.0172	0.0001	0.00005
	Sump 3, WRSA	MMS1-S3	MMS1-S3	-	-	-	-	-	-	-	0.278	0.00148	0.0923	0.0444	0.0005	0.00025
			MMS1-S3	-	-	-	-	-	-	-	0.745	0.00292	0.147	0.0195	0.0002	0.0001

Region	Area	Report ID	Sample ID	B	Cd	Ca	Cs	Cr	Co	Cu	Fe	Pb	Li	Mg	Mn	Hg	Mo	Ni
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Doris	Doris WR Influenced Area	21DC-01	21DC-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21DC-02	21DC-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21DC-03	21DC-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21DC-04	21DC-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21DC-05	21DC-05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Madrid	Overburden Stockpile	21-OVB-01	21-OVB-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21-OVB-02	21-OVB-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21-OVB-03	21-OVB-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21-OVB-04	21-OVB-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Portal Pad	21-MAD-01	21-MAD-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21-MAD-02	21-MAD-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21-MAD-03	21-MAD-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21-MAD-04	21-MAD-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WRSA Pad Seepage near Sump 1	21-WRP-01	21-WRP-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Seepage Outside the CWP Berm	21-CWP-01	21-CWP-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21-CWP-02	21-CWP-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		MMS1-OUTSIDE	MMS1-OUTSIDE	0.089	0.0000266	164	0.000031	0.00094	0.00074	0.00172	0.127	0.000070	0.0053	19.6	0.166	0.000005	0.00202	0.00456
		MMS1-OUTSIDE 2	MMS1-OUTSIDE 2	0.144	0.0000222	193	0.000058	0.00300	0.00131	0.00337	0.353	0.000097	0.0085	25.0	0.120	0.000005	0.00400	0.0159
	Inside the Contact Water Pond (CWP)	MMS-1	MMS-1	0.08	0.000029	141	-	0.00197	0.00147	0.00304	1.04	0.000143	0.0058	13.6	0.0546	0.000005	0.00213	0.0165
			MMS1-INSIDE	0.089	0.0000358	164	0.000029	0.00082	0.00115	0.00206	0.254	0.000107	0.0064	17.6	0.0509	0.000005	0.00233	0.0146
		MMS-1N	MMS-1N	0.221	0.0000822	228	-	0.0144	0.00651	0.0121	4.58	0.0015	0.016	63.6	0.962	0.000005	0.00686	0.0227
			MMS-1N	0.166	0.0000596	212	-	0.00199	0.00437	0.0109	0.527	0.000187	0.0122	78.1	0.926	0.000005	0.00514	0.0154
			MMS1-N	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0
		MMS-1S	MMS-1S	0.102	0.000377	535	-	0.001	0.00606	0.00536	0.222	0.0001	0.0088	75.7	0.492	0.000005	0.000783	0.0129
			MMS-1S	0.155	0.000575	415	-	0.001	0.01	0.0084	0.023	0.0001	0.0092	65	0.247	0.000005	0.00075	0.0158
			MMS1-S	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0
	Sump 1, WRSA	MMS1-S1	MMS1-S1	0.082	0.0000708	58.3	-	0.0005	0.00289	0.0144	0.205	0.000078	0.0042	16.7	0.317	0.0000077	0.00164	0.00242
			MMS1-S1	0.049	0.000151	99.2	-	0.0005	0.00646	0.0156	0.137	0.00005	0.0099	22.4	1.63	0.000005	0.000515	0.00514
			MMS1-S1	0.056	0.000117	98.8	-	0.0005	0.00488	0.0159	0.477	0.00005	0.0089	22.8	1.49	0.000005	0.00073	0.00541
	Sump 2, WRSA	MMS1-S2	MMS1-S2	0.026	0.0000128	19.6	-	0.00379	0.00143	0.039	1.15	0.000877	0.0108	14	0.0912	0.0000057	0.000521	0.00863
			MMS1-S2	0.05	0.000025	36.1	-	0.00266	0.0032	0.0442	0.661	0.000526	0.0127	21.8	0.233	0.000005	0.0012	0.00797
			MMS1-S2	0.03	0.0000127	42.3	-	0.00099	0.00102	0.0172	0.138	0.00005	0.0272	70.3	0.114	0.000005	0.000527	0.0042
	Sump 3, WRSA	MMS1-S3	MMS1-S3	0.143	0.0000497	70.1	-	0.0025	0.00893	0.0175	0.622	0.00025	0.014	75.2	0.898	0.000005	0.00341	0.0227
			MMS1-S3	0.573	0.000017	27.5	-	0.00202	0.00202	0.0162	0.854	0.000295	0.0085	19.6	0.0883	0.000006	0.00777	0.00689

Region	Area	Report ID	Sample ID	K	Rb	Se	Si	Ag	Na	Sr	S	Te	Tl	Th	Sn	Ti	W	U
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Doris	Doris WR Influenced Area	21DC-01	21DC-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21DC-02	21DC-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21DC-03	21DC-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21DC-04	21DC-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21DC-05	21DC-05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Madrid	Overburden Stockpile	21-OVB-01	21-OVB-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21-OVB-02	21-OVB-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21-OVB-03	21-OVB-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21-OVB-04	21-OVB-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Portal Pad	21-MAD-01	21-MAD-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21-MAD-02	21-MAD-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21-MAD-03	21-MAD-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21-MAD-04	21-MAD-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WRSA Pad Seepage near Sump 1	21-WRP-01	21-WRP-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Seepage Outside the CWP Berm	21-CWP-01	21-CWP-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21-CWP-02	21-CWP-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		MMS1-OUTSIDE	MMS1-OUTSIDE	9.78	0.00525	0.00134	1.06	0.00001	89.8	0.296	21.7	0.0002	0.00001	0.0001	0.0001	0.00296	0.0001	0.000374
		MMS1-OUTSIDE 2	MMS1-OUTSIDE 2	12.6	0.00544	0.00235	1.75	0.00001	128	0.392	37.1	0.0002	0.000011	0.0001	0.0001	0.00995	0.00022	0.00109
	Inside the Contact Water Pond (CWP)	MMS-1	MMS-1	7.34	-	0.00126	1.68	0.00001	60.2	0.273	15.1	-	0.00001	-	0.0001	0.0227	-	0.000513
			MMS1-INSIDE	9.21	0.00370	0.00144	1.15	0.00001	78.2	0.321	19.6	0.0002	0.00001	0.0001	0.0001	0.0072	0.00016	0.000551
		MMS-1N	MMS-1N	24.2	-	0.00527	7.12	0.000036	426	0.564	133	-	0.000028	-	0.0002	0.0704	-	0.00346
			MMS-1N	21.8	-	0.00166	4.3	0.00002	441	0.509	131	-	0.00002	-	0.0002	0.0113	-	0.00507
			MMS1-N	0	-	0	0	0	0	0	0	-	0	-	0	0	-	0
		MMS-1S	MMS-1S	15.7	-	0.00338	3.32	0.00002	255	0.915	65.1	-	0.00002	-	0.0002	0.00459	-	0.00139
			MMS-1S	18	-	0.00264	3.33	0.00002	286	0.606	84.8	-	0.000051	-	0.0002	0.0006	-	0.000893
			MMS1-S	0	-	0	0	0	0	0	0	-	0	-	0	0	-	0
	Sump 1, WRSA	MMS1-S1	MMS1-S1	7.73	-	0.0029	3.68	0.00001	133	0.128	51.4	-	0.00001	-	0.0001	0.00297	-	0.000397
			MMS1-S1	7.2	-	0.00228	4.4	0.000014	185	0.213	65.3	-	0.00001	-	0.0001	0.00187	-	0.000598
			MMS1-S1	7.11	-	0.00128	4.45	0.000047	144	0.236	58.9	-	0.00001	-	0.0001	0.00182	-	0.00129
	Sump 2, WRSA	MMS1-S2	MMS1-S2	2.75	-	0.000228	11.4	0.000019	11.6	0.052	1.53	-	0.000018	-	0.0001	0.0397	-	0.000412
			MMS1-S2	3.5	-	0.000289	9.91	0.00005	15.9	0.0753	5.9	-	0.00005	-	0.0005	0.0228	-	0.000862
			MMS1-S2	3.5	-	0.000216	8.4	0.00001	31.2	0.174	6.62	-	0.00001	-	0.0001	0.00183	-	0.000248
	Sump 3, WRSA	MMS1-S3	MMS1-S3	16	-	0.00139	4.22	0.00005	262	0.308	58.2	-	0.00005	-	0.0005	0.00521	-	0.000691
			MMS1-S3	13.8	-	0.00224	4.81	0.00002	210	0.106	38.7	-	0.00002	-	0.0002	0.014	-	0.000671

Region	Area	Report ID	Sample ID	V	Zn	Zr
				mg/L	mg/L	mg/L
Doris	Doris WR Influenced Area	21DC-01	21DC-01	-	-	-
		21DC-02	21DC-02	-	-	-
		21DC-03	21DC-03	-	-	-
		21DC-04	21DC-04	-	-	-
		21DC-05	21DC-05	-	-	-
Madrid	Overburden Stockpile	21-OVB-01	21-OVB-01	-	-	-
		21-OVB-02	21-OVB-02	-	-	-
		21-OVB-03	21-OVB-03	-	-	-
		21-OVB-04	21-OVB-04	-	-	-
	Portal Pad	21-MAD-01	21-MAD-01	-	-	-
		21-MAD-02	21-MAD-02	-	-	-
		21-MAD-03	21-MAD-03	-	-	-
		21-MAD-04	21-MAD-04	-	-	-
	WRSA Pad Seepage near Sump 1	21-WRP-01	21-WRP-01	-	-	-
	Seepage Outside the CWP Berm	21-CWP-01	21-CWP-01	-	-	-
		21-CWP-02	21-CWP-02	-	-	-
		MMS1-OUTSIDE	MMS1-OUTSIDE	0.00091	0.0050	0.0002
		MMS1-OUTSIDE 2	MMS1-OUTSIDE 2	0.00183	0.003	0.0002
	Inside the Contact Water Pond (CWP)	MMS-1	MMS-1	0.00321	0.0057	0.00036
			MMS1-INSIDE	0.00139	0.0097	0.0002
		MMS-1N	MMS-1N	0.0101	0.0144	0.00075
			MMS-1N	0.00228	0.006	0.00061
			MMS1-N	0	0	0
		MMS-1S	MMS-1S	0.00113	0.0157	0.0004
			MMS-1S	0.001	0.0295	0.0004
			MMS1-S	0	0	0
	Sump 1, WRSA	MMS1-S1	MMS1-S1	0.00081	3.37	0.0002
			MMS1-S1	0.0005	4.31	0.0004
			MMS1-S1	0.00065	4.51	0.00048
	Sump 2, WRSA	MMS1-S2	MMS1-S2	0.00315	4.37	0.00301
			MMS1-S2	0.0025	13.8	0.00285
			MMS1-S2	0.00113	4.25	0.00076
	Sump 3, WRSA	MMS1-S3	MMS1-S3	0.0025	17.5	0.001
			MMS1-S3	0.00356	5.18	0.00093

Appendix E 2021 Geochemical Monitoring of Flotation and Detoxified Tailings, Doris Mill

SRK Consulting (Canada) Inc.
1066 West Hastings Street, Suite 2200
Vancouver, BC V6E 3X2
Canada

+1 604 681 4196 office
+1 604 687 5532 fax

vancouver@srk.com
www.srk.com

FINAL

Technical Memo

March 22, 2022

To	Nancy Duquet Harvey, Agnico Eagle Mines Ltd.
From	Melanie Cox, SRK
Cc	Amanda Schevers, Lisa Barazzuol, SRK
Subject	2021 Geochemical Monitoring of Flotation and Detoxified Tailings, Doris Mill
Client	Agnico Eagle Mines Ltd.
Project	1CT022.073

1 Introduction

Hope Bay initiated ore processing at the Doris mill and commenced deposition of flotation tailings in the Doris tailings impoundment area (TIA) in January 2017 and placement of detoxified tailings as backfill in stopes of the Doris Mine in February 2017. The geochemical monitoring of tailings commenced in February 2017. In October 2019, ore processing started from Madrid North (Naartok East Crown Pillar Recovery, NE CPR) at the Doris mill. Ore from the NE CPR is blended with Doris ore for processing at a target ratio of a maximum 25% Naartok East ore to 75% Doris ore. In 2021, NE CPR was processed in August and October, with an equivalent to 13% and 28% of the total feed, respectively. In 2021, the process plant operated on a reduced schedule between January 1 and October 5 whereby the process plant operated for three-weeks for every six-week period. Between mid-October and December 31, the process plant did not operate. In total, 253,160 t (dry weight equivalent) of flotation tailings were deposited in the Doris TIA in 2021 and 10,006 t of detoxified tailings were placed as backfill in Doris Mine.

The geochemical monitoring program for flotation tailings slurry and detoxified tailings are specified in Schedule I, Tables 1 to 3 of NWB Type “A” Water Licence 2AM-DOH1335 Amendment No. 2 (the “Water Licence”, Nunavut Water Board 2018) and includes the following monitoring stations: process plant tailings water discharge (TL-5), flotation tailings solids (TL-6), detoxified tailings solids[1] (TL-7A), detoxified tailings filtrate (TL7-B)[2] and seepage from underground backfilled stopes (TL-11). This

[1] Detoxified tailings are referred to as cyanide leach residue in the Water Licence and prior to 2019 was monitored as station TL-7.

[2] Station TL7-B was added to the Water Licence as part of Amendment No. 2 and monitoring commenced in 2019.

memo documents the 2021 geochemical monitoring program for flotation and detoxified tailings at TL-5, TL-6, TL-7A and TL-7B and underground seepage at TL-11 and fulfills the reporting requirements outlined in Schedule B, Items 2a i, ii, iii and iv of the Water Licence.

2 Background

In the processing plant, there are two sections: the concentrate lines (CL1 and CL2) and the Concentrate Treatment Plant (CTP). Cyanide is a reagent used exclusively in the CTP to dissolve gold from the solid concentrate which is then captured by resin. The concentrate lines (CL) react poorly to the presence of cyanide and so this side must be kept free of cyanide for the process to perform well. The final stage of the CTP is cyanide destruction. Cyanide is destroyed using the INCO SO_2 process. The detoxified slurry is filtered, and the solids (TL-7A) are combined with waste rock and placed underground as permanent backfill. Seepage surveys of the backfilled detoxified tailings (TL-11) are conducted bi-annually. The detoxified tailings filtrate (TL-7B) is pumped to the tailings thickener where it is combined with the flotation tailings slurry. Samples of TL-5 and TL-6 represent the tailings slurry supernatant and solids, respectively, that are discharged to the TIA. The detoxification circuit is run to produce a total cyanide level of less than one part per million (1 ppm). The solution from the detoxification circuit and final detoxified tailings are routinely analyzed for weak acid dissociable (WAD) and total cyanide species by mill personnel to monitor the performance of the cyanide detoxification circuit. Concentrations of free, WAD and total cyanide in the process plant tailings water discharge (TL-5) are reported monthly to the Nunavut Water Board and cyanate and thiocyanate are reported quarterly. Concentrations of cyanate, thiocyanate and WAD cyanide in the detoxified tailings filtrate (TL-7B) are analyzed monthly.

3 Methods

3.1 Sample Collection and Analysis

3.1.1 Tailings and Process Water

The monitoring frequency in 2021 was monthly during operation; however, monthly samples were not collected in 2021 because the process plant operated on a reduced schedule between January and September and was not operational between October and December (Section 1).

Process Plant Flotation Tailings Slurry Discharge: Solids (TL-6) and Supernatant (TL-5)

Schedule I (Table 3) of the Water Licence specifies weekly sampling of flotation tailings (TL-6) and monthly sampling of the process plant tailings supernatant (TL-5). Samples of the flotation tailings solids (TL-6) and the supernatant solution (TL-5) are collected from the flotation tailings thickener tank. The filtrate from the detox filter press (where detoxified tailings are dewatered) is pumped to the flotation tailings thickener tank prior to discharge to the TIA.

Agnico Eagle Mines (AEM) collects flotation tailings slurry from the tailings thickener tank in a clean 5-gallon bucket. The sample is left in the bucket to allow gravitational settling and separation of the tailings solids from the liquid. After settling, samples of supernatant solution (TL-5) and flotation tailings solids (TL-6) are collected at the frequency outlined above.

The tailings supernatant solution (TL-5) is sampled using a sterile 60 mL syringe and submitted to ALS Laboratory in Yellowknife, NT once per month for the analysis of pH, total suspended solids (TSS), ammonia, nitrate, nitrite, sulphate, cyanide (WAD, free and total), cyanate, thiocyanate, dissolved and total metals. Samples were filtered at site. The 2021 monitoring program for TL-5 included geochemical characterization of nine monthly samples of tailings process supernatant collected from January to September with a duplicate sample collected in January.

After sampling is completed for the tailings supernatant solution (TL-5), the remaining supernatant is discarded and a clean stainless-steel spoon is used to transfer the solid tailings into a clean plastic Ziploc bag supplied by the laboratory. The bag is then sealed and placed in a fridge until the last weekly sample for the month has been collected. At the end of each month, AEM combines and homogenizes equal amounts of tailings from each weekly sample to create an approximately 500 g monthly composite sample of flotation tailings solids (TL-6).

The 2021 monitoring program for TL-6 included geochemical characterization of six composite samples of flotation tailings in January, March, April, May, August and September. Samples representing February and June were not collected when the plant was not operating. The July sample was discarded by AEM in error before it could be analyzed. A duplicate sample was collected in August.

Monthly flotation tailings solids (TL-6) composite samples were submitted in glass jars to Bureau Veritas Laboratory in Burnaby, BC for analysis of:

- Total sulphur – by Leco combustion;
- Sulphate sulphur – by hydrochloric acid leach;
- TIC (total inorganic carbon) – measurement of evolved CO_2 by hydrochloric acid leach; and
- Trace element content – by aqua regia digest (nitric and hydrochloric acid) with ICP-MS finish.

Detoxified Tailings Solids (TL-7A) and Filtrate (TL-7B)

As a requirement of Water License 2AM-DOH1335 samples of the detoxified tailings produced in the process plant must be submitted for laboratory analysis. Schedule I of the Water Licence identifies the detoxified tailings solids component (TL-7A) and the filtrate liquid component (TL-7B) as compliance monitoring stations.

At the end of a detoxification cycle, AEM collects one discrete sample of detoxified tailings solids (TL-7A) from the discharge compartment of the detoxification circuit filter press. A clean stainless-steel spoon is used to transfer the detoxified tailings solids into 125 mL glass sample jars supplied by the laboratory. Samples of the filtrate liquid are collected from the receiving tank of the detoxification filter press using a 10-foot sampling pole with an open top 1 L poly bottle and then poured into four 500 mL settling bottles to allow gravitational settling and separation of residual tailings solids from the liquid. After settling, the filtrate (TL-7B) is transferred into laboratory supplied sample bottles either using a clean syringe or decanting the supernatant into the sample bottles.

The 2021 monitoring program included geochemical characterization of nine samples of detoxified tailings solids (TL-7A). The samples were collected each month between January and September. AEM collected two samples on June 30 that represent June and July tailings. No duplicate sample was collected because it was scheduled for Q4 and the process plant was not operational during that period. Nine samples of filtrate (TL-7B) from the detoxified tailings were collected from January to September. One duplicate sample was collected in March.

Schedule I (Table 3) of the Water Licence specifies monitoring moisture content of the detoxified backfill tailings and a full geochemical characterization of TL-7A is required to inform the project closure planning. To satisfy both requirements AEM conducts monthly sampling and full analysis of the detoxified tailings solids (TL-7A) including moisture content, total sulphur, sulphate sulphur, TIC and trace element content at Bureau Veritas, Burnaby, BC[3] using the same methods as TL-6. The filtrate from the detoxified tailings (TL-7B) is analyzed monthly according to the Water Licence monitoring requirements. Filtrate samples are submitted to ALS Laboratory in Yellowknife, NT for analysis of pH, ammonia, cyanide (WAD, free and total), cyanate, thiocyanate, and total metals (including sulphur)[4].

3.1.2 Seepage Survey of Underground Backfilled Stopes (TL-11)

Schedule I (Table 3) of the Water Licence specifies bi-annual seepage surveys of underground backfilled stopes with opportunistic sampling of seepage for the analysis of pH, electrical conductivity (EC), trace metals by ICP-MS, alkalinity, acidity, sulphate, total and WAD cyanide, total ammonia, nitrate and nitrite.

AEM completed underground seepage inspections of backfilled stopes in August and December. Visual surveys were conducted of and limited to all backfilled stopes that could be accessed safely at the time of the survey. Three seepage locations were sampled in August and three locations were sampled in December. During the August sampling survey, AEM collected the following samples:

- Level 120: a seepage sample and duplicate sample was collected at area 120 West Limb North (TL11-1). The stope was last mined in 2019 and backfilled thereafter; the sampling location is within a few meters of backfilled material. The sample was reported to be slightly brown in color.
- Level 114: a seepage sample was collected from area 114 (TL11-2) close to a stockpile of material. The sample was reported to be brown in color.
- Level 110: a seepage sample was collected from area 110 (TL11-3). The sample was reported to be clear.

[3] TL-7A trace element analysis for September was sub-contracted to Actlabs, Kamloops, BC.

[4] Total Inorganic Carbon (TIC) is specified as a requirement for the filtrate analysis of TL-7B in the Water Licence, however, this is not an analytical parameter for aqueous samples but has been analyzed for detoxified tailings solids.

In December, AEM collected three samples during the underground survey from the following locations:

- Level 120 vent access: This is the same stope monitoring in the August 2021 seepage survey. AEM observed moving water outflowing from a pool. A seepage sample and duplicate sample was collected from this outflow (TL11-A) within a few meters of backfill material. As noted above, this stope was last mined in 2019 and backfilled thereafter.
- Level 114: The sampling location was close to a stockpile of material. AEM observed low flow and that precluded flow being measured. A water quality sample was collected from pool of water (TL-11B). The sample was noted as turbid on the field sheet.

Level 74: The sampling location is directly in front of a backfilled stope, but AEM confirmed that the distance to the stope may have been too great for the sample to represent contact water. AEM noted active dumping of backfill and observed clear water flowing from the rock face and collecting in a pool. No flow measurement was possible; a water quality sample was collected from the pool directly below the rock face. (TL11-C). Field measurements of pH, EC, ORP, temperature and flow rate (where applicable) were recorded at each station. AEM submitted samples to ALS Laboratory in Yellowknife, NT for analysis of pH, EC, TSS, total dissolved solids (TDS), alkalinity, chloride, sulphate, total, free and WAD cyanide, and dissolved and total metals. The sample for dissolved metals was filtered and preserved at the time of sampling.

3.2 Data Interpretation

The ratio of TIC to acid potential (AP) provides a measure of the acid rock drainage (ARD) potential of the sample and is the method established from geochemical characterization studies of tailings (SRK 2015). Samples are classified as non-potentially ARD generating (non-PAG) when TIC/AP ratios are greater than 3, as PAG when ratios are less than 1 and as having an uncertain potential for ARD when ratios are between 1 and 3 (MEND 2009).

4 Results and Discussion

4.1 Data QA/QC

The QA/QC program executed by the analytical laboratories and SRK is outlined in the SRK Expectations for Laboratory Geochemical Data Quality (SRK 2019). A summary of the results of SRK's QC checks for flotation (TL-6) tailings and detoxified tailings (TL-7A) is presented in Table 4-1 and Table 4-2 presents the results for detoxified tailings filtrate (TL-7B), process plant tailings supernatant (TL-5) and underground stope seepage (TL-11). All data passed the QC checks with the following exceptions:

- TL-7A, September sample: SRK was not able to complete QC checks for trace elements because QC data for the refence standards are pending, SRK is currently communicating with the lab to resolve this. Sodium content failed the QC check for the blank analyzed in the same batch as sample TL-7A (September), however the concentrations for TL-7A was >10X the sodium concentration indicated for the blank, therefore sodium contamination in the blank is considered insignificant and the data are accepted.

- TL-11: the August field duplicate failed for TSS. The original sample had higher concentrations compared with the duplicate. This result was confirmed with the laboratory by re-analysis and visual inspection. The failure is attributed to heterogeneity between the samples resulting from sampling.

SRK deemed all results acceptable while noting that the results of the QC checks for trace element data is pending for TL-7A, September.

Table 4-1: QA/QC Summary for Solid Analysis of Flotation (TL-6) and Detoxified (TL-7A) Tailings

QC Test	SRK QC Criteria	TL-6 Results	TL-7A Results
TIC			
Lab Method Blank	<5X detection limit (DL)	(n=7) (All passed.)	(n=8) (All passed.)
Lab Duplicate	For samples > 10X the detection limit (DL), % RPD within +/-20%	N/A	(n=1) (All passed.)
Field Duplicate	For samples > 10X the detection limit (DL), % RPD within +/-30%	(n=1) (All passed.)	N/A
Standard reference materials	Within +/-20% Difference	(n=9) (All passed.)	(n=8) (All passed.)
Total S & Sulphate			
Lab Method Blank	<5X detection limit (DL)	(n=6) for Total S, and (n=6) for Total SO_4 (All passed)	(n=8) for Total S, (n=8) for Total SO_4 (All passed.)
Sulphur balance (total S > sulphate S)	For samples > 10X the detection limit (DL), Total Sulphur should be greater than Total Sulphate, if not then (sulphate-total S)/Total S> 20%	(n=6) (All passed.)	(n= 9) (All passed.)
Lab Duplicate	For samples > 10X the detection limit (DL), % RPD within +/-20%	(n=1) for Total S, and (n=6) for Total SO_4 (All passed.)	(n=8) for Total SO_4, (n=0) for Total S (All passed.)
Field Duplicate	For samples > 10X the detection limit (DL), % RPD within +/-30%	(n=1) for Total S, and (n=1) for Total SO_4 (All passed.)	N/A
Standard reference materials	Within +/-20% Difference	(n=15) for Total S and (n=2) for Total SO_4 (All passed.)	(n=11) for Total S, (n=11) for Total SO_4 (All passed.)
Total S-Leco and S-ICP			
Comparison between Total S-Leco and S-ICP	For samples >10X detection limit (DL), % RPD within +/-20%	(n= 6) (All passed.)	(n=8) Not assessed because ICP-S is over range. Data considered acceptable.
Trace Element Content			
Lab Method Blank	<5X Detection Limit	(n=6). All passed Lab	(n=7) (All passed.); (n=1) failed for Na but concentration in the TL-7A (September) sample was >10x the sodium indicated for the blank.
Lab Duplicate	For samples >10X detection limit (DL), % RPD within +/- 20%, ok 10% of metal scan failing.	(n=0) (All passed.)	(n=1) (All passed.)
Field Duplicate	For samples >10X detection limit (DL), % RPD within +/- 30%, ok 10% of metal scan failing.	(n=1) (All passed.)	N/A
Standard reference materials	Within specified tolerance ranges.	(n=13). All passed except for WO# C189145 - Oreas 623 (Aqua Regia) for Hg failed.	(n=14) (All passed.); For TL-7A (September), sample could not assessed because data from the lab are pending.

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Table 4-2: QA/QC Summary for Process Plant Tailings Supernatant from Flotation Tailings (TL-5), Detoxified Tailings Filtrate (TL-7B) and Backfilled Stope Seepage Samples (TL-11)

QC Test	SRK QC Criteria	TL-5 Results	TL-11 Results	TL-7B Results
		Physical Test		
Field Blank	Minimum criteria is <2X DL, will accept <5X DL	(n=0)	(n=1) (All passed)	(n=0)
Lab Method Blank	<2X DL	(n=9) for TSS, Conductivity and Total Alkalinity (All Passed)	(n=3) for Total Dissolved Solids, Total Suspended Solids, Total Alkalinity, Acidity (as CaCO3) and Conductivity (All passed)	(n=0)
Field Duplicate	For samples >10X DL should be within +/- 30% RPD	(n=1) for TSS, Conductivity and Total Alkalinity (All Passed)	(n=2) All passed except for TSS with 179% RPD, >10X DL. TSS results for YL2101179-001 and YL2101179-002 have been rechecked, confirmed by re-analysis, and visual inspection. Failure interpreted to represent heterogeneity between samples resulting from sampling.	(n=1) for pH (Passed)
Lab Duplicate	For samples >10X DL should be within +/- 20% RPD	(n=9) for pH, TSS, Conductivity and Total Alkalinity (All Passed)	(n=3) for Total Dissolved Solids, Total Suspended Solids, Total Alkalinity, Acidity (as CaCO3) and Conductivity (All passed)	(n=9) for pH (All passed)
Field pH vs. Lab pH	Difference should not be greater than 1 pH unit	(n=8) (All Passed)	(n=6) (All passed)	Not a requirement of the monitoring program. (n=2; Aug and Sept) for pH (All passed).
Field EC vs Lab EC	For samples > 10X the detection limit (DL), % RPD should be within +/-30%	(n=8) (All Passed)	(n=6) TL11-3 and TL-11A have over-ranged field EC (All passed)	Not a requirement of the monitoring program.
Standard Reference Materials	Within specified tolerance ranges.	(n=9) for pH, TSS, Conductivity and Total Alkalinity (All Passed)	(n=3) for Total Dissolved Solids, Total Suspended Solids, Total Alkalinity, Acidity (as CaCO3) and Conductivity (All passed)	(n=9) for pH (All passed)
		Anions and Nutrients		
Field Blank	Minimum criteria is <2X DL, will accept <5X DL	(n=0)	(n=1) (All passed)	(n=0)
Lab Method Blank	<2X DL	(n=9) for Total Ammonia, Chloride, Nitrate, Nitrite and Sulfate (All Passed)	(n=3) for Total Ammonia, Chloride, Nitrate, Nitrite and Sulfate; (n=1) for Total Phosphorus and Total Nitrogen (All passed)	(n=9) for Total Ammonia (All passed)
Field Duplicate	For samples >10X DL should be within +/- 30% RPD	(n=1) for Total Ammonia, Chloride, Nitrate, Nitrite and Sulfate (All Passed)	(n=2) (All passed)	(n=1) for Total Ammonia (All passed)
Lab Duplicate	For samples >10X DL should be within +/- 20% RPD	(n=9) for Total Ammonia, Chloride, Nitrate, Nitrite and Sulfate (All Passed)	(n=3) for Total Ammonia, Chloride, Nitrate, Nitrite and Sulfate; (n=1) for Total Phosphorus and Total Nitrogen (All passed)	(n=9) for Total Ammonia (All passed)
Ion Balance	EC>100 uS/cm, % difference should be within +/-10%	(n=9) (All Passed)	(n=6) (All Passed)	No dissolved metals data, therefore ion balance could not be assessed.
Standard Reference Materials	Within specified tolerance ranges.	(n=9) forTotal Ammonia, Chloride, Nitrate, Nitrite and Sulfate (All Passed)	(n=3) for Total Ammonia, Chloride, Nitrate, Nitrite and Sulfate; (n=1) for Total Phosphorus and Total Nitrogen (All passed)	(n=9) for Total Ammonia (All passed)
		Cyanide Species and Degradation Products		
Field Blank	Minimum criteria is <2X DL, will accept <5X DL	(n=0)	(n=1) (All passed)	(n=0)
Lab Method Blank	<2X DL	(n=9) for WAD CN, Total CN, Thiocyanate (SCN), Cyanate and Cyanide, Free (All Passed)	(n=3) for Free Cyanide and Total Cyanide; (n=4) for Weak Acid Diss., Cyanide (All passed)	(n=9) for Weak Acid Diss., Total Cyanide, Thiocyanate, Cyanate, Free Cyanide (All passed)
Field Duplicate	For samples >10X DL should be within +/- 30% RPD	(n=1) for WAD CN, Total CN, Thiocyanate (SCN), Cyanate and Cyanide, Free (All Passed)	(n=2) (All passed)	(n=1) for Weak Acid Diss., Total Cyanide, Thiocyanate, Cyanate, Free Cyanide (All passed)
Lab Duplicate	For samples >10X DL should be within +/- 20% RPD	(n=9) for WAD CN, Total CN, Thiocyanate (SCN), Cyanate and Cyanide, Free (All Passed)	(n=3) for Free Cyanide, Total Cyanide and Weak Acid Diss., Cyanide (All passed)	(n=9) for Weak Acid Diss., Total Cyanide, Thiocyanate, Cyanate, Free Cyanide (All passed)
Standard Reference Materials	Within specified tolerance ranges.	(n=9) for WAD CN, Total CN, Thiocyanate (SCN), Cyanate and Cyanide, Free (All Passed)	(n=3) for Free Cyanide and Total Cyanide; (n=4) for Weak Acid Diss., Cyanide (All passed)	(n=9) for Weak Acid Diss., Total Cyanide, Thiocyanate, Cyanate Free Cyanide (All passed)
		Trace Metals by ICP-MS		
Field Blank	Minimum criteria is <2X DL, will accept <5X DL	(n=0)	(n=1) (All passed)	(n=0)
Lab Method Blank	<2X DL	(n=9) for Dissolved and Total (All Passed)	(n=3) for Total and Dissolved (All passed)	(n=9) for Total (All passed)
Field Duplicate	For samples >10X DL should be within +/- 30% RPD	(n=1) for Dissolved and Total (All Passed)	(n=2) for Total and Dissolved (All passed)	(n=1) for Total (All passed)
Lab Duplicate	For samples >10X DL should be within +/- 20% RPD	(n=9) for Dissolved and Total (All Passed)	(n=3) for Total and Dissolved (All passed)	(n=9) for Total (All passed)

QC Test	SRK QC Criteria	TL-5 Results	TL-11 Results	TL-7B Results
Total vs Dissolved Metals	Total Metals>Dissolved metals. Total Metals should be greater than Dissolved Metals, if not the % difference should be within +/-20%. ALS would use 10X DL, Maxxam would use 5X DL	(n=9) (All passed)	(n=6) (All passed)	(n=0)
Standard Reference Materials	Within specified tolerance ranges.	(n=9) for Dissolved and Total (All Passed)	(n=3) for Total and Dissolved (All passed)	(n=9) for Total (All passed)
		Hg-CVAAS		
Field Blank	Minimum criteria is <2X DL, will accept <5X DL	(n=0)	(n=1) (All passed)	(n=0)
Lab Method Blank	<2X DL	(n=9) for Dissolved and Total (All Passed)	(n=3) for Total and (n=4) for Dissolved (All passed)	(n=0)
Field Duplicate	For samples >10X DL should be within +/-30% RPD	(n=1) for Dissolved and Total (All Passed)	(n=2) for Total and Dissolved (All passed)	(n=0)
Lab Duplicate	For samples >10X DL should be within +/-20% RPD	(n=9) for Dissolved and Total (All Passed)	(n=3) for Total and (n=4) for Dissolved (All passed)	(n=0)
Standard Reference Materials	Within specified tolerance ranges.	(n=9) for Dissolved and Total (All Passed)	(n=3) for Total and (n=4) for Dissolved (All passed)	(n=0)

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4.2 Tailings Solids (TL-6 and TL-7A)

4.2.1 Acid Base Accounting

A summary of ABA results for the flotation tailings (TL-6) and detoxified tailings (TL-7A) solids are presented in Table 4-3 and Table 4-4, respectively. Full results are presented in Attachment A and Attachment B.

Table 4-3: Summary of ABA Results for Flotation Tailings (TL-6)

Year	Sampling Date	Moisture	Rinse pH	Total Sulphur	Sulphate		TIC		AP	TIC/AP	
					ALS	BV	ALS	BV		ALS	BV
		%	pH	%	% S	% S	kg $CaCO_3$/t	kg $CaCO_3$/t	kg $CaCO_3$/t	Ratio	Ratio
2021	Jan	--	--	0.32	--	0.03	--	280	10	--	28
	Mar	--	--	0.29	--	0.03	--	240	9.1	--	26
	Apr	--	--	0.12	--	0.02	--	250	3.8	--	67
	May	--	--	0.10	--	0.03	--	200	3.1	--	63
	Aug	--	--	0.18	--	0.01	--	210	5.6	--	37
	Sept	--	--	0.15	--	0.01	--	230	4.7	--	49
Statistical Summary											
2021	P005	--	--	0.11	--	0.01	--	200	3.3	--	26
	P050	--	--	0.17	--	0.03	--	230	5.2	--	43
	P095	--	--	0.31	--	0.03	--	270	10	--	66
	P100	--	--	0.32	--	0.03	--	280	10	--	67
	n	--	--	6	--	6	--	6	6	--	6
2020	P005	--	--	0.13	--	0.02	--	190	3.9	--	15
	P050	--	--	0.22	--	0.02	--	220	6.9	--	32
	P095	--	--	0.48	--	0.03	--	270	15	--	86
	P100	--	--	0.63	--	0.03	--	290	20	--	130
	n	--	--	12	--	12	--	12	12	--	12
2019	P005	--	--	0.13	--	0.01	--	100	3.4	--	11
	P050	--	--	0.24	--	0.02	--	140	7.7	--	17
	P095	--	--	0.45	--	0.04	--	210	14	--	48
	P100	--	--	0.53	--	0.04	--	220	17	--	72
	n	--	--	12	--	12	--	12	12	--	12
2018	P005	15	9.0	0.05	0.01	0.01	57	77	1.6	36	8.1
	P050	19	9.1	0.10	0.01	0.02	58	97	3.1	37	28
	P095	27	9.2	0.71	0.02	0.05	66	140	22	37	41
	P100	27	9.2	1.40	0.02	0.06	67	140	43	37	42
	n	5	3	12	3	9	3	9	12	3	9.0
2017	P005	21	8.8	0.05	0.01	--	43	--	1.6	1.7	--
	P050	24	9.0	0.07	0.02	--	63	--	2.2	25	--
	P095	26	9.3	0.86	0.02	--	92	--	27	48	--
	P100	27	9.3	1.0	0.02	--	110	--	33	48	--
	n	11	11	11	11	--	11	--	11	11	--

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Notes:

AP calculation is based upon total sulphur

Results from ALS and Bureau Veritas presented separately when methods were not comparable.

"-" denotes sample not analyzed.

2017 and 2018 results presented separately due to the differences in laboratories and analysis methods. The methods used by BV 2019 onwards are equivalent to the geochemical test work conducted on metallurgical tailings (SRK 2020)

Table 4-4: Summary of ABA Results for Detoxified Tailings (TL-7A)

Year	Sampling Date	Moisture	Rinse pH	Total Sulphur	Sulphate		TIC		AP	TIC/AP	
				ALS	ALS	BV	ALS	BV		ALS	BV
		%	pH	%	% S	% S	kg $CaCO_3$/t	kg $CaCO_3$/t	kg $CaCO_3$/t	Ratio	Ratio
2021	Jan	21	--	24	--	0.14	--	160	750	--	0.21
	Feb	17	--	25	--	0.34	--	120	790	--	0.16
	Mar	21	--	19	--	0.29	--	160	610	--	0.26
	Apr	13	--	29	--	0.28	--	110	900	--	0.12
	May	18	--	23	--	0.23	--	150	720	--	0.21
	Jun	19	--	33	--	0.29	--	89	1000	--	0.09
	Jul	18	--	30	--	0.22	--	110	940	--	0.11
	Aug	17	--	31	--	0.24	--	110	960	--	0.11
	Sep	16	--	37	--	0.21	--	110	1200	--	0.10
Statistical Summary											
2021	P005	14	--	21	--	0.17	--	96	650	--	0.09
	P050	18	--	29	--	0.24	--	110	900	--	0.12
	P095	21	--	35	--	0.32	--	160	1100	--	0.24
	P100	21	--	37	--	0.34	--	160	1200	--	0.26
	n	9	--	9	--	9	--	9	9	--	9
2020	P005	15	--	16	--	0.07	--	110	490	--	0.13
	P050	20	--	21	--	0.14	--	160	640	--	0.26
	P095	29	--	30	--	0.32	--	180	950	--	0.34
	P100	38	--	34	--	0.46	--	180	1000	--	0.36
	n	12	--	12	--	12	--	12	12	--	12
2019	P005	19	--	11	--	0.12	--	83	330	--	0.12
	P050	24	--	17	--	0.21	--	130	540	--	0.27
	P095	38	--	23	--	0.28	--	160	730	--	0.50
	P100	54	--	25	--	0.29	--	170	770	--	0.57
	n	12	--	12	--	12	--	12	12	--	12
2018	P005	19	8.4	4.6	0.04	0.09	60	76	140	0.22	0.12
	P050	21	8.9	13	0.07	0.20	67	110	420	0.37	0.24
	P095	26	9.0	23	0.10	0.26	82	140	700	0.60	0.34
	P100	26	9.0	23	0.10	0.27	84	140	720	0.64	0.37
	n	13	4	13	4	9	4	9	13	4	9

Year	Sampling Date	Moisture	Rinse pH	Total Sulphur	Sulphate		TIC		AP	TIC/AP	
				ALS	ALS	BV	ALS	BV		ALS	BV
		%	pH	%	% S	% S	kg $CaCO_3$/t	kg $CaCO_3$/t	kg $CaCO_3$/t	Ratio	Ratio
2017	P005	20	8.1	2.9	0.05	--	51	--	92	0.10	--
	P050	24	8.4	7.9	0.09	--	75	--	250	0.32	--
	P095	26	9.2	17	0.13	--	81	--	530	0.81	--
	P100	27	9.4	19	0.14	--	82	--	610	1.0	--
	n	11	11	11	11	--	11	--	11	11	--

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Notes:

AP calculation is based upon total sulphur

Results from ALS and Bureau Veritas presented separately when methods were not comparable.

"-" denotes sample not analyzed.

2017 and 2018 results presented separately due to the differences in laboratories and analysis methods. The methods used by BV 2019 onwards are equivalent to the geochemical test work conducted on metallurgical tailings (SRK 2020)

Flotation Tailings (TL-6)

Total sulphur in the flotation tailings (TL-6) ranged between 0.10% (May) and 0.32% (January) with a median value of 0.17% (Figure 4-1). Sulphate sulphur content was at or near analytical detection (0.01%) resulting in total sulphur content at near parity with sulphide sulphur content (calculated as the difference between total sulphur and sulphate sulphur). These results indicate that the majority of sulphur is present as sulphide sulphur (Figure 4-2) and on this basis, total sulphur is used to calculate AP.

In 2021, TIC content ranged between 200 and 280 kg $CaCO_3$/t which was equivalent to the range of data reported in 2020 (Figure 4-3). The TIC content reported January to March was similar to the late-2020 results (240 to 280 kg $CaCO_3$/t) whereas results for May onwards were lower (200 to 230 kg $CaCO_3$/t) and more similar to those reported in early 2021. Overall there is an increasing TIC trend between 2018 and 2020. TIC content in the flotation tailings (TL-6) was consistently greater than the detoxified tailings (TL-7A). Figure 4-4 shows that all flotation tailings samples were classified as non-PAG. The non-PAG classifications are consistent with the ARD classifications of the metallurgical flotation tailings characterized as part of the Type A Water Licence Amendment (SRK 2015).

Detoxified Tailings (TL-7A)

Total sulphur in the detoxified tailings (TL-7A) ranged from 19% (March) to 37% (September). Sulphur content in 2020 was within the equivalent range as 2020 except for a new operational maximum in September (Figure 4-1). Sulphate sulphur ranged between 0.14 and 0.34% and possibly represents sulphate as a byproduct of the cyanide detoxification process and is present in the residual moisture in tailings. This low sulphate content relative to the total sulphur content means that total sulphur and sulphide sulphur are at near parity for the detoxified tailings (Figure 4-2). Accordingly, total sulphur was used to calculate AP.

TIC content ranged between 89 and 160 kg $CaCO_3$/t and exhibited a decreasing trend in 2021 (Figure 4-3). Consistent with the ARD classifications of the metallurgical tailings characterized as part of the Type A Water Licence Amendment (SRK 2015), all detoxified tailings were classified as PAG (Figure 4-4).

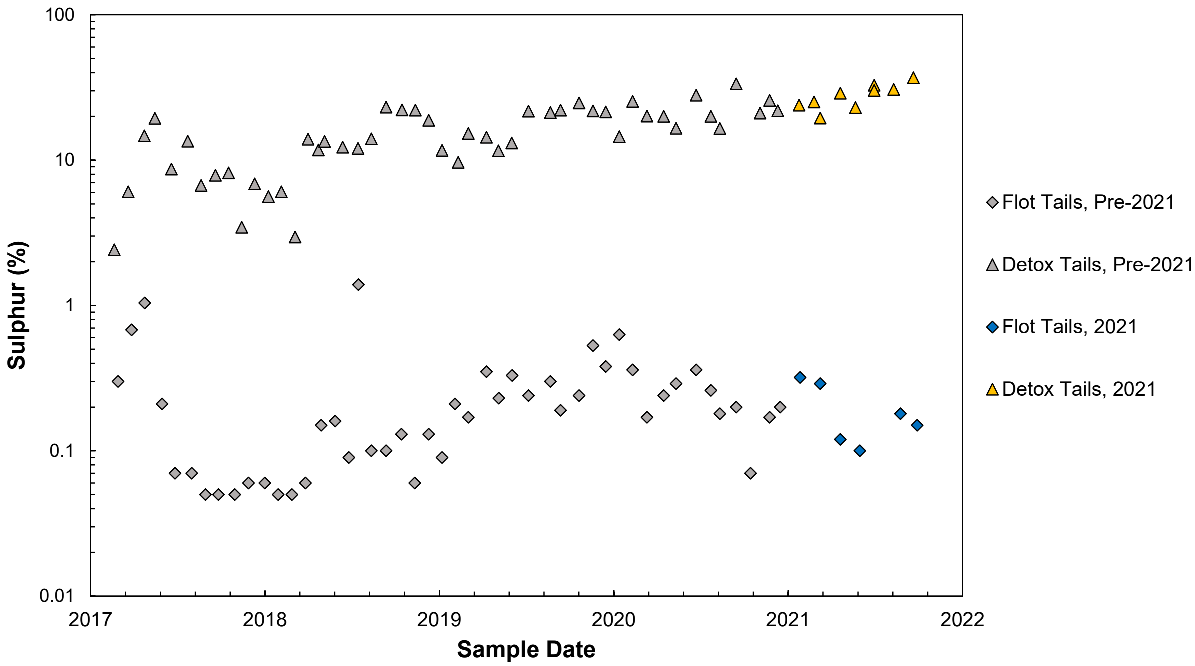

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Figure 4-1: Sulphur Concentrations for Tailings Samples Over Time

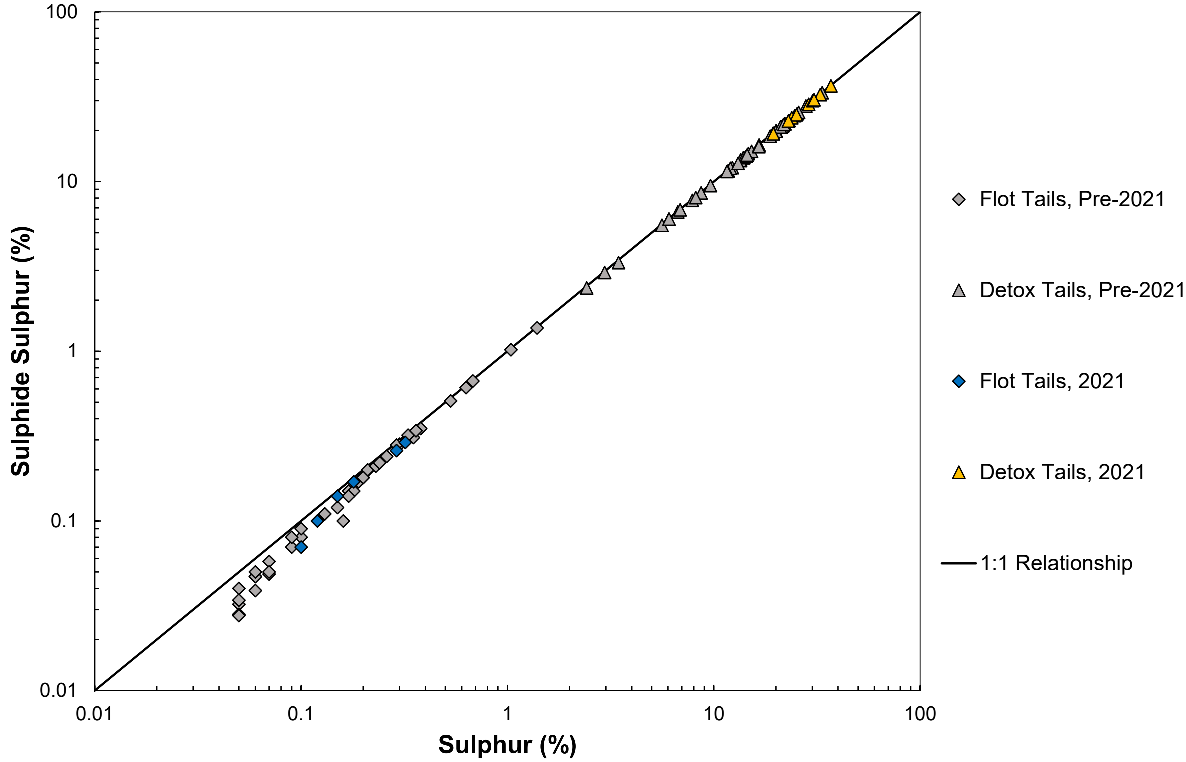

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Figure 4-2: Total Sulphur versus Calculated Sulphide Sulphur

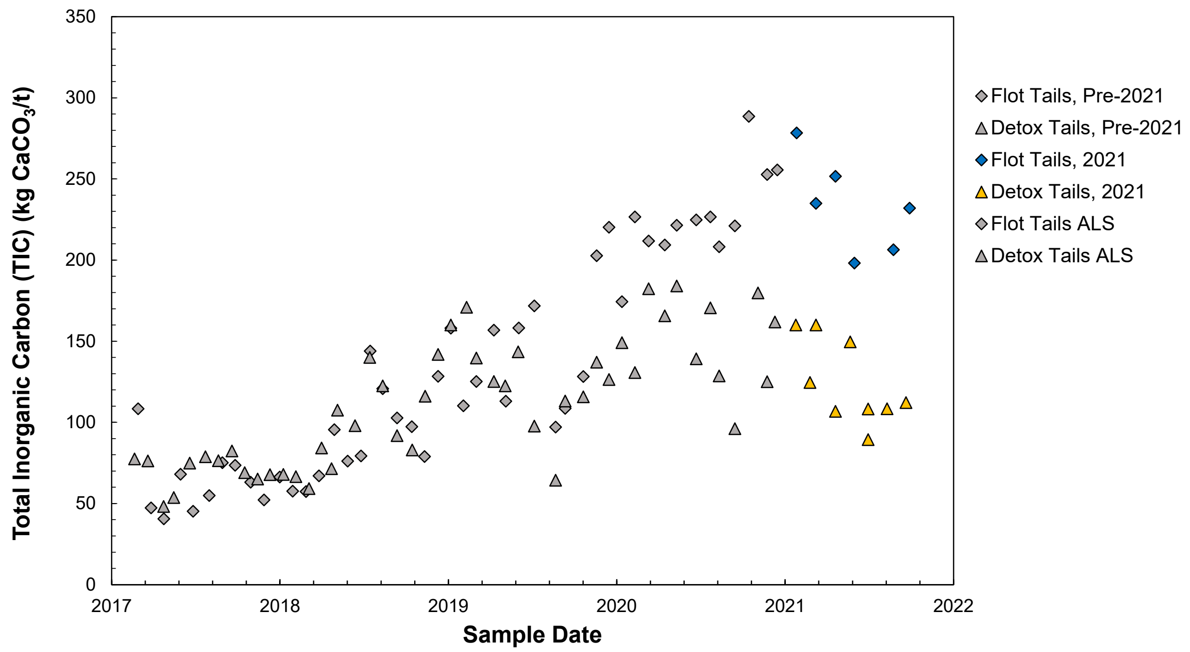

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Figure 4-3: Total Inorganic Carbon (TIC) Concentrations for Tailings Samples Over Time

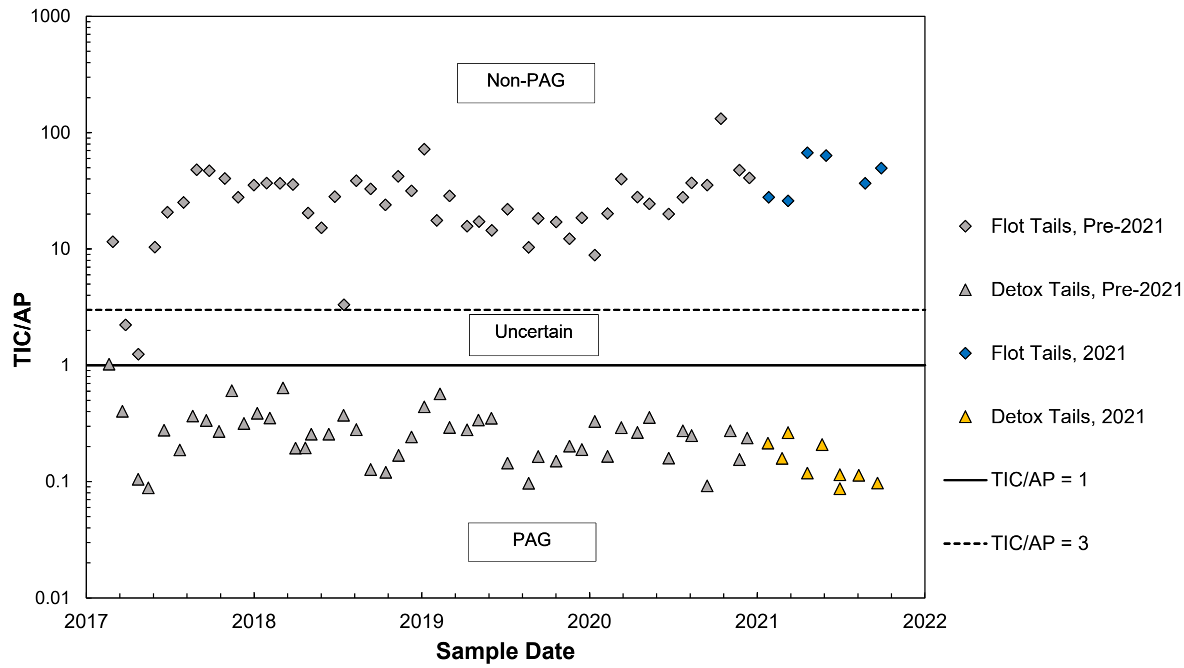

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Figure 4-4: ARD Classifications for Tailings Samples Over Time

4.2.2 Elemental Analysis

Trace element content for flotation (TL-6) and detoxified (TL-7A) tailings are summarized in Table 4-5 and Table 4-6, respectively with operational trends for selected parameters presented in Figure 4-5 to Figure 4-14. Complete results for flotation (TL-6) and detoxified (TL-7A) tailings are presented in Attachment A and Attachment B, respectively.

Data were compared to ten times the average crustal abundance data for basalt (Price 1997) as an indicator of enrichment. The detection limits for selenium and bismuth were equivalent to or higher than the screening criteria of 0.5 ppm and 0.07 ppm, respectively. Therefore, data were not assessed for selenium and bismuth when concentrations were within ten times the detection limit.

Flotation Tailings (TL-6)

In 2021, trace element content for flotation tailings samples (TL-6) was below the screening criteria in all samples except for arsenic and gold, which are summarized as follows:

- Arsenic content was slightly above the screening criteria (20 ppm) for January and August (22 and 27 ppm, respectively). An increasing trend in arsenic content was observed since November 2019 and attributed to the processing of Madrid North ore. The higher arsenic content reported in August is roughly equivalent to tailings produced between June 2019 and March 2020 but overall 2021 concentrations are typically lower than 2020.

Detoxified Tailings (TL-7A)

Several parameters were elevated relative to the screening criteria in the 2021 detoxified tailings samples (TL-7A) and are summarized as follows:

- All samples reported elevated arsenic (180 to 1,400 ppm) compared to the screening criteria (20 ppm). Concentrations were similar to 2020 except for the September result which was lower than typically reported (180 ppm) and potentially attributed to the difference in laboratory and QAQC issues described in Section 4.1.
- Copper, lead, cadmium and zinc content in the detoxified tailings has decreased since the introduction of Madrid North ore. In 2021, copper, cadmium and zinc concentrations were similar to 2020:
  - Copper was enriched in all samples (6 to 30 times screening criteria), cadmium was enriched in 56% of samples (1 to 2 times screening criteria) and zinc was slightly enriched in three samples (4 to 14% or 50 to 150 ppm above screening criteria).
  - Lead continued to show a decreasing trend; three samples were enriched relative to the screening criteria (1 to 3 times).
- All samples were enriched in bismuth (between 29 and 157 times), selenium (between 38 and 257 times) and silver (between 20 and 143 times). All aforementioned parameters exhibited stable trends since 2017 except for the April bismuth result when a new operational maximum was reported and the September silver and selenium results which were anomalously low (8.9 and 1.5 ppm respectively).

All other parameters, including cobalt and nickel were below the screening criteria indicating no appreciable enrichment.

Table 4-5: Summary of Elemental Concentrations for Flotation (TL-6) Tailings

Year	Sampling Date	Ag	As	Au	B	Bi	Cd	Co	Cu	Ni	Pb	S	Sb	Se	Zn
		ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
2021	Jan	0.2	***22***	***750***	<20	<0.1	0.2	19	52	37	4.0	2600	<0.1	<0.5	63
	Mar	0.3	16	***470***	<20	<0.1	<0.1	17	64	31	1.8	2300	<0.1	<0.5	61
	Apr	0.2	11	***450***	<20	<0.1	0.1	11	29	23	1.4	1300	<0.1	<0.5	43
	May	0.2	10	***1700***	<20	<0.1	<0.1	13	29	21	2.4	1100	<0.1	<0.5	52
	Aug	0.2	***27***	***370***	<20	<0.1	<0.1	12	41	33	2.6	1900	0.1	<0.5	49
	Sept	0.3	9	***1000***	<20	<0.1	0.2	10	30	19	7.8	1000	<0.1	<0.5	91
Summary Statistics															
2021	P005	0.2	9.5	***390***	<20	<0.1	0.1	11	29	19	1.5	1000	0.1	<0.5	45
	P050	0.2	14	***610***	<20	<0.1	0.1	12	36	27	2.5	1600	0.1	<0.5	57
	P095	0.3	***26***	***1500***	<20	<0.1	0.2	18	61	36	6.9	2500	0.1	<0.5	84
	P100	0.3	***27***	***1700***	<20	<0.1	0.2	19	64	37	7.8	2600	0.1	<0.5	91
	n	6	6	6	6	6	6	6	6	6	6	6	6	6	6
2020	P005	0.1	15	***300***	<20	***0.1***	0.1	12	29	28	1.5	1200	0.1	<0.5	37
	P050	0.2	***46***	***690***	<20	***0.1***	0.1	16	46	51	2.8	2300	0.1	<0.5	49
	P095	0.4	***110***	***1100***	31	***0.2***	0.1	20	100	100	5.4	***4800***	0.2	<0.5	68
	P100	0.6	***110***	***1100***	38	***0.2***	0.1	21	130	110	5.9	***6200***	0.2	<0.5	70
	n	12	12	12	12	12	12	12	12	12	12	12	12	12	12
2019	P005	0.2	7.8	***720***	<20	***0.1***	0.1	10	32	18	2.8	1100	0.1	<0.5	37
	P050	0.3	15	***1100***	<20	***0.1***	0.1	13	90	22	10	2500	0.1	<0.5	63
	P095	1.0	***110***	***2800***	32	***4.4***	0.5	19	360	55	43	***4500***	***2.5***	***0.6***	100
	P100	1.0	***170***	***3100***	47	***9.4***	0.7	21	640	58	44	***5300***	***5.0***	***0.6***	140
	n	12	12	12	12	12	12	12	12	12	12	12	12	12	12
2018	P005	0.1	6.2	***280***	<20	***0.1***	0.1	8.7	25	16	4.8	910	0.1	<0.2	30
	P050	0.2	9.2	***530***	<20	***0.1***	0.1	11	39	21	11	1200	0.1	<0.5	45
	P095	***1.6***	***39***	***7600***	49	***0.2***	0.4	30	180	36	47	***7200***	0.1	<0.5	110
	P100	***2.9***	***67***	***12000***	***68***	***0.2***	0.4	44	300	50	***70***	***14000***	0.1	<0.5	150
	n	12	12	9	12	12	12	12	12	12	12	12	12	12	12
2017	P005	0.2	6.6	--	7.3	<0.2	0.1	10	22	18	4.2	1000	0.1	<0.2	47
	P050	0.3	8.3	--	14	<0.2	0.1	13	27	22	6.3	1100	0.1	<0.2	61
	P095	***1.4***	***47***	--	34	<0.2	0.2	32	140	42	15	1400	0.2	***0.5***	130
	P100	***2.1***	***83***	--	41	<0.2	0.3	48	200	55	22	1500	0.2	***0.8***	130
	n	11	11	--	11	11	11	11	11	11	11	8	11	11	11
10 X Basalt Average		***1.1***	***20***	***40***	***50***	***0.07***	***2.2***	***480***	***870***	***1300***	***60***	***3000***	***2.0***	***0.5***	***1050***

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Notes

Numbers highlighted in bold exceed 10 times the average crustal abundance for basaltic rocks from Price (1997).

Where bismuth is reported below detection limit the data could not be assessed because the detection limit was greater than the screening criteria.

Table 4-6: Summary of Elemental Concentrations for Detoxified Tailings (TL-7A)

Year	Sampling Date	Ag	As	Au	B	Bi	Cd	Co	Cu	Ni	Pb	S	Sb	Se	Zn
		ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
	Jan	***19***	***1200***	***6600***	<20	***2.4***	***3.1***	400	***3300***	370	***150***	***>100000***	1.3	***19***	940
	Feb	***16***	***830***	***5700***	<20	***2.1***	1.8	350	***3100***	200	33	***>100000***	0.6	***14***	500
	Mar	***22***	***790***	***5500***	<20	***2.0***	2.0	340	***1900***	250	38	***>100000***	0.6	***13***	600
	Apr	***22***	***590***	***7700***	<20	***11.0***	1.6	260	***3400***	130	48	***>100000***	1.4	***15***	380
2021	May	***13***	***890***	***2500***	<20	***2.7***	***3.8***	310	***2000***	180	***91***	***>100000***	1.0	***17***	***1100***
	Jun	***19***	***890***	***5400***	<20	***6.7***	***4.5***	360	***4800***	170	56	***>100000***	1.7	***18***	***1200***
	Jul	***22***	***1200***	***6300***	<20	***4.1***	***3.2***	380	***2200***	250	***62***	***>100000***	1.4	***17***	890
	Aug	***15***	***1400***	***4400***	<20	***2.5***	2.0	300	***2300***	480	38	***>100000***	1.9	***14***	530
	Sep	***8.9***	***180***	***12000***	<20	***3.4***	***3.2***	170	***3000***	140	38	***90000***	0.8	***1.5***	***1100***
Summary Statistics															
	P005	***10***	***340***	***3200***	<20	***2.0***	1.7	200	***2000***	130	35	***>100000***	0.6	***6.1***	430
	P050	***19***	***890***	***5700***	<20	***2.7***	***3.1***	340	***3000***	200	48	***>100000***	1.3	***15***	890
2021	P095	***22***	***1300***	***10000***	<20	***9.1***	***4.2***	390	***4200***	440	***120***	***>100000***	1.8	***19***	***1200***
	P100	***22***	***1400***	***12000***	<20	***11.0***	***4.5***	400	***4800***	480	***150***	***>100000***	1.9	***19***	***1200***
	n	8	8	8	8	8	8	8	8	8	8	8	8	8	8
	P005	***12***	***550***	***4600***	<20	***2.1***	1.0	190	***2000***	140	31	***>100000***	0.7	***9.3***	310
	P050	***17***	***1200***	***8800***	<20	***4.1***	1.6	260	***3200***	430	***80***	***>100000***	1.5	***14***	540
2020	P095	***25***	***2500***	***17000***	<20	***5.3***	***3.9***	390	***7100***	880	***230***	***>100000***	***2.5***	***22***	***1100***
	P100	***28***	***2600***	***19000***	<20	***5.3***	***4.5***	430	***10000***	880	***260***	***>100000***	***2.7***	***22***	***1200***
	n	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	P005	***14***	***450***	***5500***	<20	***1.3***	0.8	200	***3500***	170	***96***	***92000***	0.5	***6.7***	400
	P050	***17***	***590***	***14000***	<20	***3.6***	***3.5***	280	***5300***	210	***370***	***>100000***	1.2	***12***	***1700***
2019	P095	***37***	***1000***	***36000***	22	***5.7***	***6.6***	330	***9300***	330	***810***	***>100000***	***2.9***	***17***	***3400***
	P100	***51***	***1000***	***56000***	24	***6.2***	***7.1***	350	***9400***	350	***850***	***>100000***	***4.6***	***19***	***3900***
	n	8	8	8	8	8	8	8	8	8	8	8	8	8	8

Year	Sampling Date	Ag	As	Au	B	Bi	Cd	Co	Cu	Ni	Pb	S	Sb	Se	Zn
		ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
2018	P005	***8.9***	***240***	***7100***	<20	***1.8***	1.8	140	***4000***	120	***180***	***71000***	0.8	***5.8***	800
	P050	***17***	***490***	***15000***	<20	***3.2***	***3.2***	260	***5700***	230	***410***	***>100000***	1.3	***10***	***1400***
	P095	***42***	***840***	***25000***	47	***6.9***	***6.9***	410	***10000***	370	***610***	***130000***	1.9	***18***	***3100***
	P100	***65***	***860***	***26000***	47	***7.5***	***7.5***	430	***10000***	420	***610***	***170000***	1.9	***18***	***3400***
	n	13	13	9	13	13	13	13	13	13	13	13	13	13	13
2017	P005	***6.5***	***260***		8.3	***1.9***	1.9	150	***2900***	130	***180***	***82000***	0.9	***4.7***	850
	P050	***21***	***410***		13	***5.7***	***5.7***	280	***5400***	220	***380***	***>100000***	1.4	***8.2***	***2800***
	P095	***50***	***710***		24	***12***	***12***	460	***16000***	320	***1100***	***210000***	***2.3***	***17***	***5100***
	P100	***51***	***730***		24	***13***	***13***	***510***	***20000***	350	***1500***	***230000***	***2.6***	***18***	***6100***
	n	11	11	--	11	11	11	11	11	11	11	9	11	11	11
	10 X Basalt Average	***1.1***	***20***	***40***	***50***	***0.07***	***2.2***	***480***	***870***	***1300***	***60***	***3000***	***2.0***	***0.5***	***1050***

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Notes

Numbers highlighted in bold exceed 10 times the average crustal abundance for basaltic rocks from Price (1997).

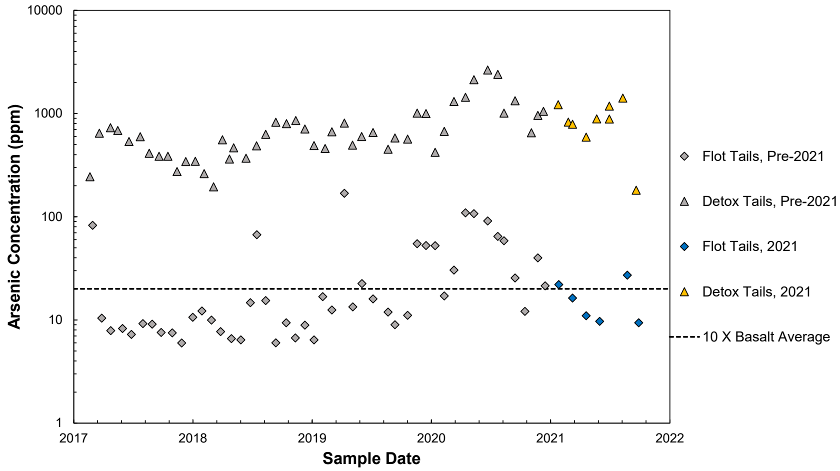

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Figure 4-5: Arsenic Concentrations in Tailings Samples

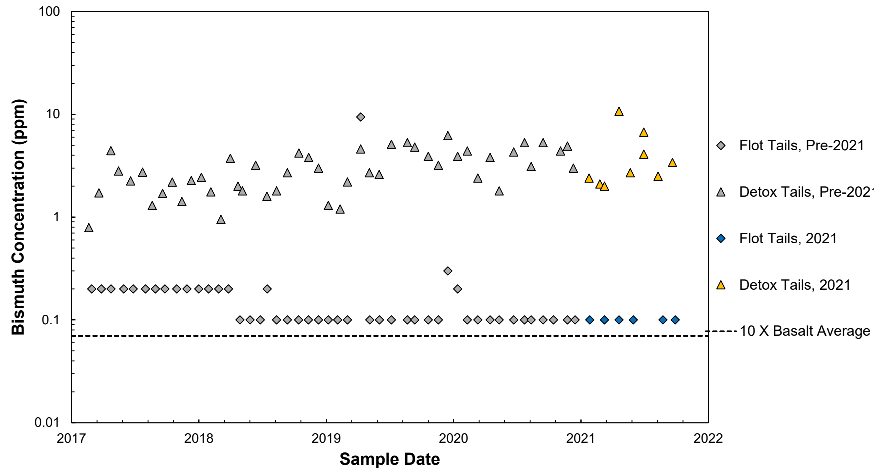

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Figure 4-6: Bismuth Concentrations in Tailings Samples

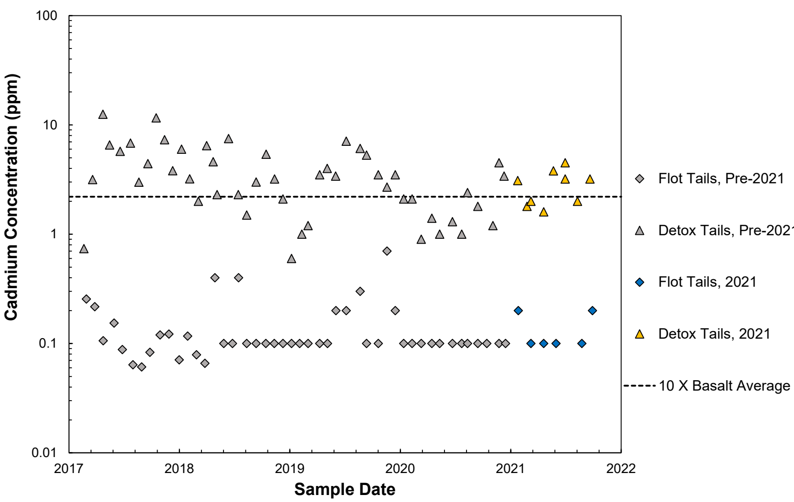

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Figure 4-7: Cadmium Concentrations in Tailings Samples

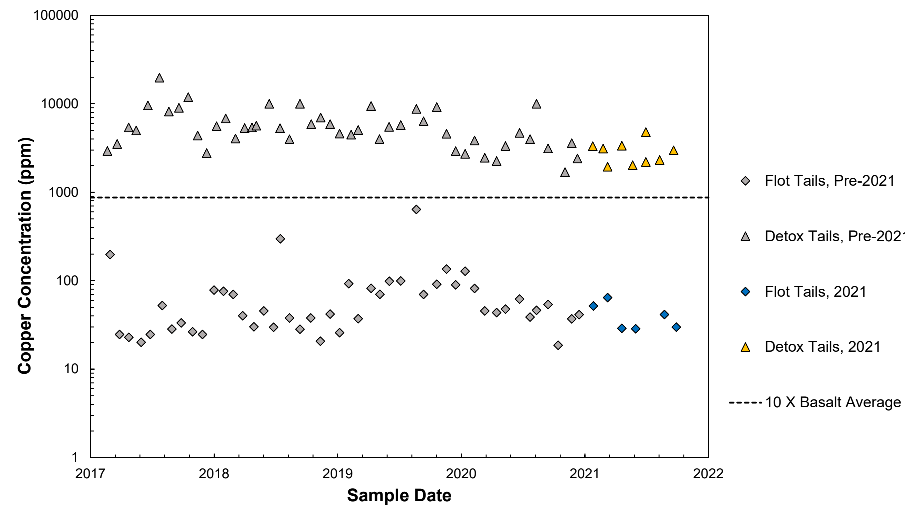

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Figure 4-8: Copper Concentrations in Tailings Samples

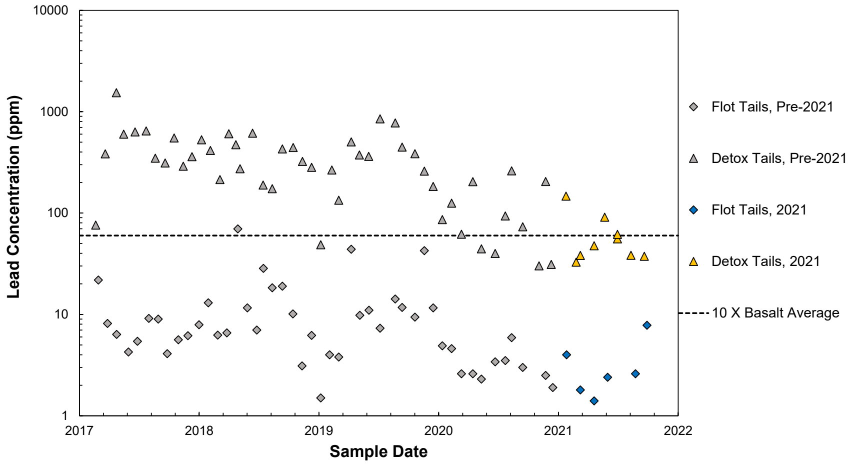

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Figure 4-9: Lead Concentrations in Tailings Samples

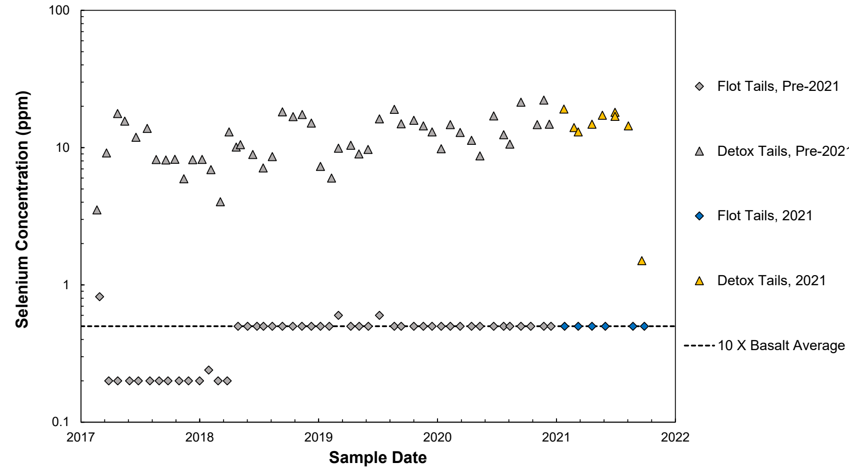

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Figure 4-10: Selenium Concentrations in Tailings Samples

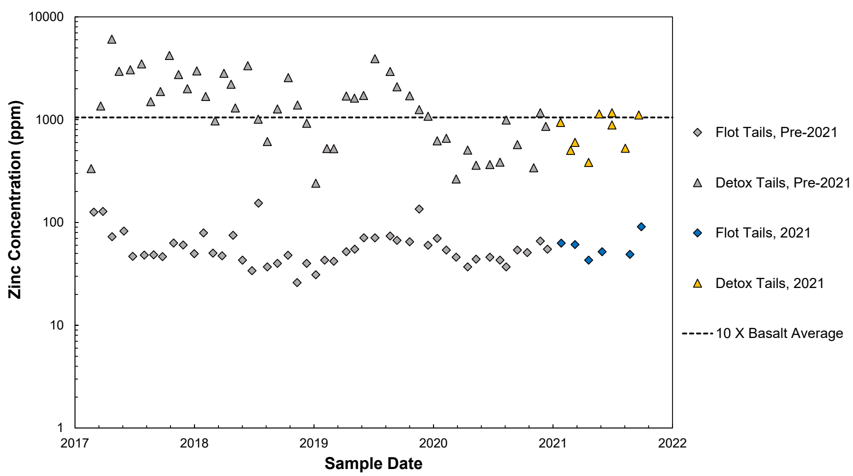

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Figure 4-11: Zinc Concentrations in Tailings Samples

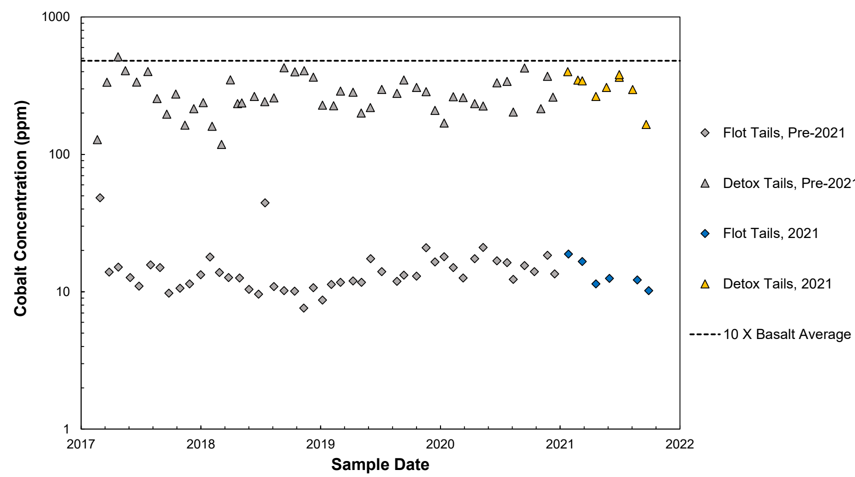

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Figure 4-12: Cobalt Concentrations in Tailings Samples

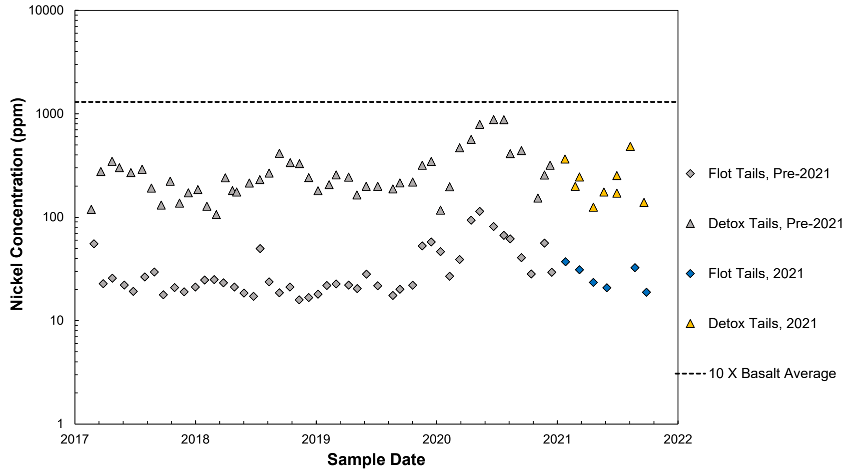

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Figure 4-13: Nickel Concentrations in Tailings Samples

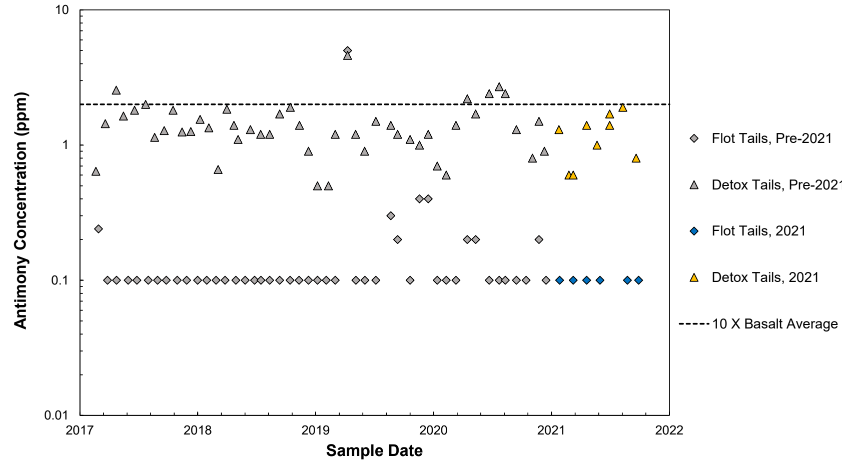

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Figure 4-14: Antimony Concentrations in Tailings Samples

4.3 Detoxified Tailings Filtrate (TL-7B)

A summary of the detoxified tailings filtrate (TL-7B) data is presented in Table 4-7. Full results are presented in Attachment C. Detoxified tailings slurry is squeezed in a filter press to separate the detoxified tailings filtrate from solids (TL-7A). The detoxified tailings filtrate is subsequently combined with the flotation tailings slurry in the thickener tank (TL-5). The detoxified tailings filtrate is approximately 7% of the volume of TL-5 and is managed within the TIA. TL-7B represents the chemistry of the residual moisture within the detoxified tailings, which ranges from 18 to 24%. Monitoring of TL-7B commenced in 2019.

The 2021 detoxified tailings filtrate (TL-7B) monitoring data were within the range of the previous monitoring data (except where stated) and are summarized as follows (all metals are total as per the Water Licence):

- pH ranged between 8.5 and 8.7 with values roughly equivalent to previous years.
- Sulphur as sulphate ranged between 13,000 and 20,000 mg/L with concentrations within the range of previous data (Figure 4-15).
- Sodium is used as a milling reagent and ranged between 7,200 and 11,000 mg/L. Concentrations fluctuated with no discernible trend and were within the range of previous data.
- Total cyanide concentrations ranged from 0.15 to 5.3 mg/L and were within range of previous data except for March (5.3 mg/L).
- Concentrations of free cyanide were consistently reported below or near the analytical detection limit (detection limits ranged from 0.01 to 0.5 mg/L).
- WAD cyanide concentrations ranged from 0.04 to 0.27 mg/L and were within range of previous monitoring data (0.01 to 0.5 mg/L).
- Thiocyanate, cyanate and ammonia are degradation products of the cyanide detoxification process. Thiocyanate and cyanate concentrations ranged from 190 mg/L to 580 mg/L and 540 mg/L to 1,100 mg/L, respectively. Ammonia concentrations ranged from 190 to 370 mg/L. Thiocyanate concentrations were within the range of previous data except for March (580 mg/L) and July (560 mg/L). Cyanate and ammonia concentrations fluctuated to operational maximums of approximately 830 mg/L and 300 mg/L, respectively with periodic increases in February, March and July for cyanate (Figure 4-16) and in March for ammonia (Figure 4-17).
- Arsenic concentrations ranged from 0.04 to 0.23 mg/L and were within the same range as previous data (Figure 4-18) except for two operational maximums indicated in 2020.
- Antimony concentrations ranged between 0.02 and 0.04 mg/L and were equivalent to the range of concentrations observed between late-2019 and early 2020 (Figure 4-19). Antimony concentrations were lower in early 2019 and periodic spikes were observed in 2020.
- Cobalt concentrations ranged between 0.03 and 0.3 mg/L and were within range of the previous data except for March.

- Copper concentrations ranged between 1.5 and 11 mg/L and were similar to or lower than previous data (Figure 4-20).
- Concentrations of manganese were 59 to 99 mg/L and within the same range as historic concentrations (Figure 4-21).
- Molybdenum and selenium concentrations ranged from 0.08 to 0.13 mg/L and from 0.006 to 0.04 mg/L respectively. Concentrations were within the range of the historic data.
- Nickel concentrations were close to detection limit (0.01 to 0.04 mg/L), within the same range of concentrations observed prior to 2020 (Figure 4-22). Cadmium and zinc concentrations were consistently below the analytical detection limit.
- Silver concentrations ranged between <0.0005 and 0.04 mg/L and were within the same range as the previous data except for January and March.

Table 4-7: Summary of 2021 Detoxified Tailings Filtrate (TL-7B) Analyses

Parameters	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Moisture Content[1]	%	21	17	21	13	18	19	18	17	16
pH	s.u.	8.7	8.6	8.5	8.6	8.7	8.5	8.6	8.7	8.6
Ca	mg/L	51	87	72	65	62	65	38	43	62
Mg	mg/L	69	99	87	91	93	70	65	56	61
K	mg/L	54	58	70	76	87	72	71	68	54
Na	mg/L	9900	7200	11000	11000	9500	9200	8300	7800	7500
Al	mg/L	1.10	0.90	< 0.93	0.24	0.55	0.59	0.15	0.23	0.13
Ag	mg/L	0.037	0.012	0.042	0.014	0.014	0.007	< 0.001	0.014	0.003
As	mg/L	0.17	0.05	0.07	0.05	0.08	0.06	0.05	0.23	0.04
B	mg/L	1.2	1.3	1.5	1.4	1.7	1.4	1.9	1.0	1.1
Cd	mg/L	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	0.0003	< 0.0003	< 0.0003	< 0.0001
Cr	mg/L	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03	< 0.01
Co	mg/L	0.21	0.05	0.32	0.03	0.19	0.03	0.15	0.06	0.12
Cu	mg/L	5.5	4.5	1.5	8.1	2.3	11.0	2.8	6.9	2.5
Fe	mg/L	13	4.3	7.7	8.0	9.9	7.5	0.5	3.1	2.8
Pb	mg/L	0.013	0.003	< 0.003	0.003	< 0.006	0.012	0.003	0.003	0.001
Mn	mg/L	69	99	87	91	93	70	65	56	61
Mo	mg/L	0.12	0.08	0.10	0.10	0.13	0.10	0.09	0.12	0.10
Ni	mg/L	< 0.04	< 0.03	0.03	0.03	0.03	0.03	0.03	0.04	< 0.01
Se	mg/L	0.02	0.04	0.01	0.04	0.01	0.02	0.01	0.01	0.03
Sb	mg/L	0.03	0.04	0.04	0.03	0.04	0.04	0.02	0.04	0.03
S	mg/L as SO_4	19000	13000	20000	19000	16000	16000	14000	13000	14000
Zn	mg/L	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15	0.15	< 0.15	< 0.15	< 0.06
NH_3	mg/L as N	300	300	370	200	300	270	300	270	190
Cyanate	mg/L	650	960	1100	570	830	800	890	700	540
Thiocyanate	mg/L	440	290	580	190	480	190.0	560	400.0	380
Total CN	mg/L	0.77	0.83	5.30	0.15	1.80	0.30	0.80	0.40	0.45
WAD CN[2]	mg/L	0.10	0.18	< 0.50	0.13	< 0.50	< 0.04	< 0.10	0.05	0.27
Free CN[2]	mg/L	< 0.02	< 0.01	< 0.50	< 0.02	< 0.50	< 0.04	< 0.10	< 0.02	0.01

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Notes:

< denotes value less than analytical detection limit.

Metal(loid) concentrations are reported as 'Totals'

[1] Moisture content of TL-7A

[2] March and May detection limits for WAD and Free CN raised to 0.5 mg/L by analytical lab. Dilution required due to high concentration of test analytes.

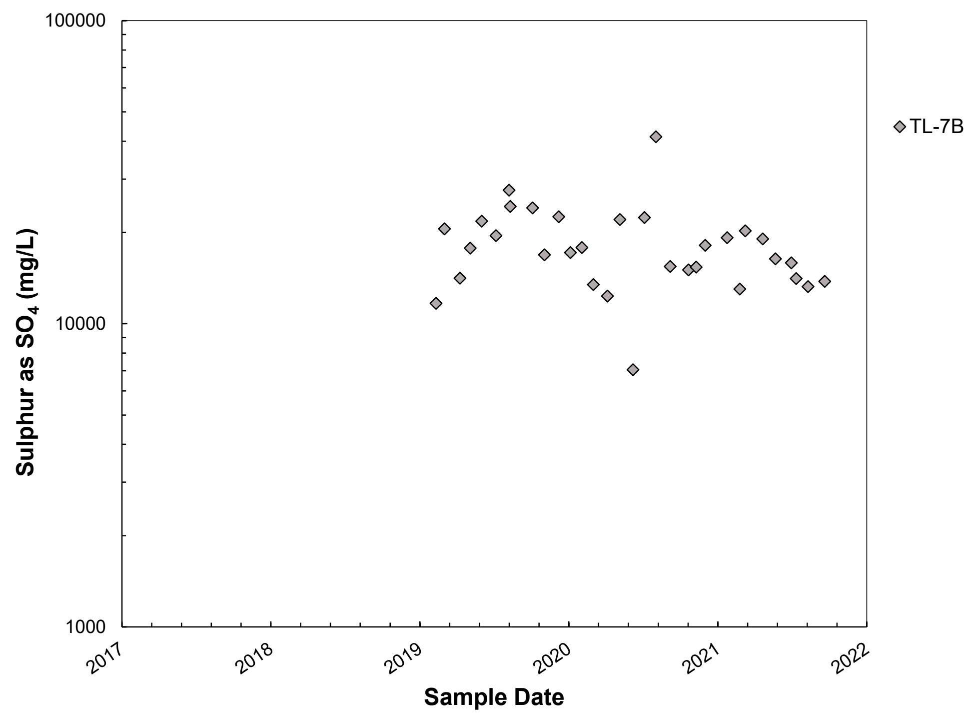

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Figure 4-15: Sulphur as SO_4 Concentrations Over Time (TL-7B)

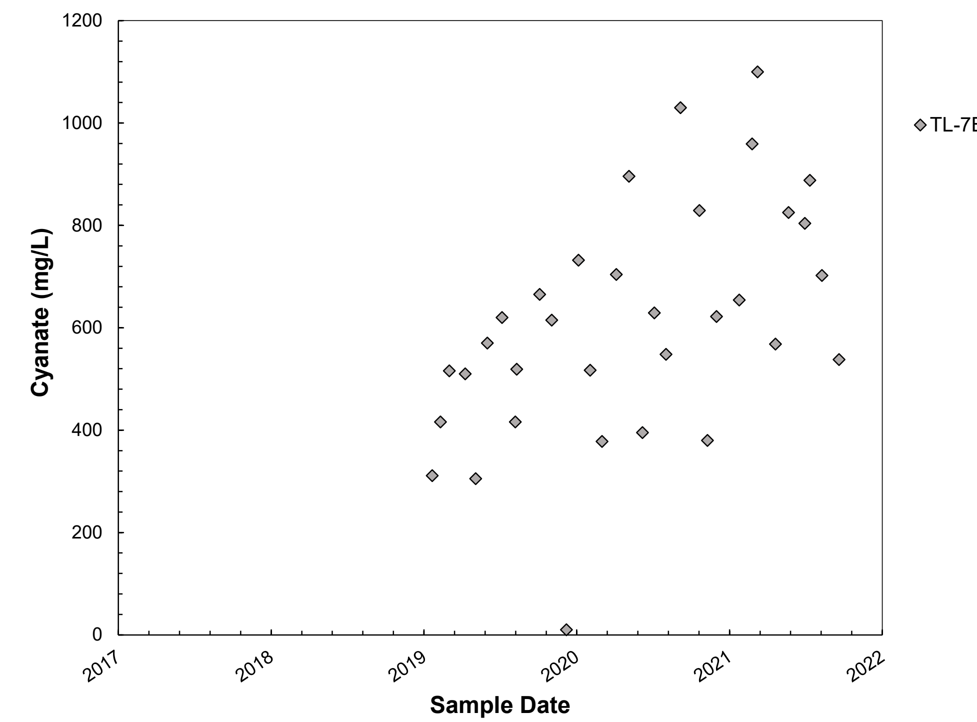

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Figure 4-16: Cyanate Concentrations Over Time (TL-7B)

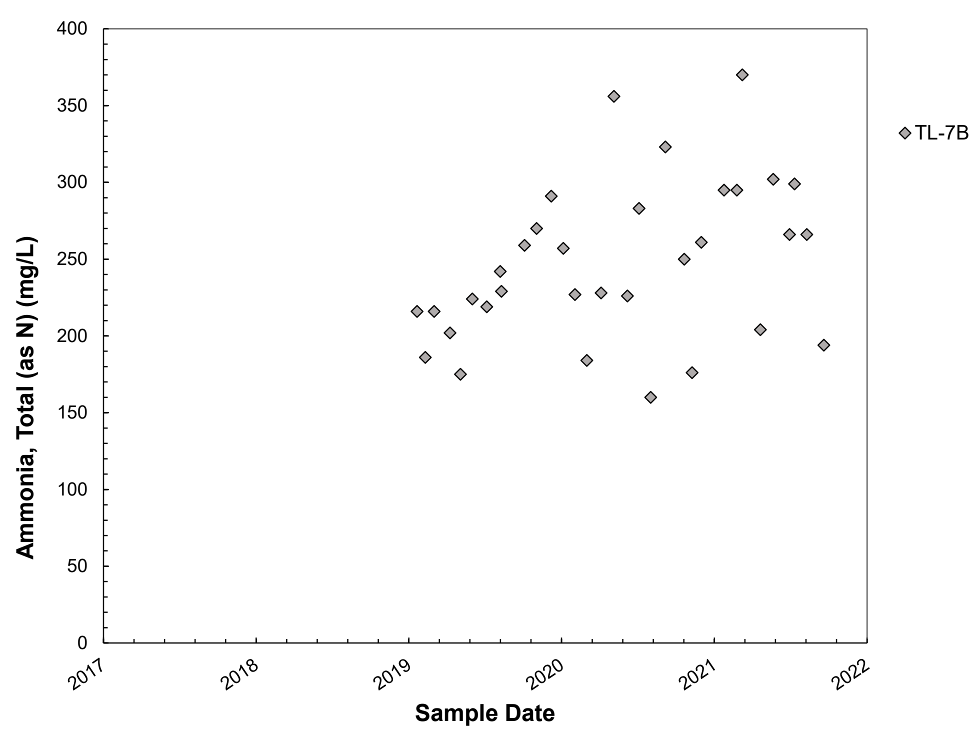

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Figure 4-17: Ammonia Concentrations Over Time (TL-7B)

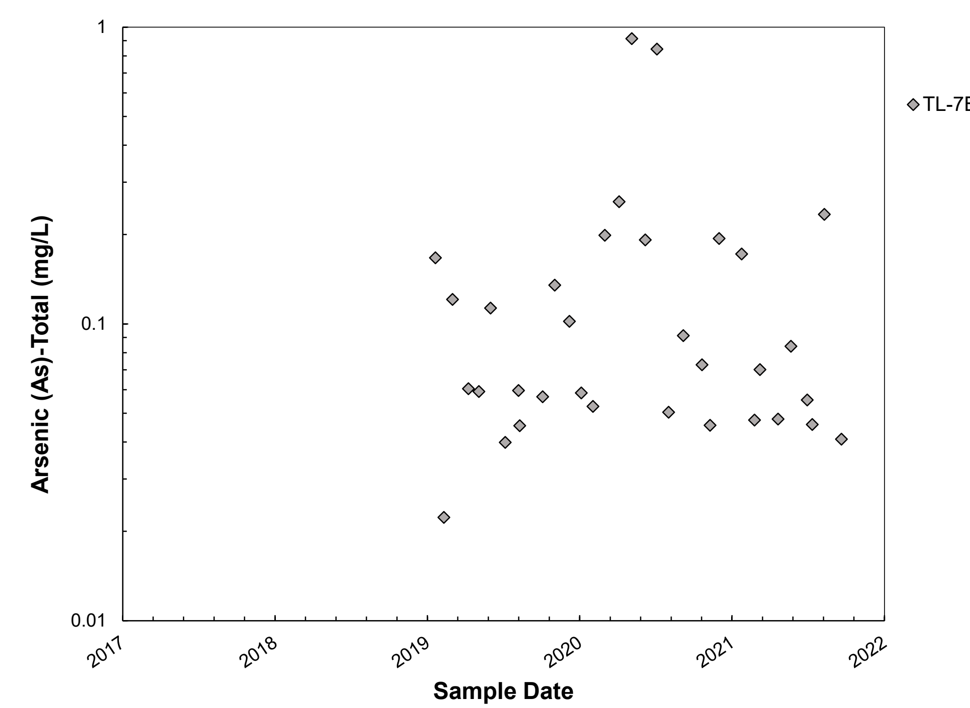

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Figure 4-18: Arsenic Concentrations Over Time (TL-7B)

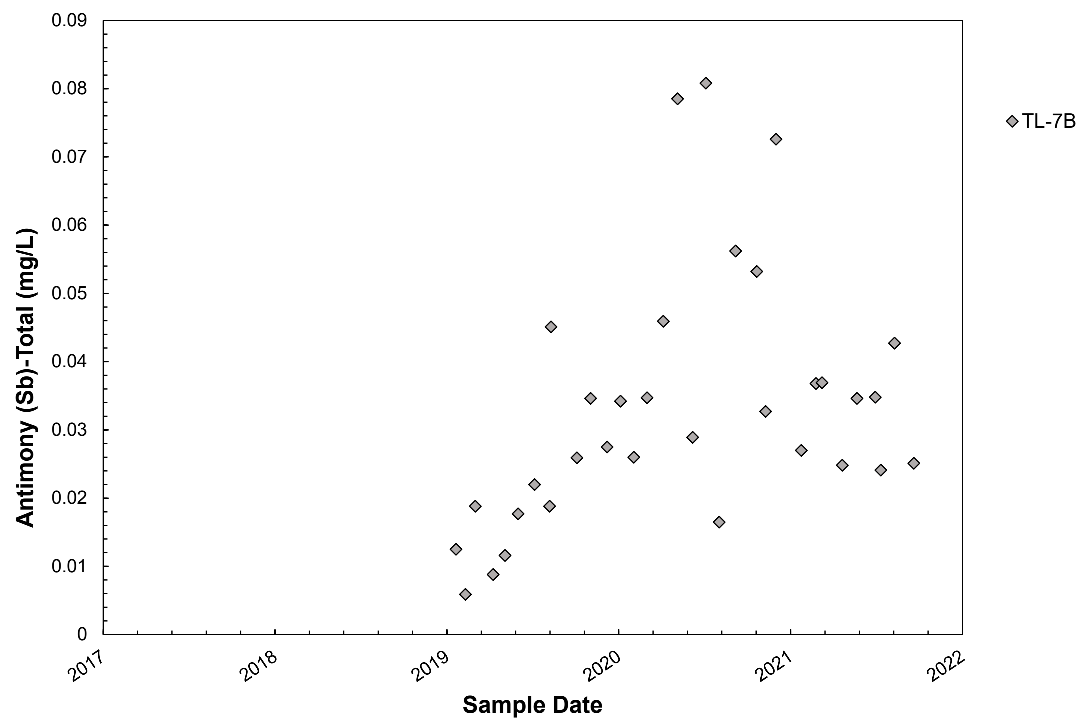

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Figure 4-19: Antimony Concentrations Over Time (TL-7B)

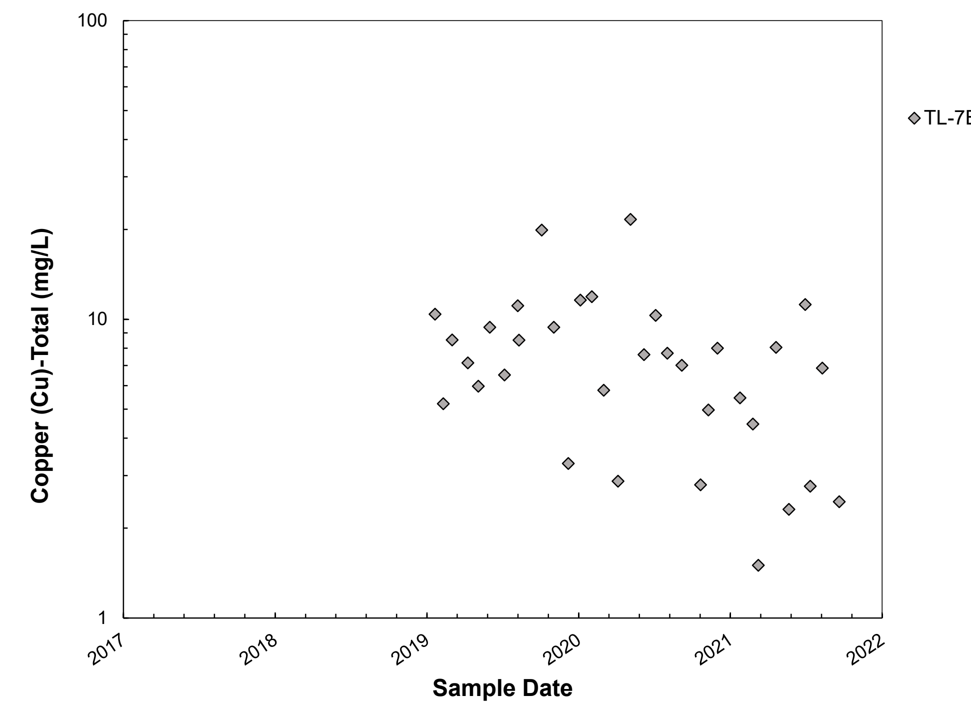

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Figure 4-20: Copper Concentrations Over Time (TL-7B)

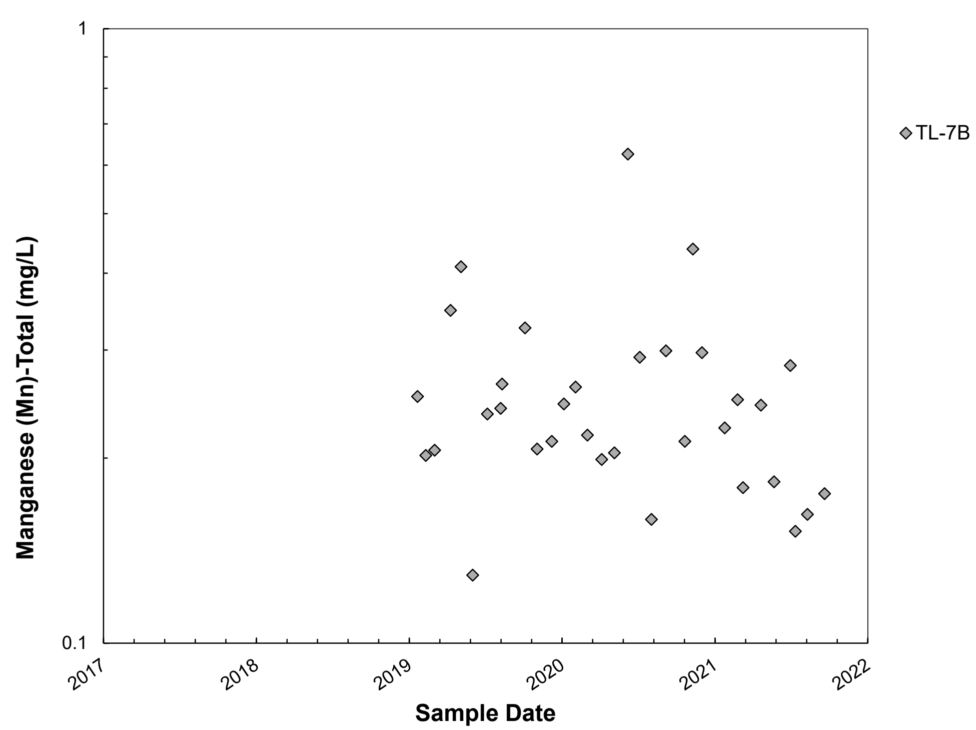

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Figure 4-21: Manganese Concentrations Over Time (TL-7B)

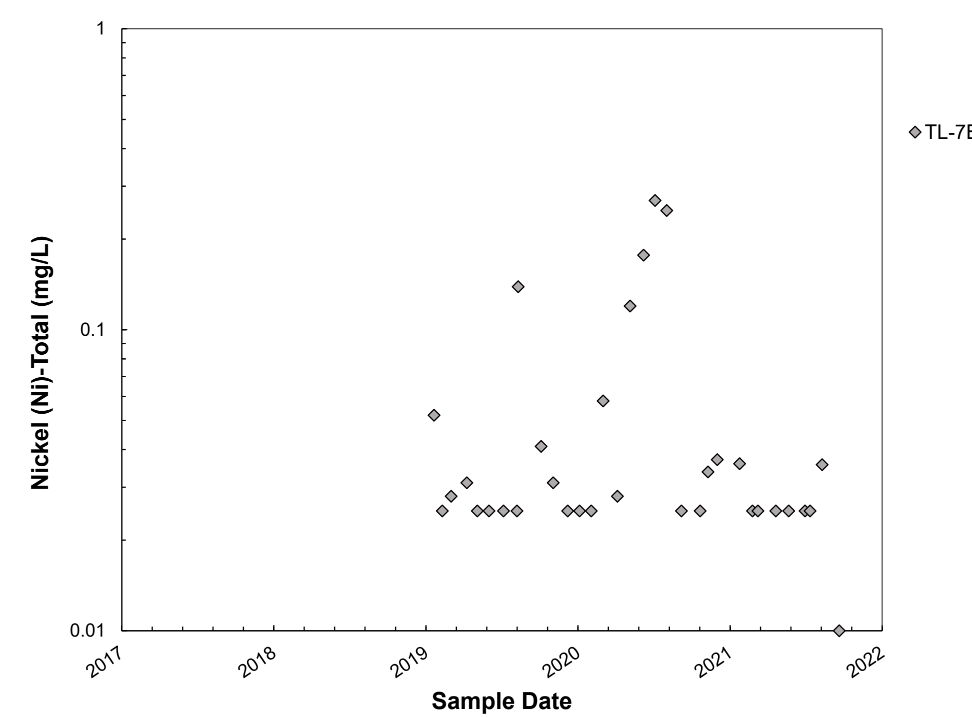

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Figure 4-22: Nickel Concentrations Over Time (TL-7B)

4.4 Process Plant Tailings Water Discharge (TL-5)

A summary of key parameters for process plant tailings water discharge (TL-5) are summarized in Table 4-8 and presented in Figure 4-23 to Figure 4-32. Full results are included in Attachment D. Prior to April 2019, total metals were determined at TL-5 as per the Water Licence whereas from April 2019 to present both total and dissolved metals were analyzed. The subsequent figures present total metals data to April 2019 and dissolved metals data thereafter.

The geochemistry of the 2021 process plant tailings discharge (TL-5) was similar to previous monitoring data (except where stated) and is summarized as follows:

- The pH ranged between 8.1 and 8.4 and was consistent with previous years (Figure 4-23).
- Sulphate concentrations fluctuated between 1,300 and 3,000 mg/L within range of historical data (Figure 4-24).
- Ammonia concentrations ranged between 25 and 47 mg/L as N and within the range of previous years. Overall trends for ammonia are higher from January 2019 to present compared with 2018 and earlier. (Figure 4-25).
- Cyanate concentrations ranged between 41 and 130 mg/L and followed a similar trend to ammonia. Thiocyanate concentrations ranged between 12 and 51 mg/L and were stable and similar to previous years. Concentrations of total cyanide, free and WAD cyanide were all within range of 2019 and 2020 data.
- Nitrate and nitrite concentrations ranged between 8.9 and 29 mg/L as N and 0.7 to 3.3 mg/L as N, respectively. Nitrate concentrations were within the same range as previous data. Nitrite concentrations were within the same range as the 2020 concentrations but pre-2020 concentrations are generally lower (Figure 4-26).
- Chloride concentrations ranged between 2,500 and 4,100 mg/L. Data is available from 2019 onwards and shows an oscillating trend with two distinctive spikes in spring 2020 and 2021 (March and April) which are likely related to cryoconcentration within the TIA (Figure 4-27).
- Sodium, which is used as a milling agent, reported concentrations ranging from 1,600 to 2,900 mg/L similar to the 2020 results but generally higher than concentrations reported mid-2019 and earlier.
- Arsenic concentrations ranged from 0.002 to 0.005 mg/L and were generally stable within range of historic data (Figure 4-28). Concentrations of cobalt and nickel were between 0.005 and 0.03 mg/L and between 0.006 and 0.1 mg/L respectively and fluctuated within the same range as historical data between.
- Concentrations of antimony ranged between 0.002 and 0.004 mg/L; an increasing trend occurred in 2019 but concentrations have remained stable since 2019 (Figure 4-29).
- Concentrations of boron ranged between 0.9 and 1.5 mg/L and show a gradually increasing trend since December 2017 (Figure 4-30).
- Copper concentrations ranged between 0.01 and 0.6 mg/L, showing a stable trend (Figure 4-31).

- Molybdenum concentrations ranged between 0.02 and 0.03 mg/L. An increasing trend occurred in mid-2018 but concentrations have remained relatively stable thereafter (Figure 4-32).
- Selenium concentrations ranged from 0.002 to 0.005 mg/L in TL-5 and were within range of the previous data.
- Manganese concentrations ranged between 0.1 and 0.3 mg/L, within range of the previous data.
- Cadmium and zinc were consistently reported at limit of detection in all of the 2021 samples; the limit of detection ranged between <0.00003 and <0.0001 mg/L for cadmium and <0.01 and <0.02 mg/L for zinc (Figure 4-33). These trends are consistent with previous data since 2019.
- Calcium and magnesium concentrations ranged from 160 to 240 mg/L and from 130 to 220 mg/L respectively. Both parameters report overall increasing trends since January 2018 with seasonal spikes in March and May/June potentially related to cryoconcentration within the TIA.

Table 4-8: Summary of 2021 Process Plant Tailings Water Discharge (TL-5) Analyses

Parameter	Units	Detection Limit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
pH	pH	0.1	8.3	8.4	8.2	8.2	8.3	8.1	8.2	8.3	8.3
TSS	mg/L	3	18	10	230	16	6.6	110	260	14	34
NO_3 as N	mg/L	0.1	8.9	19	15	27	16	27	29	15	21
NO_2 as N	mg/L	0.02	0.72	1.4	0.88	1.2	0.79	1.2	3.3	0.77	0.67
NH_4 as N	mg/L	0.25	27	47	45	46	34	39	40	37	25
Cl	mg/L	25	2600	3100	3200	4100	3800	3300	3600	2500	2100
SO_4	mg/L	6	1900	1700	2000	3000	1800	1800	1900	1900	1300
Ca	mg/L	0.1	190	220	210	240	240	230	220	160	160
Mg	mg/L	0.01	160	190	200	190	220	220	200	160	130
K	mg/L	0.1	110	130	130	100	120	120	120	120	100
Na	mg/L	0.1	2100	2400	2700	2900	2700	2600	2400	2200	1600
Total CN	mg/L	0.005	3.9	4.7	3.0	1.6	1.4	0.9	1.1	1.0	1.1
WAD CN	mg/L	0.005	0.73	0.49	0.13	0.12	0.035	0.082	0.13	0.07	0.04
Free CN	mg/L	0.005	0.41	0.44	0.042	0.11	0.026	0.04	0.065	0.047	0.04
Cyanate	mg/L	2	47	130	97	74	64	63	61	75	41
Thiocyanate (SCN)	mg/L	0.5	19	36	51	21	24	12	23	40	33
Ag	mg/L	0.00002	< 0.0001	< 0.0001	< 0.0003	< 0.0001	< 0.0001	< 0.0002	< 0.0001	< 0.0001	< 0.0001
Al	mg/L	0.006	0.093	0.075	0.064	0.052	0.076	0.079	0.033	0.063	0.064
As	mg/L	0.0002	0.004	0.003	0.003	0.003	0.003	0.004	0.002	0.005	0.003
B	mg/L	0.02	0.94	1.2	1.1	1.5	1.2	1.3	1.3	0.98	1.2
Cd	mg/L	0.00001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00010	< 0.00005	< 0.00005	< 0.00003
Co	mg/L	0.0002	0.012	0.014	0.030	0.008	0.015	0.005	0.011	0.008	0.010
Cr	mg/L	0.0002	< 0.001	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010	< 0.005	< 0.005	< 0.003
Cu	mg/L	0.001	0.42	0.55	0.13	0.04	0.03	0.10	0.10	0.03	0.01
Fe	mg/L	0.02	1.3	1.7	1.1	0.64	0.57	0.46	0.55	0.42	0.35
Mn	mg/L	0.0002	0.14	0.19	0.18	0.29	0.23	0.22	0.3	0.18	0.16
Mo	mg/L	0.0001	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.02
Ni	mg/L	0.001	0.14	0.11	0.086	0.013	0.028	0.037	0.066	0.027	0.0063
Pb	mg/L	0.0001	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0010	< 0.0005	< 0.0005	< 0.0003
S	mg/L	1	700	710	830	970	660	720	700	750	520
Sb	mg/L	0.0002	0.003	0.004	0.004	0.004	0.003	0.004	0.003	0.003	0.002
Se	mg/L	0.0001	0.003	0.005	0.005	0.005	0.002	0.003	0.003	0.002	0.002
Zn	mg/L	0.006	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01

Source: \\van-svr0.van.na.srk.ad\Projects\01_SITES\Hope.Bay\1CT022.073_2021 Geochem Compliance\!080_Deliverables\2021 Doris Madrid Annual Report\Doris Tailings\Working Files\[1CT022.056_HopeBay_TailingsMonitoringData_TL-5_2021_Figs_Rev09_lnb_rtc_mlt_jce_mc.xlsm]

Notes:

< denotes value less than analytical detection limit.

Metal(loid) concentrations are reported as 'Dissolved

-- denotes no result reported

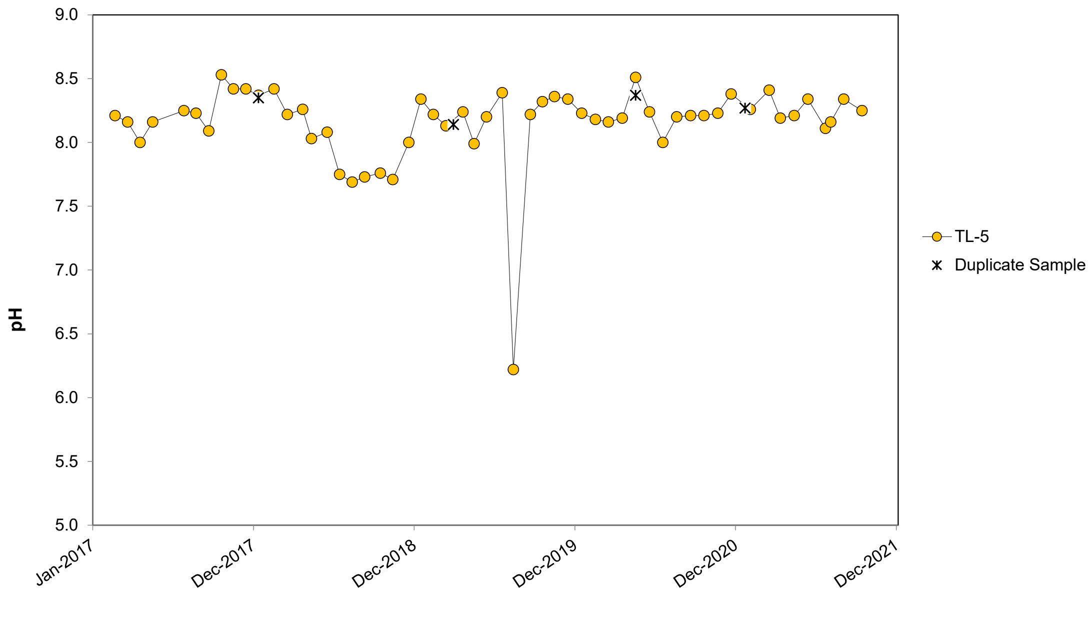

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Figure 4-23: Trends in pH for Process Plant Supernatant Discharge (TL-5)

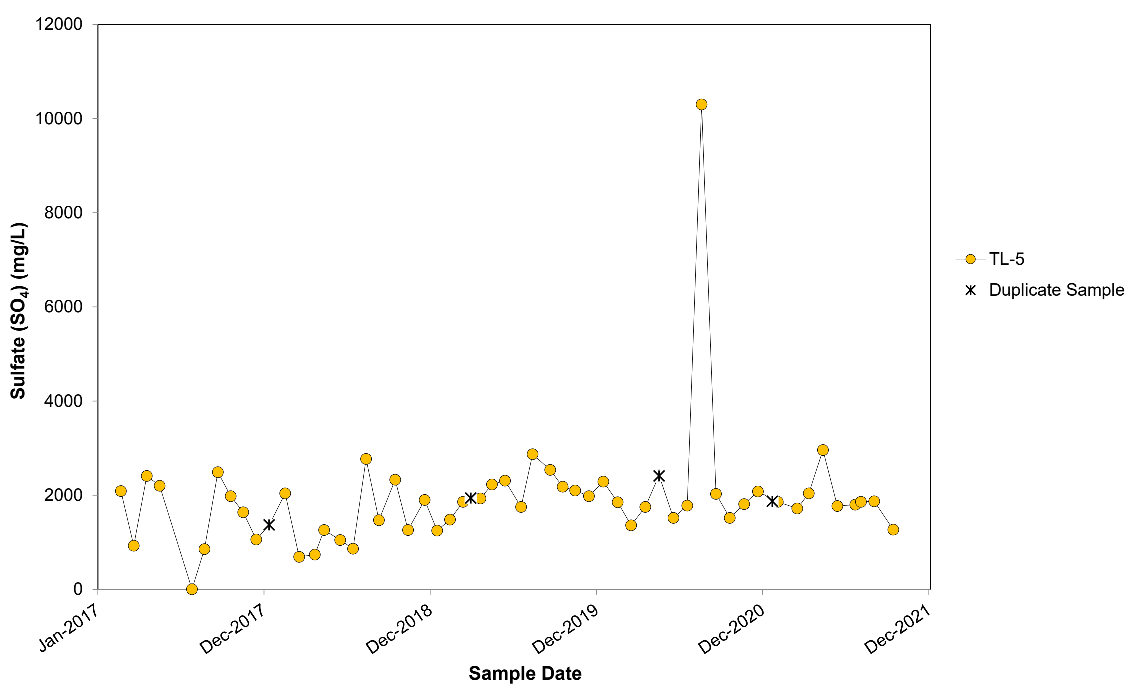

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Figure 4-24: Trends in Sulphate for Process Plant Supernatant Discharge (TL-5)

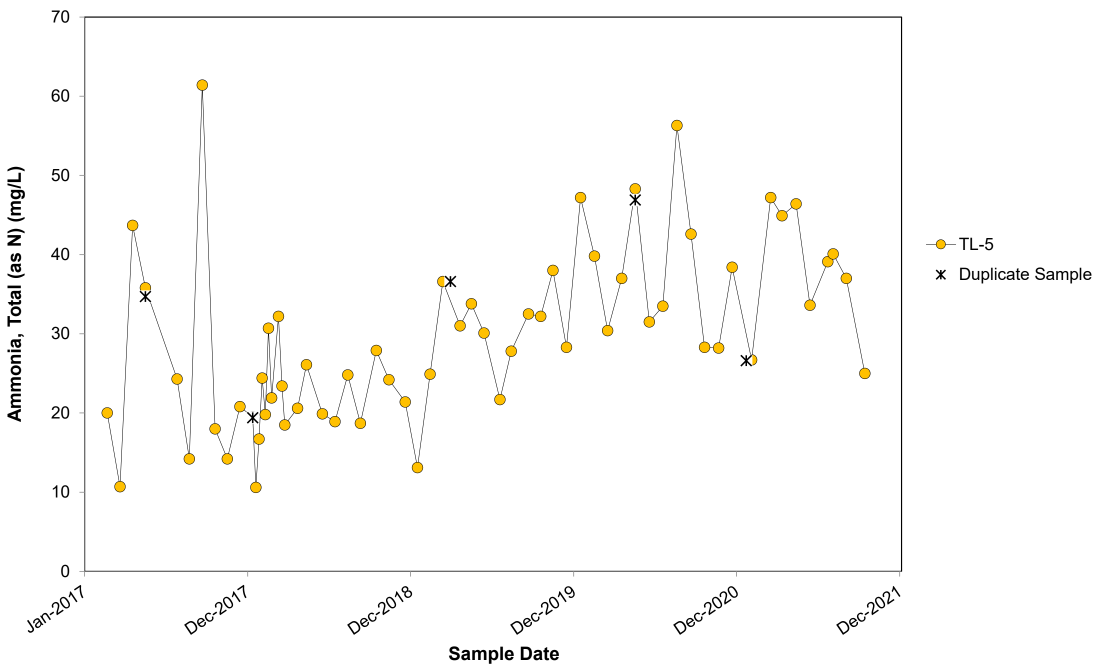

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Figure 4-25: Trends in Ammonia for Process Plant Supernatant Discharge (TL-5)

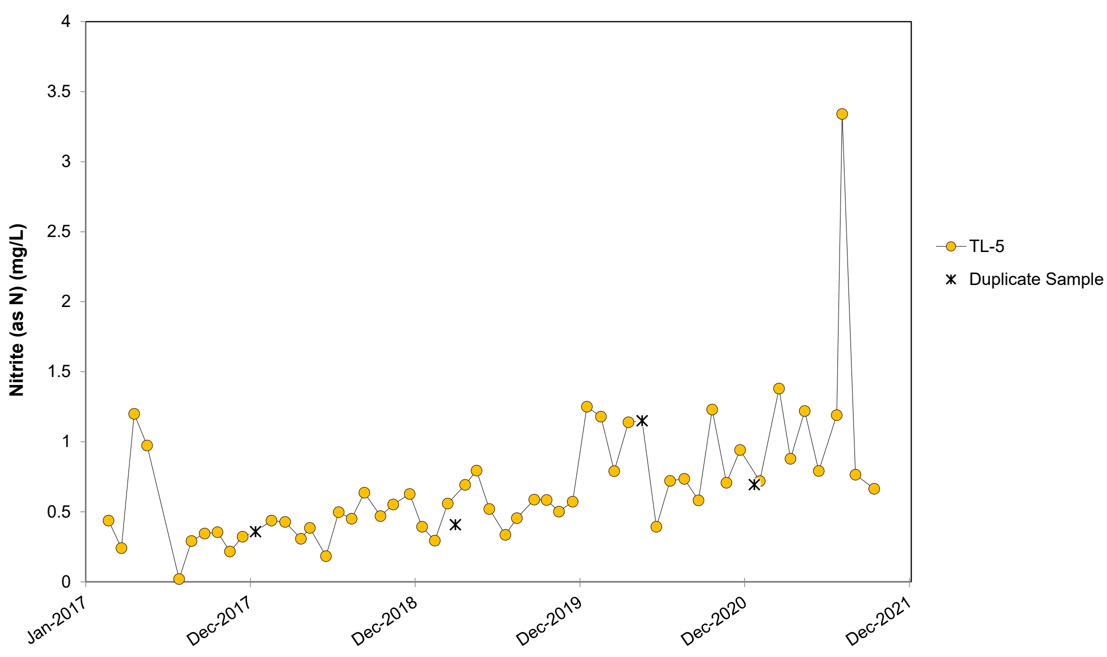

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Figure 4-26: Trends in Nitrite for Process Plant Supernatant Discharge (TL-5)

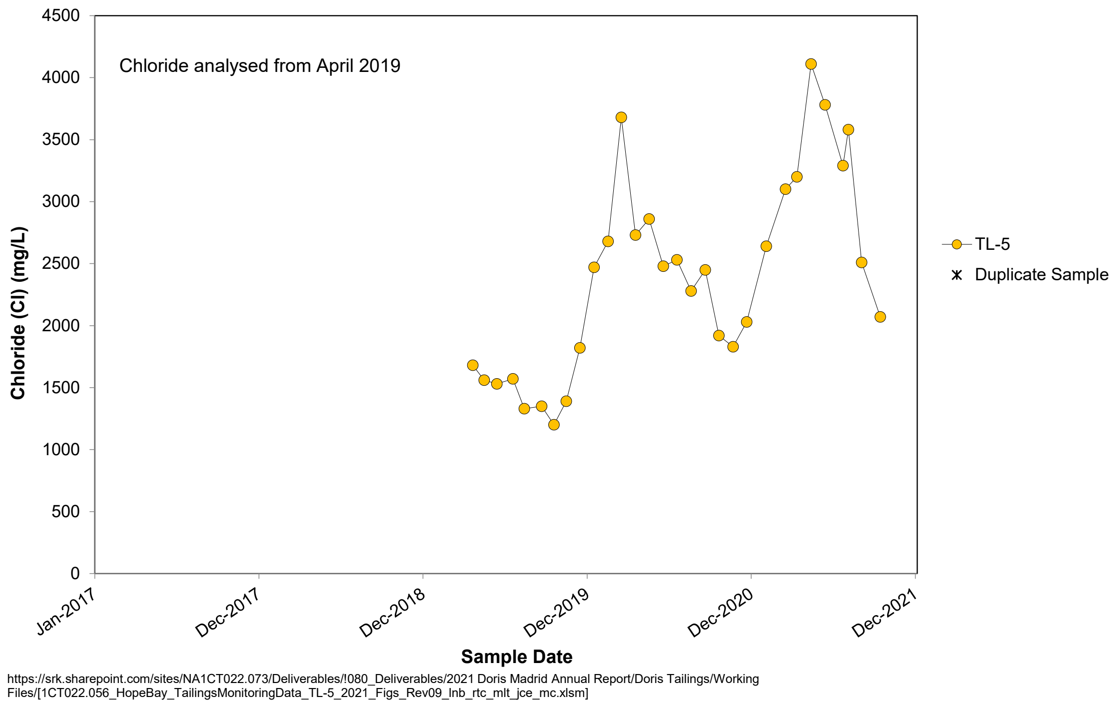

Figure 4-27: Trends in Chloride for Process Plant Supernatant Discharge (TL-5)

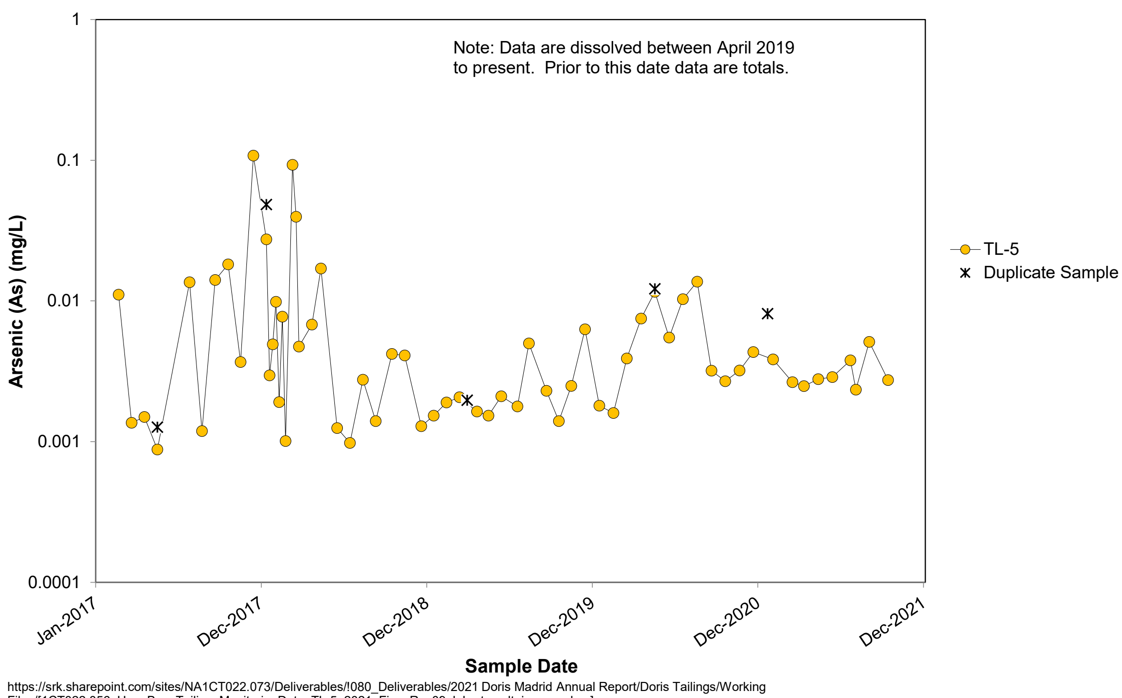

Figure 4-28: Trends in Arsenic for Process Plant Supernatant Discharge (TL-5)

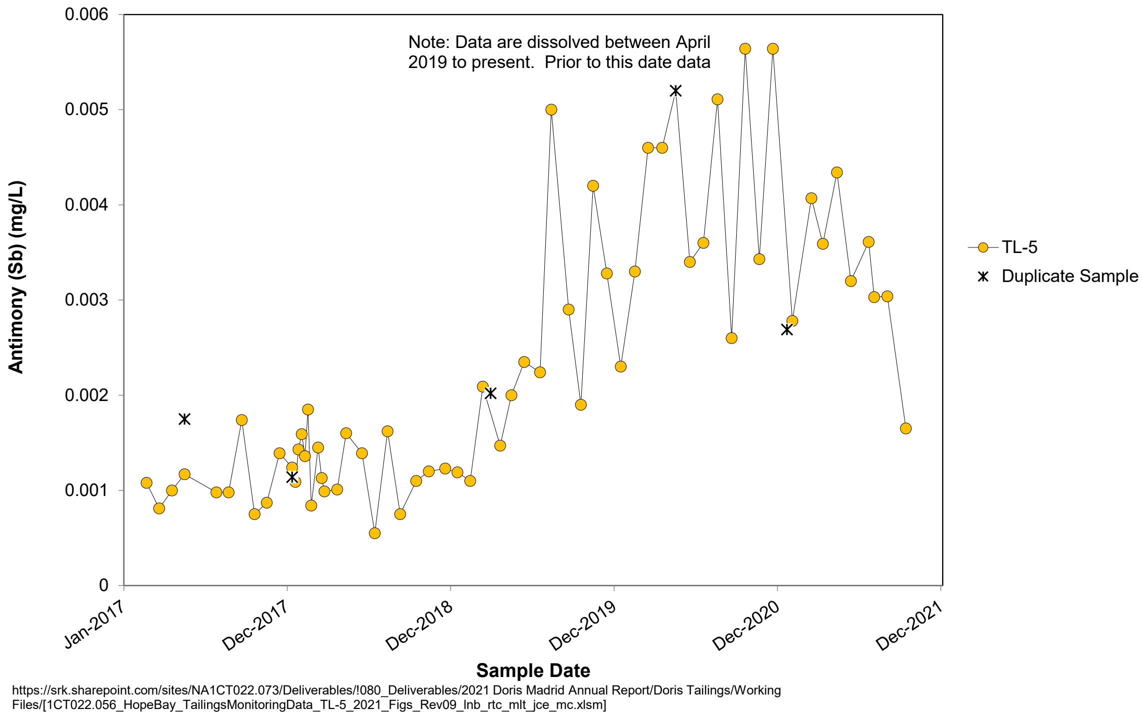

Figure 4-29: Trends in Antimony for Process Plant Supernatant Discharge (TL-5)

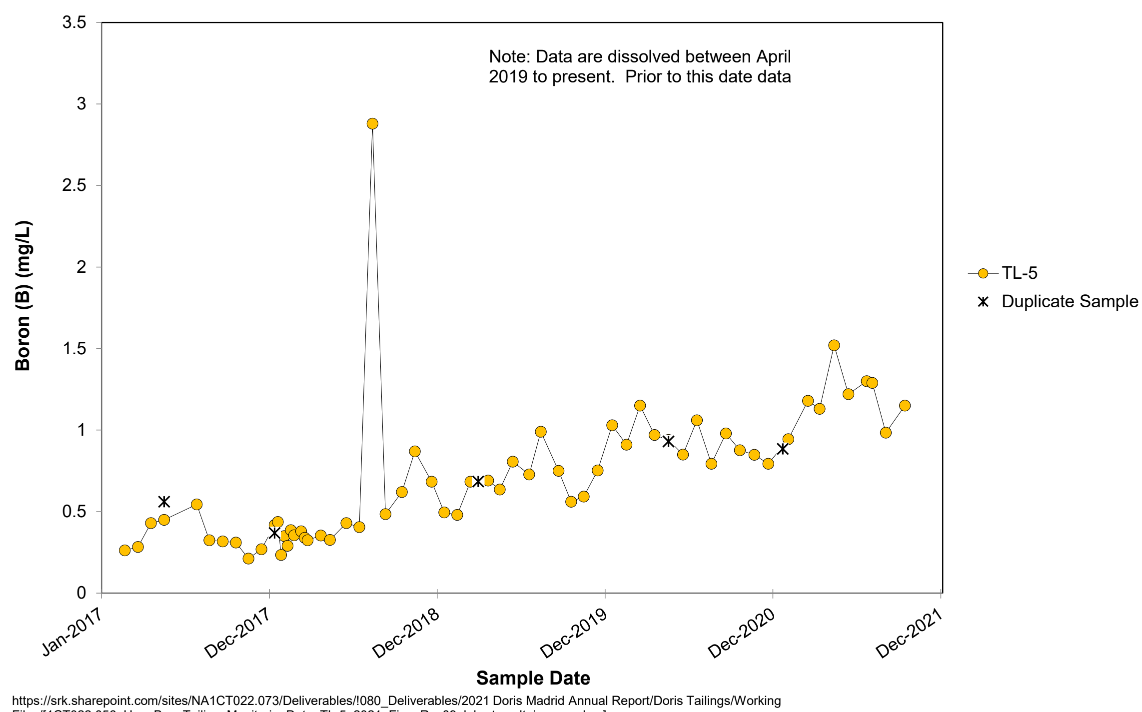

Figure 4-30: Trends in Boron for Process Plant Supernatant Discharge (TL-5)

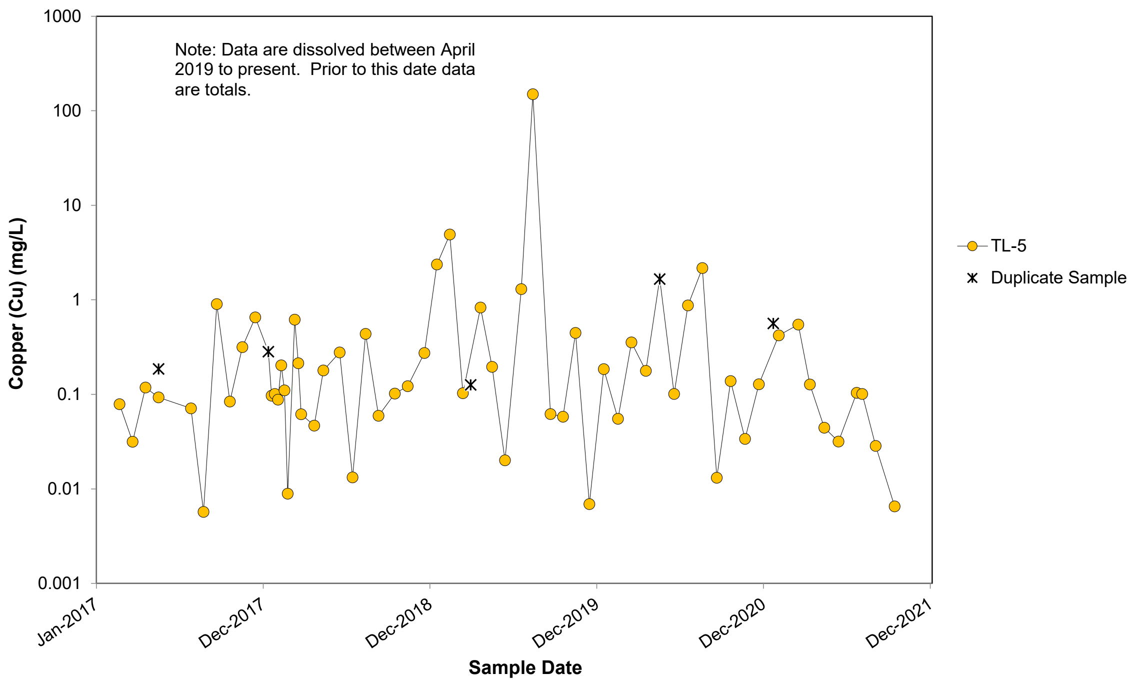

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Figure 4-31: Trends in Copper for Process Plant Supernatant Discharge (TL-5)

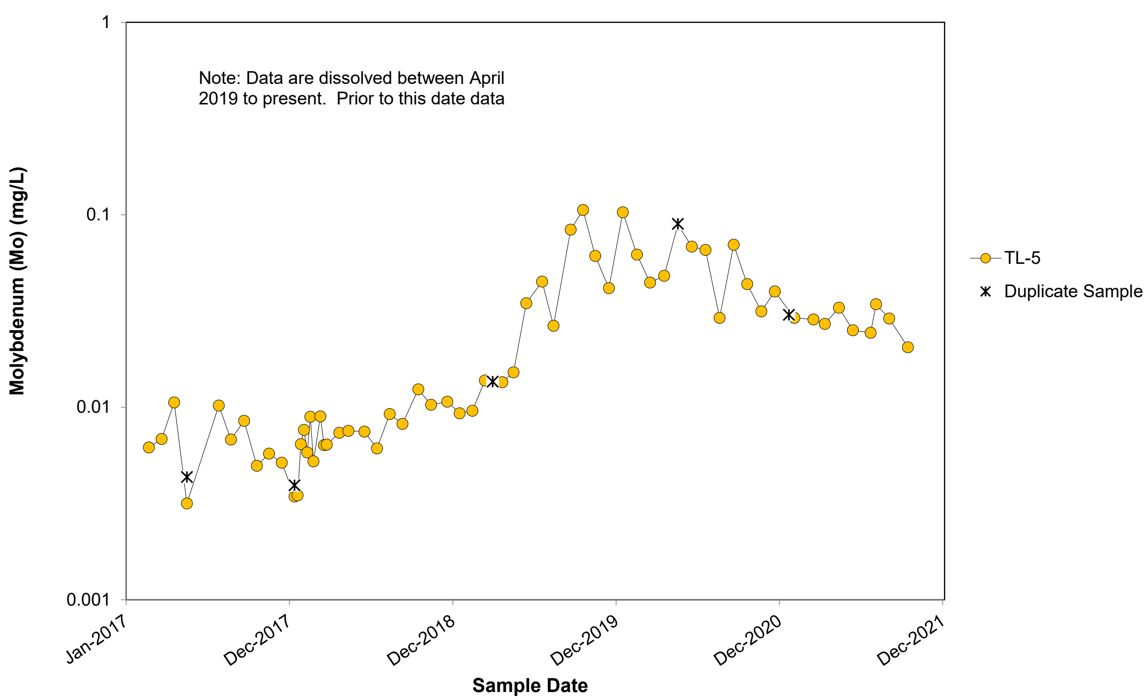

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Figure 4-32: Trends in Molybdenum for Process Plant Supernatant Discharge (TL-5)

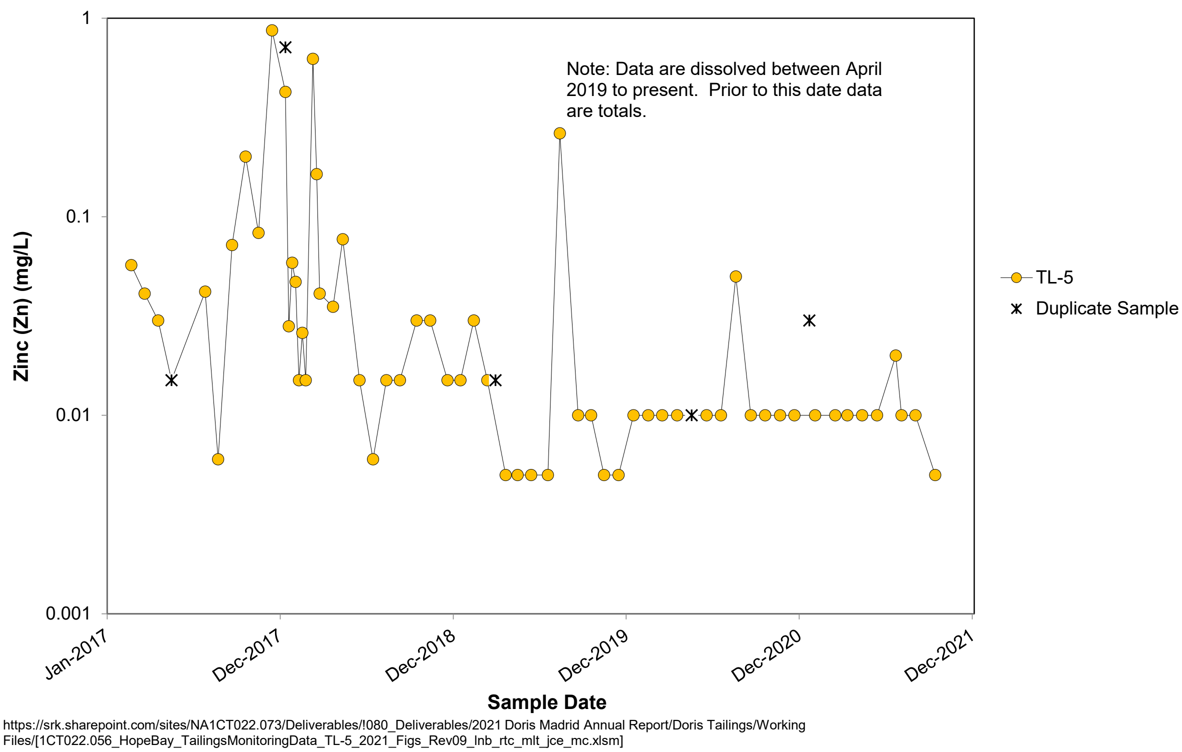
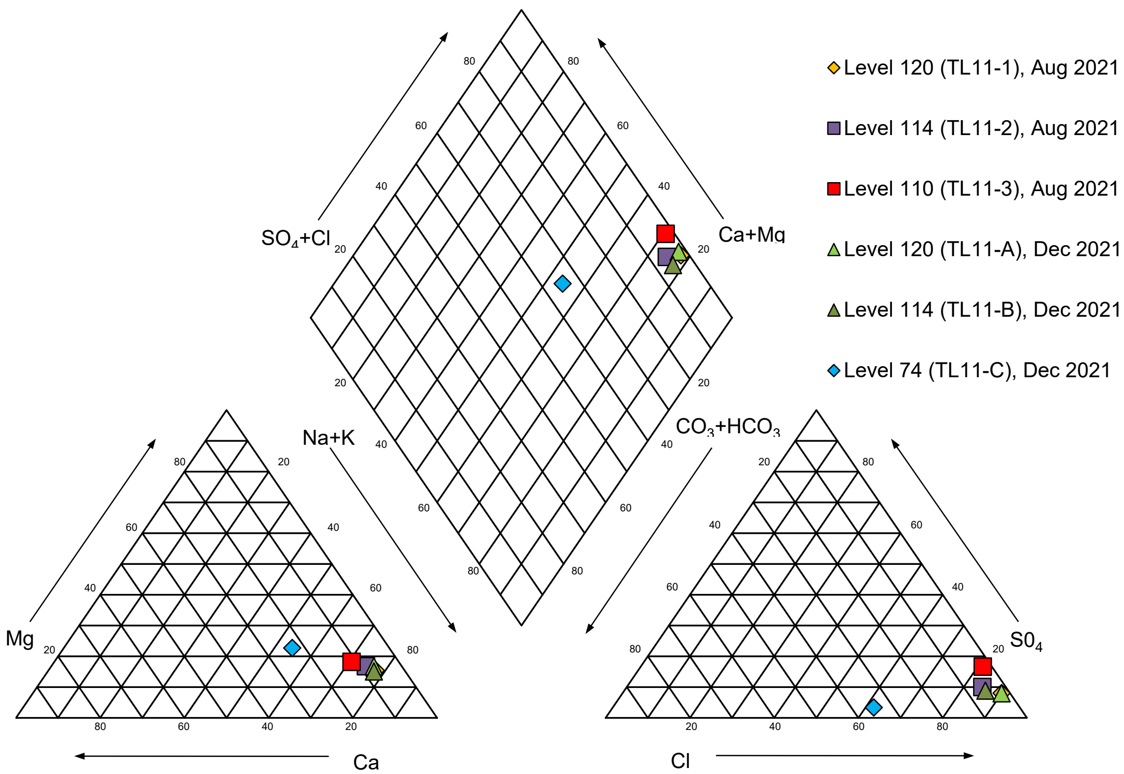


Figure 4-33: Trends in Zinc for Process Plant Supernatant Discharge (TL-5)

4.5 Seepage Monitoring of Backfilled Stopes (TL-11)

Selected water quality analyses of the seepage monitoring samples collected from the base of underground stopes are provided in Table 4-9 and full results are included in Attachment E. The results are compared to median and 5th and 95th percentile concentrations reported in the previous TL-11 monitoring surveys (2017 to 2020).

Figure 4-34 illustrates the differences in the major ion chemistry of the underground samples discussed above. In all cases the major ion chemistry is dominated by chloride (57 to 6,900 mg/L) and sodium (31 to 3,900 mg/L) but concentrations were significantly higher in the samples collected from Level 120 and Level 110. The sample collected from Level 74 in December is notably different; chloride is still the dominant anion, but this sample also contained a larger proportion of alkalinity and sodium is still the dominant cation, but the sample also contained a larger proportion of calcium and magnesium. Potential sources of the major ions include residues on waste rock from drilling brines (calcium and chloride), process reagents (sodium), and sulphide oxidation with resulting carbonate dissolution from waste rock and detoxified tailings (sulphate, calcium and magnesium).



\\van-svr0.van.na.srk.ad\Projects\01_SITES\Hope.Bay\1CT022.073_2021 Geochem Compliance\!080_Deliverables\2021 Doris Madrid Annual Report\Doris Tailings\Working Files\[1CT022.056_Hope Bay_TailingsMonitoringData_PiperPlot_TL-11_2021_mc_rev03.xlsx]Sheet H

Figure 4-34: Major Ion Chemistry for TL-11 Seepage Water Quality Analysis

In August three samples were collected from flowing seepage (Level 120, 114 and 110). The results of the August seepage survey are summarized as follows:

- The pH ranged from 8.0 to 8.2 in all of the samples.
- The seepage sample collected from Level 114 reported lower concentrations of EC, TDS, TSS and major ions compared to the samples collected from Level 110 and 120. The sample was collected close to stockpiled material but may not represent direct contact waters.
- EC was 22,000 and 20,000 µS/cm in the Level 120 and Level 110 samples respectively which is similar to historical seepage samples. EC was 7,200 µS/cm in the Level 114 sample.
- Sulphate concentrations were 830 and 1,900 mg/L in Level 120 and Level 110 samples respectively and 330 mg/L in the Level 114 sample. The higher result reported in the Level 110 sample was above the 95th percentile concentration from the historical sample set.
- Chloride was reported at 6,900 mg/L in both the Level 120 and Level 110 samples and 2,100 mg/L in the Level 114 sample. TSS concentrations were reported at 560, 520 and 250 mg/L in the samples from Level 120, 110 and 114 respectively, all results were greater than the 50th percentile concentrations from the historical sample set.

- Levels of ammonia (1.6 to 34 mg/L), nitrate (1.5 to 62 mg/L as N) and nitrite (0.13 to 2.4 mg/L as N) were lower than the 50th percentile concentrations from the historical sample set. Concentrations of these parameters were lowest in the sample collected at Level 114.
- The Level 114 sample reported total cyanide at 0.33 mg/L which is above the 95th percentile concentration from the historical sample set. Total cyanide concentrations in the Level 120 and Level 110 samples plus concentrations of free and WAD cyanide in all of the August samples were below the 50th percentile concentrations from the historical sample set.
- Dissolved arsenic concentrations ranged from 0.002 to 0.005 mg/L in all three samples, similar to the 50th percentile of concentrations from the historical data.
- Dissolved chromium concentrations ranged from <0.003 mg/L in the Level 114 sample to <0.01 mg/L in the Level 120 and Level 110 samples. The Level 120 and Level 110 results were above the 50th percentile concentration from the historical sample set but this was due to an increase in detection limits.
- Concentrations of dissolved cadmium, copper, silver and selenium were all below the 50th percentile concentration from the historical sample set.
- The sample collected from Level 110 also reported concentrations of boron, cobalt, nickel and selenium greater than the 50th percentile concentrations from the historical sample set.
-
- Zinc was not noted as a parameter of potential concern in the HCT program but has historically reported elevated concentrations. In August zinc concentrations ranged between 0.02 and 0.04 mg/L in all of the seepage samples and were below the 50th percentile from the historical sample set.

Three underground samples were collected from Levels 120, 114 and 74 during the December inspections. A flowing sample could only be collected from Level 120; minor flows were noted at Level 114 and Level 74 but these samples were collected from pooled water. Key results from the water quality analyses are summarized as follows:

- pH conditions ranged from 7.6 to 8.1; the Level 74 sample reported the lowest pH.
- The Level 120 seepage sample results were comparable to the Level 120 and Level 110 seepage sample results for August. This sample reported higher concentrations of EC, TDS and major ions compared with the other December samples.
- The Level 114 sample results collected in December were comparable to the August results from the same location and the Level 74 sample reported concentrations lower than any other sample for the majority of parameters. The Level 114 sample was collected from a pool close to stockpiled materials and may represent mixed waters rather than direct contact waters. Based on the chemistry and distance of the sampling station from the stope, the Level 74 sample represents wall rock seepage rather than any backfilled contact water.

- EC was 20,000, 7,900 and 280 µS/cm in the Level 120, Level 114 and Level 74 samples respectively. TSS ranged from 3.8 in the Level 74 sample to 190 mg/L in the Level 114 sample and was above the 50th percentile concentration from the historical sample set in the Level 114 sample.
- Sulphate concentrations were 820, 330 and 4.2 mg/L in the Level 120, Level 114 and Level 74 samples respectively. Chloride was reported at 6,800 mg/L, 2,400 and 57 mg/L in the Level 120, Level 114 and Level 74 samples respectively.
- Concentrations of ammonia (0.012 to 1.2 mg/L), nitrate (0.13 to 5.6 mg/L as N) and nitrite (0.001 to 0.37 mg/L as N) were all below the 50th percentile concentrations from the historical sample set. Lowest concentrations were consistently reported in the Level 74 sample.
- The Level 114 sample reported total cyanide above the 50th percentile concentration from the historical sample set (0.06 mg/L) but not as high as the total cyanide reported for the same location in August (0.33 mg/L). Free and WAD cyanide were both reported at limit of detection (<0.01 mg/L) in the Level 114 sample in December, but this limit of detection was above the 50th percentile concentrations from the historical sample set.
- All other parameters were consistently below the 50th percentile concentrations from the historical sample set.

Cadmium, copper, nickel, selenium and silver were noted as parameters of potential concern based upon the humidity cell test (HCT) program for Doris detoxified tailings (SRK 2015) and arsenic, cobalt, manganese, nickel and selenium were noted as parameters of potential concern based upon the humidity cell test (HCT) program for Madrid detoxified tailings (SRK 2017).

Table 4-9: Summary of Underground Stope Seepage and Ponded Water Samples (TL-11)

Parameter	Units	Detection Limit	August			December			Historical Statistics (2017-2021)		
			Level 120	Level 114	Level 110	Level 120	Level 114	Level 74	P05	P50	P95
			Seepage	Seepage	Seepage	Seepage	Pooled	Pooled			
			TL11-1	TL11-2	TL11-3	TL11-A	TL11-B	TL11-C	n=20	n=20	n=20
Flow Rate	L/s		n/a	n/a	n/a	0.12	**0**	**0**			
pH	pH	0.1	8.1	8.2	8.0	8.1	8.0	7.6	6.7	7.4	8.0
EC	uS/cm	2	20000	7200	22000	20000	7900	280	4900	50000	100000
TSS	mg/L	3	560	250	520	19	190	3.8	3.0	28	3100
TDS	mg/L	10	17000	4100	17000	11000	4400	170	3000	41000	85000
SO_4	mg/L	0.3	830	330	1900	820	330	4.2	460	1100	1300
Total Alkalinity	mg/L as $CaCO_3$	1	220	190	260	220	210	45	37	98	260
Cl	mg/L	0.5	6900	2100	6900	6800	2400	57	1000	19000	48000
Ca	mg/L	0.05	300	120	550	280	150	12	190	4300	17000
Mg	mg/L	0.1	410	150	540	430	190	7.2	86	950	1800
K	mg/L	0.05	120	45	140	120	57	2.4	39	290	580
Na	mg/L	0.05	3800	1200	3900	3700	1500	31	660	7000	12000
Total CN	mg/L	0.005	0.03	0.33	0.02	0.01	0.06	0.02	0.01	0.05	0.29
WAD CN	mg/L	0.005	*0.005*	*0.005*	*0.005*	*0.005*	*0.01*	*0.005*	0.005	0.007	0.03
Free CN	mg/L	0.005	*0.005*	*0.005*	0.006	*0.005*	*0.01*	*0.005*	0.005	0.006	0.02
NH_3	mg/L	0.005	1.8	1.6	34	1.2	1.2	0.012	4.7	200	380
NO_3	as N mg/L	0.005	6.7	1.5	62	5.6	3.0	0.13	8.6	210	590
NO_2	as N mg/L	0.001	0.36	0.13	2.4	0.37	0.12	0.001	0.39	2.8	18
Al	mg/L	0.001	*0.02*	*0.005*	*0.02*	*0.02*	0.02	0.01	0.01	0.05	0.1
Ag	mg/L	0.00001	*0.0002*	0.000061	0.00027	*0.0002*	*0.0001*	*0.00001*	0.0001	0.004	0.05
As	mg/L	0.0001	0.004	0.002	0.005	0.004	0.002	0.0004	0.001	0.005	0.01
B	mg/L	0.01	2	1.1	2.6	2.0	1.4	0.03	0.38	2.4	3.7
Ba	mg/L	0.0001	0.04	0.04	0.04	0.03	0.04	0.003	0.02	0.17	0.6
Cd	mg/L	0.000005	0.0002	0.0001	0.0005	0.0002	0.00003	*0.00001*	0.0001	0.006	0.035
Co	mg/L	0.0001	0.02	0.02	0.14	0.02	0.01	*0.0001*	0.01	0.06	0.22
Cr	mg/L	0.0001	*0.01*	*0.003*	*0.01*	--	*0.003*	*0.0005*	0.001	0.005	0.01
Cu	mg/L	0.0002	0.01	0.01	0.04	0.01	0.01	0.004	0.02	0.14	0.65
Fe	mg/L	0.01	*0.2*	*0.05*	*0.2*	*0.2*	*0.05*	*0.01*	0.03	0.5	1.0
Mn	mg/L	0.0001	0.78	0.2	2.8	0.78	0.26	0.002	0.41	5.0	10
Mo	mg/L	0.00005	0.004	0.003	0.009	0.004	0.004	0.0003	0.004	0.02	0.05
Ni	mg/L	0.0005	0.03	0.009	0.36	0.02	0.01	*0.0005*	0.01	0.17	0.44
Pb	mg/L	0.00005	*0.001*	*0.0003*	*0.001*	*0.001*	*0.0003*	*0.0001*	0.0001	0.003	0.15
S	mg/L	0.5	310	120	760	290	150	1.6	200	470	590
Sb	mg/L	0.0001	*0.002*	0.002	0.002	*0.002*	0.002	0.0002	0.0006	0.005	0.01
Se	mg/L	0.00005	*0.001*	0.0007	0.008	*0.001*	0.0004	0.0001	0.001	0.005	0.02
Zn	mg/L	0.001	*0.02*	0.02	0.04	*0.02*	0.02	0.006	0.02	0.16	2.0

Source: "\\van-svr0.van.na.srk.ad\Projects\01_SITES\Hope.Bay\1CT022.073_2021 Geochem Compliance\!080_Deliverables\2021 Doris Madrid Annual Report\Doris Tailings\Working Files\1CT022.056_HopeBay_TailingsMonitoringData_TL-11_2021_jce_mc_rev10.xlsx"

Notes:

Blue italics = Value less than laboratory detection limit. Detection limit shown.

Metal(loid) concentrations are reported as dissolved

Flow velocity was recorded using an OTT MF Pro flow meter in August. The Level 120 flow rate recorded in December was determined by recording time to fill a fixed volume container because the flow meter could not be fully submerged.

5 Summary and Conclusions

In 2021, the Doris mill processed ore between January and September.

5.1 Tailings Slurry to TIA

In 2021, a total of 253,160 t (dry weight equivalent) of flotation tailings were deposited in the Doris TIA.

5.1.1 Flotation Tailings Solids (TL-6)

The flotation tailings solids (TL-6) were analyzed in January, March, April, May, August and September. The key results are summarized as follows:

- Total sulphur concentrations ranged between 0.10 and 0.32% with a median value of 0.17%.
- TIC content ranged between 200 and 280 kg $CaCO_3$/t. All flotation tailings samples were classified as non-PAG, which in consistent with 2017 to 2020 operational tailings monitoring (SRK 2020) and metallurgical tailings samples (SRK 2015).
- Trace element content was below the screening criteria indicating no appreciable enrichment except for arsenic in January and August (22 and 27 ppm, respectively compared to the criterion of 20 ppm)

5.1.2 Tailings Detoxified Filtrate (TL-7B) and Process Plant Tailings Discharge (TL-5)

The detoxified tailings filtrate (TL-7B) is combined with the flotation tailings slurry in the thickener tank (TL-5). The detoxified tailings filtrate is approximately 7% of the volume of TL-5 and is managed within the TIA. TL-7B represents the chemistry of the residual moisture within the detoxified tailings, which ranges from 18 to 24%. Monthly monitoring of TL-5 and TL-7B is summarized as follows:

- pH was stable in both TL-5 (8.1 to 8.4) and TL-7B (8.5 to 8.7).
- Sulphate concentrations ranged from 1,300 to 3,000 mg/L in TL-5 and from 13,000 to 20,000 mg/L in TL-7B, both of which are within the range of historical data.
- Sodium ranged between 1,600 and 2,900 mg/L in TL-5 and between 7,200 and 11,000 mg/L in TL-7B. TL-B concentrations were within the range of previous data. Sodium concentrations at TL-5 were equivalent to 2020 and generally higher than concentrations reported mid-2019 and earlier.
- Concentrations of total ammonia were 25 to 47 mg/L as N in TL-5 and 190 to 370 mg/L as N in TL-7B. Results were similar to previous data except for a new maximum at TL-7B in March. Concentrations of ammonia at TL-5 have higher since January 2019 compared to 2018 and earlier.
- Total cyanide concentrations ranged from 0.9 to 4.7 mg/L in TL-5 and from 0.15 to 5.3 mg/L in TL-7B and were also within range of previous data except for at TL-7B in March (5.3 mg/L)

- WAD cyanide and free cyanide was either at limit of detection or at concentrations similar to previous data in TL-5 and TL-7B.
- Thiocyanate ranged from 12 to 51 mg/L in TL-5 and from 190 mg/L to 580 mg/L in TL-7B. These concentrations were within range of the previous data except for TL-7B in March and July, which were 580 and 560 mg/L, respectively. Cyanate ranged from 41 to 130 mg/L in TL-5 and from 540 mg/L to 1,100 mg/L in TL-7B. Cyanate concentrations fluctuated with periodic increases including February, March and April.
- Chloride data is available for TL-5 from April 2019 onward. Concentrations ranged between 2,500 and 4,100 mg/L showing an oscillating trend with two distinctive spikes in spring 2020 and 2021 (March and April) which are likely related to cryoconcentration within the TIA. Chloride was not analyzed in TL-7B.
- Arsenic ranged from 0.002 to 0.005 mg/L in TL-5 and 0.04 to 0.23 mg/L in TL-7B. Concentrations have been stable since late 2019 except for two operational maximums at TL-7B indicated previously in 2020.
- Cobalt and nickel concentrations were within range of historical data except for a new operational maximum result for cobalt in TL-7B in March (0.3 mg/L).
- Concentrations of antimony in TL-5 and TL-7B ranged between 0.002 and 0.004 mg/L in TL-5 and 0.02 to 0.04 mg/L in TL-7B. TL-5 reported an increasing trend in 2019 and stable concentrations since. TL-7B concentrations were equivalent to the range observed between late-2019 and early 2020. Antimony concentrations in TL-7B were lower in early 2019 and periodic spikes were observed in 2020.
- Molybdenum concentrations were 0.02 to 0.03 mg/L in TL-5 and 0.08 to 0.13 mg/L in TL-7B and within the range of previous data.
- Copper concentrations ranged from 0.01 to 0.6 mg/L in TL-5 and from 1.5 to 11 mg/L in TL-7B and were similar to or lower than previous years.
- Cadmium and zinc concentrations were consistently at or close to detection limit in both TL-5 and TL-7B, similar to previous years.
- Concentrations of manganese ranged from 0.1 to 0.3 mg/L in TL-5 and from 59 to 99 mg/L in TL-7B, similar to previous data.
- Selenium concentrations ranged from 0.002 to 0.005 mg/L in TL-5 and from 0.006 to 0.04 mg/L in TL-7B, within range of the previous data.

5.2 Detoxified Tailings to Doris Mine

5.2.1 Detoxified Tailings Solids (TL-7A)

In 2021 10,006 t of detoxified tailings were placed as backfill in the stopes of the Doris Mine. The results of the 2021 geochemical monitoring program of detoxified tailings solids (TL-7A) are summarized as follows:

- Sulphur concentrations ranged between 19% and 37% in 2021, with the latter being an operational maximum for detoxified tailings.
- TIC results for 2021 ranged between 89 and 160 kg $CaCO_3$/t. All detoxified tailings samples were classified as PAG, which is consistent with 2017 to 2020 operational tailings monitoring and metallurgical tailings samples (SRK 2015).
- All detoxified tailings samples were elevated in arsenic, bismuth, copper, selenium, silver and sulphur compared to the screening criteria. Selected samples were also elevated in cadmium (56% of samples), lead (33% of samples) and zinc (33% of samples) relative to the screening criteria. All other parameters, including cobalt and nickel were below the screening criteria indicating no appreciable enrichment.

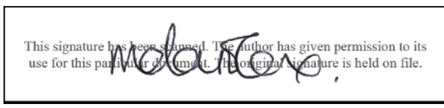
5.2.2 Underground Seepage Survey (TL-11)

The results of the opportunistic seepage sampling from underground backfilled stopes (TL-11) are summarized as follows:

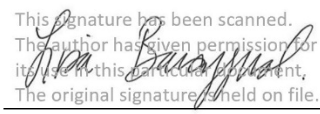
- Based on the major ion composition and field notes, the seepage sample from Level 74 is not considered to be contact water of mine backfill. The subsequent text excludes the sample from Level 74 (TL-11C, December).
- The major ion composition for all other TL-11 samples has the equivalent chemical signature and are considered to be contact water of mine backfill. Ion chemistry was dominated by chloride (2,100 to 6,900 mg/L) and sodium (3,900 to 3,900 mg/L). Seepage collected from Level 120 and Level 110 had higher concentrations of major ions than Level 114.
- The pH and EC ranged between 8.0 and 8.2 and 7,200 to 22,000 µS/cm respectively. The higher EC values were reported in the Level 120 and Level 110 samples.
- Levels of ammonia, nitrate and nitrite were lower than the 50th percentile concentrations from the historical sample set in all samples.
- The following parameters were elevated relative to the 50th percentile concentration from the historical sample set:
  - TSS in all samples except for the Level 120 sample in December.
  - Sulphate in the Level 110 sample collected in August.
  - Alkalinity in all samples.
  - Total cyanide in the two samples collected from Level 114 in August and December.
  - Chromium in the Level 120 and Level 110 samples collected in August.
  - Boron, cobalt, nickel, selenium and sulfur in the Level 110 sample collected in August.
- Arsenic and silver concentrations were within the same range as previous seepage surveys (0.002 to 0.005 mg/L and 0.00005 to 0.0003 mg/L respectively.
- Copper and zinc concentrations were notably lower than indicated by previous seepage surveys.

- Manganese and cadmium concentrations were also lower than the 50th percentile concentrations from the historical sample set in all samples

Regards,
SRK Consulting (Canada) Inc.



Melanie Cox, BSc, FGS
Consultant



Lisa Barazzuol, PGeo
Principal Consultant

Attachments:

Attachment A	TL-6 Geochemical Data
Attachment B	TL-7A Geochemical Data
Attachment C	TL-7B Geochemical Data
Attachment D	TL-5 Geochemical Data
Attachment E	TL-11 Geochemical Data

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Attachment A TL-6 Geochemical Data

Flotation Tailings (TL-6)				ABA								
Sample ID	Station ID	Lab ID	Date Sampled	Moisture	Total Sulfur	Sulfate (S)	Sulfide Sulfur (by diff.)	CO_2	Inorganic Carbon	$CaCO_3$ Equiv.	AP	NP_{TIC}/AP
			Units>	%	%	%	%	%	%	kg $CaCO_3$/t	kg $CaCO_3$/t	Ratio
TL6-26JAN21	TL-6	C107638	26/01/2021	-	0.32	0.03	0.29	12.3	3.3	278	10.00	27.84
TL6-09MAR21	TL-6	C118118	09/03/2021	-	0.29	0.03	0.26	10.3	2.8	235	9.06	25.93
TL6-20APR21	TL-6	C136957	20/04/2021	-	0.12	0.02	0.10	11.1	3.0	252	3.75	67.09
TL6-08JUN21	TL-6	C142399	31/05/2021	-	0.10	0.03	0.07	8.7	2.4	198	3.13	63.42
TL6-24AUG21	TL-6	C168565	24/08/2021	-	0.18	0.01	0.17	9.1	2.5	206	5.63	36.69
TL6-28SEP21	TL-6	C189145	28/09/2021	-	0.15	0.01	0.14	10.2	2.8	232	4.69	49.45

Flotation Tailings (TL-6)				Metals																		
Sample ID	Station ID	Lab ID	Date Sampled	Al	Sb	As	Ba	Bi	B	Cd	Ca	Cr	Co	Cu	Fe	La	Pb	Ga	Au	Mg	Mn	Hg
			Units>	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppm	ppm	ppm
TL6-26JAN21	TL-6	C107638	26/01/2021	8300	<0.1	22	9	<0.1	<20	0.2	57100	43	18.8	51.8	6090	2	4	3	745	18600	1580	<0.01
TL6-09MAR21	TL-6	C118118	09/03/2021	9900	<0.1	16.3	8	<0.1	<20	<0.1	55900	50	16.6	64.3	59600	2	1.8	3	469	15800	1440	<0.01
TL6-20APR21	TL-6	C136957	20/04/2021	8800	<0.1	11	7	<0.1	<20	0.1	50100	65	11.4	28.9	55500	2	1.4	3	450	16400	1400	<0.01
TL6-08JUN21	TL-6	C142399	31/05/2021	8600	<0.1	9.7	6	<0.1	<20	<0.1	48300	33	12.5	28.6	52200	2	2.4	3	1720	15100	1430	<0.01
TL6-24AUG21	TL-6	C168565	24/08/2021	6400	0.1	27.2	6	<0.1	<20	<0.1	43500	59	12.2	41.4	48300	3	2.6	2	371	15100	1290	<0.01
TL6-28SEP21	TL-6	C189145	28/09/2021	4700	< 0.1	9.4	8.4	< 0.1	< 20	0.2	42500	26	10.2	29.8	50900	2	7.8	2	> 1000	12800	1220	0.23

Flotation Tailings (TL-6)				Metals																	
Sample ID	Station ID	Lab ID	Date Sampled	Sc	Se	Ag	Na	Sr	S	Te	Tl	Th	Ti	W	U	V	Zn	Mo	Ni	P	K
			Units>	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
TL6-26JAN21	TL-6	C107638	26/01/2021	10.6	<0.5	0.2	1080	34	2600	<0.2	<0.1	0.2	40	0.6	<0.1	27	63	0.5	37.1	470	500
TL6-09MAR21	TL-6	C118118	09/03/2021	9.1	<0.5	0.3	1190	29	2300	<0.2	<0.1	0.2	150	0.9	<0.1	33	61	0.5	31	440	500
TL6-20APR21	TL-6	C136957	20/04/2021	8.1	<0.5	0.2	1030	28	1300	<0.2	<0.1	0.2	40	0.7	<0.1	25	43	0.4	23.4	440	500
TL6-08JUN21	TL-6	C142399	31/05/2021	8.6	<0.5	0.2	1200	28	1100	<0.2	<0.1	0.3	200	1.7	<0.1	29	52	0.3	20.8	500	400
TL6-24AUG21	TL-6	C168565	24/08/2021	8.4	<0.5	0.2	820	36	1900	<0.2	<0.1	0.4	120	1.4	<0.1	25	49	0.3	32.5	590	500
TL6-28SEP21	TL-6	C189145	28/09/2021	7	< 0.5	0.3	650	27	< 1000	< 0.2	< 0.1	0.2	40	1.6	< 0.1	19	91	0.4	18.8	530	400

Attachment B TL-7A Geochemical Data

Detoxified Tailings (TL-7A)				ABA								
Sample ID	Station ID	Lab ID	Date Sampled	Moisture	Total Sulfur	Sulfate (S)	Sulfide Sulfur (by diff.)	CO_2	Inorganic Carbon	$CaCO_3$ Equiv.	AP	NP_{TIC}/AP
			Units>	%	%	%	%	%	%	kg $CaCO_3$/t	kg $CaCO_3$/t	Ratio
TL7-24JAN21	TL-7A	C107644	24/01/2021	21	24	0.14	24	7.0	1.9	160	747	0.21
TL7-24FEB21	TL-7A	C118128	24/02/2021	17	25	0.34	25	5.5	1.5	125	785	0.16
TL7-09MAR21	TL-7A	C118132	09/03/2021	21	19	0.29	19	7.0	1.9	160	607	0.26
TL7-20APR21	TL-7A	C136961	20/04/2021	12.7	29	0.28	29	4.7	1.3	107	901	0.12
TL7-22MAY21	TL-7A	C142406	22/05/2021	18	23	0.23	23	6.6	1.8	150	718	0.21
TL7-30JUN21	TL-7A	C153294	30/06/2021	19	33	0.29	32	3.9	1.1	89	1024	0.09
TL7-30JUL21	TL-7A	C153294	30/06/2021	18	30	0.22	30	4.8	1.3	108	943	0.11
TL7-10AUG21	TL-7A	C168661	10/08/2021	17	31	0.24	30	4.8	1.3	108	957	0.11
TL7-20SEPT21	TL-7A	C207278	20/09/2021	16	37	0.21	37	4.9	1.3	112	1153	0.10

Detoxified Tailings (TL-7A)				Metals																		
Sample ID	Station ID	Lab ID	Date Sampled	Al	Sb	As	Ba	Bi	B	Cd	Ca	Cr	Co	Cu	Fe	La	Pb	Ga	Au	Mg	Mn	Hg
			Units>	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppm	ppm	ppm
TL7-24JAN21	TL-7A	C107644	24/01/2021	5200	1.3	1220	6	2.4	<20	3.1	31900	301	400	3310	224000	<1	147	2	6620	10100	974	0.06
TL7-24FEB21	TL-7A	C118128	24/02/2021	5900	0.6	827	8	2.1	<20	2	27400	289	347	3120	224000	<1	32.8	2	5720	8800	907	0.05
TL7-09MAR21	TL-7A	C118132	09/03/2021	6600	0.6	788	8	2	<20	2.0	32500	299	343	1940	204000	<1	38.2	2	5540	11000	1020	0.05
TL7-20APR21	TL-7A	C136961	20/04/2021	3400	1.4	590	5	10.7	<20	1.6	20900	343	264	3360	268000	<1	47.6	1	7680	6600	727	0.06
TL7-22MAY21	TL-7A	C142406	22/05/2021	6200	1	889	7	2.7	<20	4	30600	316	307	2020	207000	<1	91.1	2	2470	9400	1050	0.08
TL7-30JUN21	TL-7A	C153294	30/06/2021	2300	1.7	886	4	6.7	<20	4.5	17400	408	364	4780	301000	<1	55.7	1	5420	5100	681	0.05
TL7-30JUL21	TL-7A	C153294	30/06/2021	3300	1.4	1180	6	4.1	<20	3.2	23200	369	380	2200	279000	<1	61.7	1	6250	6500	800	0.08
TL7-10AUG21	TL-7A	C168661	10/08/2021	3200	1.9	1410	4	2.5	<20	2.0	20200	262	296	2320	247000	<1	38.3	1	4400	8600	666	0.02
TL7-20SEPT21	TL-7A	C207278	20/09/2021	2600	0.8	181	1.8	3.4	<20	3.2	16600	478	165	2970	126000	1	37.5	1	12.1	4900	631	0.08

Detoxified Tailings (TL-7A)				Metals																	
Sample ID	Station ID	Lab ID	Date Sampled	Mo	Ni	P	K	Sc	Se	Ag	Na	Sr	S	Te	Tl	Th	Ti	W	U	V	Zn
			Units>	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
TL7-24JAN21	TL-7A	C107644	24/01/2021	4.1	365	280	400	6.4	19.1	19	2220	28	100000	4	0.3	0.2	70	2	<0.1	20	941
TL7-24FEB21	TL-7A	C118128	24/02/2021	4	199	280	600	4.9	14.0	16	2100	23	100000	3	<0.1	0.1	40	2.9	<0.1	19	503
TL7-09MAR21	TL-7A	C118132	09/03/2021	3.3	245	270	600	6.2	13	22	2880	23	100000	3.3	0.1	0.1	60	3.9	<0.1	22	602
TL7-20APR21	TL-7A	C136961	20/04/2021	3.3	125	260	400	4.1	15	22	2320	19	100000	10.7	0.1	1.3	30	3	<0.1	13	384
TL7-22MAY21	TL-7A	C142406	22/05/2021	4.5	175	270	400	5.7	17.2	13	2320	26	100000	2.9	0.2	0.5	80	5.6	<0.1	23	1140
TL7-30JUN21	TL-7A	C153294	30/06/2021	4	171	240	300	3.2	18	19	1400	19	100000	7.4	<0.1	0.3	20	2.6	<0.1	11	1170
TL7-30JUL21	TL-7A	C153294	30/06/2021	5.1	253	240	300	4	17	22	1860	22	100000	5.1	0.2	0.2	40	3	<0.1	14	890
TL7-10AUG21	TL-7A	C168661	10/08/2021	3.5	484	200	300	4.5	14	15	1210	29	100000	4.2	0.1	0.3	30	3.8	<0.1	15	527
TL7-20SEPT21	TL-7A	C207278	20/09/2021	1.4	139	230	300	3.2	2	9	1300	14	90000	4.2	<0.1	0.2	50	3.2	--	6	1110

Attachment C TL-7B Geochemical Data

TL-7B Detoxified Tailings Filtrate			Aluminum (Al)-Total	Ammonia, Total (as N)	Antimony (Sb)-Total	Arsenic (As)-Total	Barium (Ba)-Total	Beryllium (Be)-Total	Bismuth (Bi)-Total	Boron (B)-Total	Cadmium (Cd)-Total	Calcium (Ca)-Total	Cesium (Cs)-Total	Chromium (Cr)-Total	Cobalt (Co)-Total	Copper (Cu)-Total	Cyanate	Cyanide, Total
Sample ID	Lab ID	Sample Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
TL7B	YL2100060-001	24-Jan-2021 17:30	1.06	295	0.03	0.17	0.04	<0.001	<0.0025	1.22	<0.00025	51.3	<0.0005	0.0333	0.207	5.46	654	0.769
TL7B	YL2100124-001	24-Feb-2021 16:00	0.90	295	0.04	0.05	0.04	<0.001	<0.0025	1.32	<0.00025	86.6	<0.0005	<0.025	0.0506	4.46	959	0.831
TL7B	YL2100156-001	09-Mar-2021 16:30	0.9	370	0.04	0.07	0.04	<0.001	<0.0025	1.54	<0.00025	71.7	<0.0005	0.0406	0.323	1.5	1100	5.3
TL7B	YL2100293-001	21-Apr-2021 03:40	0.24	204	0.02	0.05	0.03	<0.001	<0.0025	1.38	<0.00025	65.0	<0.0005	<0.025	0.0343	8.05	568	0.152
TL7B	YL2100434-001	22-May-2021 09:25	0.55	302	0.03	0.08	0.04	<0.001	<0.0025	1.65	<0.00025	61.5	<0.0005	<0.025	0.186	2.31	825	1.78
TL7B	YL2100674-001	30-Jun-2021 13:25	0.59	266	0.03	0.06	0.04	<0.001	<0.0025	1.35	0.00034	65	<0.0005	0.0259	0.0286	11.2	804	0.301
TL7B	YL2100779-001	12-Jul-2021 00:00	<0.15	299	0.02	0.05	0.02	<0.001	<0.0025	1.92	<0.00025	38.2	<0.0005	<0.025	0.146	2.76	888	0.798
TL7B	YL2101014-001	10-Aug-2021 15:50	0.23	266	0.04	0.23	0.03	<0.001	<0.0025	1.01	<0.00025	43.1	<0.0005	<0.025	0.055	6.86	702	0.395
TL7B	YL2101367-001	20-Sep-2021 15:00	0.13	194	0.03	0.04	0.01	<0.0004	<0.001	1.13	<0.00012	61.7	<0.0002	0.0126	0.122	2.45	538	0.451

TL-7B Detoxified Tailings Filtrate			Cyanide, Weak Acid Diss	Iron (Fe)-Total	Lead (Pb)-Total	Lithium (Li)-Total	Magnesium (Mg)-Total	Manganese (Mn)-Total	Molybdenum (Mo)-Total	Nickel (Ni)-Total	pH	Phosphorus (P)-Total	Potassium (K)-Total	Rubidium (Rb)-Total	Selenium (Se)-Total	Silicon (Si)-Total	Silver (Ag)-Total	Sodium (Na)-Total
Sample ID	Lab ID	Sample Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
TL7B	YL2100060-001	24-Jan-2021 17:30	0.0956	12.9	0.0132	<0.05	69	0.224	0.116	0.0359	8.7	<2.5	54	<0.01	0.0166	<5	0.0372	9900
TL7B	YL2100124-001	24-Feb-2021 16:00	0.176	4.3	<0.0025	<0.05	99.4	0.249	0.0775	<0.025	8.6	<2.5	58.2	<0.01	0.0424	<5	0.0115	7200
TL7B	YL2100156-001	09-Mar-2021 16:30	<0.5	7.68	0.00304	<0.05	87.1	0.179	0.0979	<0.025	8.5	<2.5	70.2	<0.01	0.0129	<5	0.0417	11200
TL7B	YL2100293-001	21-Apr-2021 03:40	0.133	8.03	<0.0025	0.0725	90.8	0.244	0.103	<0.025	8.6	<2.5	76.3	<0.01	0.0379	<5	0.0143	10600
TL7B	YL2100434-001	22-May-2021 09:25	<0.5	9.9	0.00546	<0.05	92.9	0.183	0.131	<0.025	8.7	<2.5	87.4	<0.01	0.00564	<5	0.0143	9530
TL7B	YL2100674-001	30-Jun-2021 13:25	<0.04	7.52	0.0121	0.0592	70.4	0.283	0.0987	<0.025	8.5	<2.5	71.9	<0.01	0.0167	<5	0.00714	9240
TL7B	YL2100779-001	12-Jul-2021 00:00	<0.1	0.509	<0.0025	<0.05	65.4	0.152	0.0919	<0.025	8.6	<2.5	71.1	<0.01	0.00602	<5	<0.0005	8300
TL7B	YL2101014-001	10-Aug-2021 15:50	0.052	3.08	<0.0025	<0.05	56.4	0.162	0.117	0.0356	8.7	<2.5	68.1	<0.01	0.00784	<5	0.0142	7820
TL7B	YL2101367-001	20-Sep-2021 15:00	0.267	2.77	0.00121	0.0386	61.4	0.175	0.102	<0.01	8.6	<1	54.3	<0.004	0.0331	2.12	0.00286	7540

TL-7B Detoxified Tailings Filtrate			Strontium (Sr)-Total	Sulfur (S)-Total	Tellurium (Te)-Total	Thallium (Tl)-Total	Thiocyanate (SCN)	Thorium (Th)-Total	Tin (Sn)-Total	Titanium (Ti)-Total	Tungsten (W)-Total	Uranium (U)-Total	Vanadium (V)-Total	Zinc (Zn)-Total	Zirconium (Zr)-Total	Cyanide, Free
Sample ID	Lab ID	Sample Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
TL7B	YL2100060-001	24-Jan-2021 17:30	0.673	6410	<0.01	<0.0005	436	<0.005	<0.005	<0.015	0.0868	<0.0005	<0.025	<0.15	<0.01	<0.02
TL7B	YL2100124-001	24-Feb-2021 16:00	1.07	4340	<0.01	<0.0005	287	<0.005	<0.005	<0.0204	0.0537	<0.0005	<0.025	<0.15	<0.01	<0.005
TL7B	YL2100156-001	09-Mar-2021 16:30	1	6750	<0.01	<0.0005	584	<0.005	<0.005	<0.015	0.069	0.00143	<0.025	<0.15	<0.01	<0.5
TL7B	YL2100293-001	21-Apr-2021 03:40	0.85	6350	<0.01	<0.0005	190	<0.005	<0.005	<0.015	0.063	<0.0005	<0.025	<0.15	<0.01	<0.02
TL7B	YL2100434-001	22-May-2021 09:25	0.886	5460	<0.01	<0.0005	484	<0.005	<0.005	<0.015	0.105	0.000546	<0.025	<0.15	<0.01	<0.5
TL7B	YL2100674-001	30-Jun-2021 13:25	1.07	5290	<0.01	<0.0005	194	<0.005	<0.005	<0.015	0.0562	0.00055	<0.025	<0.15	<0.01	<0.04
TL7B	YL2100779-001	12-Jul-2021 00:00	0.476	4700	<0.01	<0.0005	556	<0.005	<0.005	<0.015	0.0625	0.0016	<0.025	<0.15	<0.01	<0.1
TL7B	YL2101014-001	10-Aug-2021 15:50	0.626	4420	<0.01	<0.0005	400	<0.005	<0.005	<0.015	0.0941	<0.0005	<0.025	<0.15	<0.01	<0.02
TL7B	YL2101367-001	20-Sep-2021 15:00	0.685	4600	<0.004	<0.0002	381	<0.002	<0.002	<0.006	0.0312	0.000389	<0.01	<0.06	<0.004	0.0119

Attachment D TL-5 Geochemical Data

		Sample ID	TL5-13JAN-21	TL5-24FEB-21	TL5-9MAR-21	TL5-21APR-21	TL5-22MAY-21	TL5-30JUN-21	TL5-12JUL-21	TL5-10AUG-21	TL5-20SEP-21
			Jan-2021	Feb-2021	Mar-2021	Apr-2021	May-2021	Jun-2021	Jul-2021	Aug-2021	Sep-2021
Parameter	**Units**	**Detection Limit**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Hardness (as CaCO3)	mg/L	0.5	1070	1460	1410	1640	1420	1480	1440	973	946
pH	pH	0.1	8.26	8.41	8.19	8.21	8.34	8.11	8.16	8.34	8.25
Total Suspended Solids	mg/L	3	17.7	10.4	228	16	6.6	111	257	14.1	34.1
Ammonia, Total (as N)	mg/L	0.25	26.7	47.2	44.9	46.4	33.6	39.1	40.1	37	25
Chloride (Cl)	mg/L	25	2640	3100	3200	4110	3780	3290	3580	2510	2070
Nitrate (as N)	mg/L	0.1	8.94	19	14.8	27.4	16.3	26.5	28.8	15.1	20.6
Nitrite (as N)	mg/L	0.02	0.72	1.38	0.879	1.22	0.792	1.19	3.34	0.765	0.665
Sulfate (SO4)	mg/L	6	1860	1720	2040	2960	1770	1800	1860	1870	1270
Cyanide, Weak Acid Diss	mg/L	0.005	0.731	0.492	0.127	0.121	0.0348	0.0817	0.128	0.0698	*0.04*
Cyanide, Total	mg/L	0.005	3.92	4.66	3.03	1.64	1.35	0.901	1.07	0.946	1.14
Cyanate	mg/L	2	47.4	130	97.2	74.1	64.2	63	60.9	75.3	41.1
Thiocyanate (SCN)	mg/L	0.5	18.7	36.2	51.4	20.6	24.2	11.8	23.2	40.4	32.8
Cyanide, Free	mg/L	0.005	0.409	0.438	0.0417	0.114	0.0261	0.0395	0.0647	0.0468	*0.04*
Aluminum (Al)-Dissolved	mg/L	0.006	0.093	0.0753	0.0643	0.0518	0.0756	0.0792	0.0334	0.0634	0.0642
Antimony (Sb)-Dissolved	mg/L	0.0002	0.00278	0.00407	0.00359	0.00434	0.0032	0.00361	0.00303	0.00304	0.00165
Arsenic (As)-Dissolved	mg/L	0.0002	0.00384	0.00265	0.00248	0.00278	0.00288	0.00378	0.00234	0.00512	0.00274
Barium (Ba)-Dissolved	mg/L	0.0001	0.0364	0.0449	0.043	0.0501	0.0494	0.0481	0.0517	0.0482	0.0316
Beryllium (Be)-Dissolved	mg/L	0.0002	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.002*	*0.001*	*0.001*	*0.0005*
Bismuth (Bi)-Dissolved	mg/L	0.0001	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.001*	*0.0005*	*0.0005*	*0.00025*
Boron (B)-Dissolved	mg/L	0.02	0.944	1.18	1.13	1.52	1.22	1.3	1.29	0.984	1.15
Cadmium (Cd)-Dissolved	mg/L	0.00001	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.0001*	*0.00005*	*0.00005*	*0.000025*
Calcium (Ca)-Dissolved	mg/L	0.1	188	215	208	236	243	226	223	156	157
Cesium (Cs)-Dissolved	mg/L	0.00002	0.000121	0.000635	0.000376	0.000122	0.000747	0.00109	0.000658	0.000217	0.000265
Chromium (Cr)-Dissolved	mg/L	0.0002	*0.001*	*0.001*	*0.001*	*0.005*	*0.005*	*0.01*	*0.005*	*0.005*	*0.0025*
Cobalt (Co)-Dissolved	mg/L	0.0002	0.0117	0.0141	0.0295	0.0077	0.0151	0.00531	0.0106	0.00785	0.00964
Copper (Cu)-Dissolved	mg/L	0.001	0.421	0.548	0.127	0.0444	0.0316	0.104	0.101	0.0285	0.00651
Iron (Fe)-Dissolved	mg/L	0.02	1.27	1.69	1.08	0.639	0.569	0.463	0.55	0.416	0.354
Lead (Pb)-Dissolved	mg/L	0.0001	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.001*	*0.0005*	*0.0005*	*0.00025*
Lithium (Li)-Dissolved	mg/L	0.002	0.0377	0.0425	0.0398	0.0558	0.0445	0.0417	0.0533	0.0459	0.0304
Magnesium (Mg)-Dissolved	mg/L	0.01	159	189	198	193	216	221	200	156	125
Manganese (Mn)-Dissolved	mg/L	0.0002	0.142	0.192	0.179	0.289	0.227	0.215	0.298	0.18	0.157
Mercury (Hg)-Dissolved	mg/L	0.000005	*0.000005*	*0.000005*	*0.00005*	*0.000005*	*0.00005*	*0.000005*	*0.000005*	*0.000025*	*0.000025*
Molybdenum (Mo)-Dissolved	mg/L	0.0001	0.0291	0.0286	0.0271	0.0329	0.0251	0.0244	0.0343	0.0289	0.0205
Nickel (Ni)-Dissolved	mg/L	0.001	0.144	0.105	0.0864	0.0126	0.0275	0.0371	0.0662	0.0274	0.00633
Phosphorus (P)-Dissolved	mg/L	0.1	0.511	0.856	0.879	*0.5*	0.669	1.08	0.524	0.94	0.607
Potassium (K)-Dissolved	mg/L	0.1	113	125	127	103	120	119	122	118	104
Rubidium (Rb)-Dissolved	mg/L	0.0004	0.0278	0.0565	0.0327	0.044	0.0496	0.073	0.0527	0.0515	0.0479
Selenium (Se)-Dissolved	mg/L	0.0001	0.0028	0.00472	0.00467	0.00498	0.002	0.00324	0.00298	0.00157	0.0015
Silicon (Si)-Dissolved	mg/L	0.2	1.22	1.07	1.2	1.7	1.37	1.45	2.22	1.87	1.68
Silver (Ag)-Dissolved	mg/L	0.00002	0.00014	*0.0001*	0.000323	*0.0001*	*0.0001*	*0.0002*	*0.0001*	0.000124	*0.00005*
Sodium (Na)-Dissolved	mg/L	0.1	2100	2390	2720	2900	2700	2570	2390	2210	1620
Strontium (Sr)-Dissolved	mg/L	0.0004	1.56	1.97	2.08	2.24	2.23	2.05	2.15	1.51	1.27
Sulfur (S)-Dissolved	mg/L	1	701	711	832	965	656	719	697	746	515
Tellurium (Te)-Dissolved	mg/L	0.0004	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.004*	*0.002*	*0.002*	*0.001*
Thallium (Tl)-Dissolved	mg/L	0.00002	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0002*	*0.0001*	*0.0001*	*0.00005*
Thorium (Th)-Dissolved	mg/L	0.0002	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.002*	*0.001*	*0.001*	*0.0005*
Tin (Sn)-Dissolved	mg/L	0.0002	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.002*	*0.001*	*0.001*	*0.0005*
Titanium (Ti)-Dissolved	mg/L	0.0006	*0.003*	*0.003*	*0.003*	*0.003*	*0.003*	*0.006*	*0.003*	*0.003*	*0.0015*
Tungsten (W)-Dissolved	mg/L	0.0002	0.00394	0.0058	0.00398	0.00496	0.00662	0.00324	0.00229	0.00363	0.00194
Uranium (U)-Dissolved	mg/L	0.00002	0.000672	0.000252	0.000684	0.000377	0.000277	0.000334	0.000419	0.000341	0.00019
Vanadium (V)-Dissolved	mg/L	0.001	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.01*	*0.005*	*0.005*	*0.0025*
Zinc (Zn)-Dissolved	mg/L	0.006	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.02*	*0.01*	*0.01*	*0.005*
Zirconium (Zr)-Dissolved	mg/L	0.00012	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.004*	*0.002*	*0.002*	*0.001*

Blue italics denotes sample below detection limit

MONTHLY LOADINGS FOR TL-5 TO TIA

		Sample ID	TL5-13JAN-21	TL5-24FEB-21	TL5-9MAR-21	TL5-21APR-21	TL5-22MAY-21	TL5-30JUN-21	TL5-12JUL-21	TL5-10AUG-21	TL5-20SEP-21
			Jan-2021	Feb-2021	Mar-2021	Apr-2021	May-2021	Jun-2021	Jul-2021	Aug-2021	Sep-2021
Parameter	**Units**	**Detection Limit**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Hardness (as CaCO3)	kg/year	0.5	581,132	555,256	337,853	947,634	924,642	361,307	844,955	464,977	374,440
pH		0.1	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Total Suspended Solids	kg/year	3	9,613	3,955	54,632	9,245	4,298	27,098	150,801	6,738	13,497
Ammonia, Total (as N)	kg/year	0.25	14,501	17,951	10,759	26,811	21,879	9,545	23,530	17,682	9,895
Chloride (Cl)	kg/year	25	1,433,820	1,178,968	766,759	2,374,863	2,461,370	803,175	2,100,651	1,199,478	819,336
Nitrate (as N)	kg/year	0.1	4,855	7,226	3,546	15,832	10,614	6,469	16,899	7,216	8,154
Nitrite (as N)	kg/year	0.02	391	525	211	705	516	291	1,960	366	263
Sulfate (SO4)	kg/year	6	1,010,191	654,137	488,809	1,710,363	1,152,546	439,427	1,091,400	893,635	502,684
Cyanide, Weak Acid Diss	kg/year	0.005	397	187	30	70	23	20	75	33	16
Cyanide, Total	kg/year	0.005	2,129	1,772	726	948	879	220	628	452	451
Cyanate	kg/year	2	25,744	49,441	23,290	42,817	41,804	15,380	35,735	35,984	16,268
Thiocyanate (SCN)	kg/year	0.5	10,156	13,767	12,316	11,903	15,758	2,881	13,613	19,306	12,983
Cyanide, Free	kg/year	0.005	222	167	10	66	17	10	38	22	16
Aluminum (Al)-Dissolved	kg/year	0.006	51	29	15	30	49	19	20	30	25
Antimony (Sb)-Dissolved	kg/year	0.0002	1.51	1.55	0.86	2.51	2.08	0.88	1.78	1.45	0.65
Arsenic (As)-Dissolved	kg/year	0.0002	2.09	1.01	0.59	1.61	1.88	0.92	1.37	2.45	1.08
Barium (Ba)-Dissolved	kg/year	0.0001	20	17	10	29	32	12	30	23	13
Beryllium (Be)-Dissolved	kg/year	0.0002	0.54	0.38	0.24	0.58	0.65	0.49	0.59	0.48	0.20
Bismuth (Bi)-Dissolved	kg/year	0.0001	0.27	0.19	0.12	0.29	0.33	0.24	0.29	0.24	0.10
Boron (B)-Dissolved	kg/year	0.02	513	449	271	878	794	317	757	470	455
Cadmium (Cd)-Dissolved	kg/year	0.00001	0.03	0.02	0.01	0.03	0.03	0.02	0.03	0.02	0.01
Calcium (Ca)-Dissolved	kg/year	0.1	102,105	81,767	49,839	136,367	158,231	55,173	130,851	74,549	62,143
Cesium (Cs)-Dissolved	kg/year	0.00002	0.07	0.24	0.09	0.07	0.49	0.27	0.39	0.10	0.10
Chromium (Cr)-Dissolved	kg/year	0.0002	0.54	0.38	0.24	2.89	3.26	2.44	2.93	2.39	0.99
Cobalt (Co)-Dissolved	kg/year	0.0002	6.35	5.36	7.07	4.45	9.83	1.30	6.22	3.75	3.82
Copper (Cu)-Dissolved	kg/year	0.001	229	208	30	26	21	25	59	14	3
Iron (Fe)-Dissolved	kg/year	0.02	690	643	259	369	371	113	323	199	140
Lead (Pb)-Dissolved	kg/year	0.0001	0.27	0.19	0.12	0.29	0.33	0.24	0.29	0.24	0.10
Lithium (Li)-Dissolved	kg/year	0.002	20	16	10	32	29	10	31	22	12
Magnesium (Mg)-Dissolved	kg/year	0.01	86,355	71,879	47,443	111,520	140,650	53,952	117,355	74,549	49,477
Manganese (Mn)-Dissolved	kg/year	0.0002	77	73	43	167	148	52	175	86	62
Mercury (Hg)-Dissolved	kg/year	0.000005	0.003	0.002	0.012	0.003	0.033	0.001	0.003	0.012	0.010
Molybdenum (Mo)-Dissolved	kg/year	0.0001	16	11	6	19	16	6	20	14	8
Nickel (Ni)-Dissolved	kg/year	0.001	78	40	21	7	18	9	39	13	3
Phosphorus (P)-Dissolved	kg/year	0.1	278	326	211	289	436	264	307	449	240
Potassium (K)-Dissolved	kg/year	0.1	61,372	47,539	30,431	59,516	78,139	29,051	71,586	56,390	41,165
Rubidium (Rb)-Dissolved	kg/year	0.0004	15	21	8	25	32	18	31	25	19
Selenium (Se)-Dissolved	kg/year	0.0001	1.52	1.80	1.12	2.88	1.30	0.79	1.75	0.75	0.59
Silicon (Si)-Dissolved	kg/year	0.2	663	407	288	982	892	354	1,303	894	665
Silver (Ag)-Dissolved	kg/year	0.00002	0.08	0.04	0.08	0.06	0.07	0.05	0.06	0.06	0.02
Sodium (Na)-Dissolved	kg/year	0.1	1,140,539	908,946	651,745	1,675,694	1,758,121	627,404	1,402,390	1,056,114	641,219
Strontium (Sr)-Dissolved	kg/year	0.0004	847	749	498	1,294	1,452	500	1,262	722	503
Sulfur (S)-Dissolved	kg/year	1	380,723	270,402	199,357	557,602	427,158	175,527	408,982	356,498	203,844
Tellurium (Te)-Dissolved	kg/year	0.0004	1.09	0.76	0.48	1.16	1.30	0.98	1.17	0.96	0.40
Thallium (Tl)-Dissolved	kg/year	0.00002	0.05	0.04	0.02	0.06	0.07	0.05	0.06	0.05	0.02
Thorium (Th)-Dissolved	kg/year	0.0002	0.54	0.38	0.24	0.58	0.65	0.49	0.59	0.48	0.20
Tin (Sn)-Dissolved	kg/year	0.0002	0.54	0.38	0.24	0.58	0.65	0.49	0.59	0.48	0.20
Titanium (Ti)-Dissolved	kg/year	0.0006	1.63	1.14	0.72	1.73	1.95	1.46	1.76	1.43	0.59
Tungsten (W)-Dissolved	kg/year	0.0002	2.14	2.21	0.95	2.87	4.31	0.79	1.34	1.73	0.77
Uranium (U)-Dissolved	kg/year	0.00002	0.36	0.10	0.16	0.22	0.18	0.08	0.25	0.16	0.08
Vanadium (V)-Dissolved	kg/year	0.001	2.72	1.90	1.20	2.89	3.26	2.44	2.93	2.39	0.99
Zinc (Zn)-Dissolved	kg/year	0.006	5.43	3.80	2.40	5.78	6.51	4.88	5.87	4.78	1.98
Zirconium (Zr)-Dissolved	kg/year	0.00012	1.09	0.76	0.48	1.16	1.30	0.98	1.17	0.96	0.40

Attachment E TL-11 Geochemical Data

Seepage Monitoring of Backfilled Stopes (TL-11)	Sample ID	TL11-1-29-AUG21	TL11-2-29-AUG21	TL11-3-29-AUG21	TL11-A-14DEC21	TL11-B-17DEC21	TL11-C-17DEC21
	ALS ID	YL2101179-001	YL2101179-003	YL2101179-004	YL2101778-001	YL2101799-001	YL2101799-002
	Date Sampled	29/08/2021 11:41	29/08/2021 11:55	29/08/2021 00:10	14/12/2021 14:50	17/12/2021 08:40	17/12/2021 09:15
Parameter	**Units**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Conductivity	uS/cm	20100	7160	21800	20100	7910	279
Hardness (as CaCO3)	mg/L	2410	919	3590	2480	1140	59.5
pH	pH	8.11	8.21	8	8.11	7.99	7.62
Total Suspended Solids	mg/L	564	254	520	19	188	3.8
Total Dissolved Solids	mg/L	16500	4100	17200	10500	4380	172
Acidity (as CaCO3)	mg/L	8	2.8	18.5	8.8	9.1	3.7
Alkalinity, Total (as CaCO3)	mg/L	218	194	256	216	214	45.4
Ammonia, Total (as N)	mg/L	1.81	1.6	34.2	1.18	1.17	0.0117
Chloride (Cl)	mg/L	6870	2080	6890	6820	2380	57.4
Nitrate (as N)	mg/L	6.65	1.51	62.2	5.63	2.97	0.13
Nitrite (as N)	mg/L	0.364	0.125	2.43	0.372	0.1170	<0.0010
Sulfate (SO4)	mg/L	829	334	1910	822	333	4.23
Cyanide, Weak Acid Diss	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0100	<0.0050
Cyanide, Total	mg/L	0.026	0.328	0.0236	0.0071	0.0620	0.0173
Cyanide, Free	mg/L	<0.0050	<0.0050	0.0056	<0.0050	<0.0100	<0.0050
Aluminum (Al)-Total	mg/L	0.299	2.08	0.103	0.0536	2.53	0.0181
Antimony (Sb)-Total	mg/L	<0.00200	0.00285	0.00243	<0.001	0.00169	<0.00010
Arsenic (As)-Total	mg/L	0.00556	0.0942	0.00586	0.00439	0.0104	0.0005
Barium (Ba)-Total	mg/L	0.0381	0.0368	0.0376	0.0324	0.0347	0.00254
Beryllium (Be)-Total	mg/L	<0.000400	<0.0001	<0.0004	<0.0002	<0.000500	<0.000100
Bismuth (Bi)-Total	mg/L	<0.00100	0.000381	<0.00100	<0.0005	<0.000250	<0.000050
Boron (B)-Total	mg/L	2.12	1.03	2.73	2.27	1.1	0.027
Cadmium (Cd)-Total	mg/L	0.000157	0.000134	0.000405	0.000119	0.0000653	<0.0000050
Calcium (Ca)-Total	mg/L	295	130	548	298	143	11.1
Cesium (Cs)-Total	mg/L	0.000742	0.000311	<0.0002	0.000665	0.000143	<0.000010
Chromium (Cr)-Total	mg/L	#N/A	#N/A	#N/A	<0.00500	0.00569	<0.00050
Cobalt (Co)-Total	mg/L	0.0185	0.035	0.142	0.0159	0.0121	<0.00010
Copper (Cu)-Total	mg/L	0.0205	0.348	0.0457	0.0129	0.0854	0.00419
Iron (Fe)-Total	mg/L	1.25	22.5	1.5	0.407	7.68	0.024
Lead (Pb)-Total	mg/L	<0.00100	0.00834	<0.00100	<0.000500	0.00176	<0.000050
Lithium (Li)-Total	mg/L	0.0742	0.0342	0.0961	0.0811	0.0359	0.0037
Magnesium (Mg)-Total	mg/L	445	152	559	452	168	7.09
Manganese (Mn)-Total	mg/L	0.846	0.566	2.91	0.838	0.3770	0.0010
Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.00392	0.00391	0.01	0.00342	0.00372	0.000289
Nickel (Ni)-Total	mg/L	0.0354	0.0393	0.365	0.0288	0.0146	0.00052
Phosphorus (P)-Total	mg/L	<1.00	0.295	<1.00	<0.500	<0.250	<0.050
Potassium (K)-Total	mg/L	119	43.8	144	118	48.7	2.44
Rubidium (Rb)-Total	mg/L	0.0587	0.0218	0.0591	0.0643	0.0209	0.00139
Selenium (Se)-Total	mg/L	0.00116	0.00113	0.00872	0.000766	0.000471	0.000091
Silicon (Si)-Total	mg/L	3.89	5.08	3.99	3.74	5.99	1.51
Silver (Ag)-Total	mg/L	<0.000200	0.00103	0.000308	0.000114	0.000331	<0.000010
Sodium (Na)-Total	mg/L	3700	1150	3780	3910	1280	29.9
Strontium (Sr)-Total	mg/L	4.75	1.79	5.65	4.03	1.72	0.0426
Sulfur (S)-Total	mg/L	326	139	780	322	135	1.52
Tellurium (Te)-Total	mg/L	<0.00400	<0.00100	<0.00400	<0.00200	<0.00100	<0.00020
Thallium (Tl)-Total	mg/L	<0.000200	<0.000050	<0.000200	<0.000100	<0.000050	<0.000010
Thorium (Th)-Total	mg/L	<0.00200	<0.00050	<0.00200	<0.00100	<0.00050	<0.00010
Tin (Sn)-Total	mg/L	<0.00200	<0.00050	<0.00200	<0.00100	<0.00050	<0.00010
Titanium (Ti)-Total	mg/L	<0.00600	0.0362	<0.00600	<0.00300	0.047	0.00038
Tungsten (W)-Total	mg/L	<0.00200	0.001	0.00261	<0.00100	0.00064	0.00017
Uranium (U)-Total	mg/L	0.000221	0.00107	0.000574	0.000198	0.000804	0.000081
Vanadium (V)-Total	mg/L	<0.0100	0.00802	<0.0100	<0.00500	0.0117	<0.00050
Zinc (Zn)-Total	mg/L	<0.0600	0.0892	<0.0600	<0.0300	0.0302	0.0048
Zirconium (Zr)-Total	mg/L	<0.00400	<0.00100	<0.00400	<0.00200	<0.00100	<0.00020
Aluminum (Al)-Dissolved	mg/L	<0.02	<0.005	<0.02	<0.02	0.0178	0.0114
Antimony (Sb)-Dissolved	mg/L	<0.002	0.00239	0.0024	<0.002	0.00165	0.00015
Arsenic (As)-Dissolved	mg/L	0.00366	0.00231	0.0049	0.00357	0.00233	0.00044
Barium (Ba)-Dissolved	mg/L	0.0386	0.0353	0.0378	0.0298	0.0352	0.00274
Beryllium (Be)-Dissolved	mg/L	<0.002	<0.0005	<0.002	<0.002	<0.000500	<0.000100
Bismuth (Bi)-Dissolved	mg/L	<0.001	<0.00025	<0.001	<0.001	<0.000250	<0.000050
Boron (B)-Dissolved	mg/L	2.03	1.05	2.6	2.01	1.43	0.03
Cadmium (Cd)-Dissolved	mg/L	0.000175	0.0000579	0.000453	0.000163	0.0000274	<0.0000050
Calcium (Ca)-Dissolved	mg/L	296	124	548	282	152	12
Cesium (Cs)-Dissolved	mg/L	0.000586	0.000185	<0.0002	0.000693	0.000077	<0.000010
Chromium (Cr)-Dissolved	mg/L	<0.01	<0.0025	<0.01	#N/A	<0.00250	<0.00050
Cobalt (Co)-Dissolved	mg/L	0.018	0.0152	0.139	0.015	0.00833	<0.00010
Copper (Cu)-Dissolved	mg/L	0.0139	0.0101	0.0422	0.0125	0.0129	0.00433
Iron (Fe)-Dissolved	mg/L	<0.2	<0.05	<0.2	<0.2	<0.050	<0.010
Lead (Pb)-Dissolved	mg/L	<0.001	<0.00025	<0.001	<0.001	<0.000250	<0.000050
Lithium (Li)-Dissolved	mg/L	0.0718	0.0326	0.0935	0.0663	0.0381	0.0032
Magnesium (Mg)-Dissolved	mg/L	405	148	540	431	186	7.17
Manganese (Mn)-Dissolved	mg/L	0.777	0.199	2.78	0.777	0.26	0.00193
Mercury (Hg)-Dissolved	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Dissolved	mg/L	0.00366	0.00323	0.00932	0.00346	0.00368	0.000313
Nickel (Ni)-Dissolved	mg/L	0.0343	0.00911	0.358	0.024	0.00964	<0.00050
Phosphorus (P)-Dissolved	mg/L	<1	<0.25	<1	1	<0.250	<0.050
Potassium (K)-Dissolved	mg/L	117	45.1	143	115	56.8	2.41
Rubidium (Rb)-Dissolved	mg/L	0.0603	0.0204	0.057	0.0599	0.0226	0.00125
Selenium (Se)-Dissolved	mg/L	<0.001	0.000713	0.00816	<0.001	0.000438	0.000096
Silicon (Si)-Dissolved	mg/L	4.04	2.44	3.29	3.68	3.04	1.4
Silver (Ag)-Dissolved	mg/L	<0.0002	0.000061	0.000268	<0.0002	<0.000050	<0.000010
Sodium (Na)-Dissolved	mg/L	3790	1220	3880	3660	1470	30.8
Strontium (Sr)-Dissolved	mg/L	4.27	1.57	5.24	3.93	1.85	0.0439
Sulfur (S)-Dissolved	mg/L	312	124	758	291	149	1.55
Tellurium (Te)-Dissolved	mg/L	<0.004	<0.001	<0.004	<0.004	<0.00100	<0.00020
Thallium (Tl)-Dissolved	mg/L	<0.0002	<0.00005	<0.0002	<0.0002	<0.000050	<0.000010
Thorium (Th)-Dissolved	mg/L	<0.002	<0.0005	<0.002	<0.002	<0.00050	<0.00010
Tin (Sn)-Dissolved	mg/L	<0.002	<0.0005	<0.002	<0.002	<0.00050	<0.00010
Titanium (Ti)-Dissolved	mg/L	<0.006	<0.0015	<0.006	<0.006	<0.00150	<0.00030
Tungsten (W)-Dissolved	mg/L	<0.002	0.00051	0.0023	<0.002	<0.00050	0.00015
Uranium (U)-Dissolved	mg/L	0.000227	0.000941	0.000541	0.000217	0.000763	0.000094
Vanadium (V)-Dissolved	mg/L	<0.01	<0.0025	<0.01	<0.01	<0.00250	<0.00050
Zinc (Zn)-Dissolved	mg/L	<0.02	0.024	0.0408	<0.02	0.0148	0.0062
Zirconium (Zr)-Dissolved	mg/L	<0.004	<0.001	<0.004	<0.006	<0.00100	<0.00020

Appendix G

2021 Waste Rock and Ore Monitoring Report, Boston Camp, Hope Bay Project

AGNICO EAGLE

FINAL

2021 Waste Rock and Ore Monitoring Report, Boston Camp

Hope Bay Project, Nunavut, Canada

Agnico Eagle Mines Ltd.

SRK Consulting (Canada) Inc. ▪ 1CT022.073 ▪ February 25, 2022

srk consulting

FINAL

2021 Waste Rock and Ore Monitoring Report, Boston Camp

Hope Bay Project, Nunavut, Canada

Prepared for:
Agnico Eagle Mines Ltd
145 King Street East, Suite 400
Toronto, ON, M5C 2Y7
Canada

+1 416 947 1212
www.agnicoeagle.com

Prepared by:
SRK Consulting (Canada) Inc.
1066 West Hastings Street, Suite 2200
Vancouver, BC, V6E 3X2
Canada

+1 604 681 4196
www.srk.com

Lead Author: Amanda Schevers, GIT (BC) **Initials:** AJS
Reviewer: Lisa Barazzuol, PGeo (BC, NT/NU) **Initials:** LNB

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Contents

Appendices

1 Introduction

At the Boston site, ore and waste rock were generated as part of a 1996-1997 BHP Billiton underground exploration program. The ore was placed in several stockpiles on the camp pad and the waste rock was used to construct a camp pad, roads, and an airstrip at Boston. Since then, the site has been primarily in care and maintenance, with periodic use of the camp and airstrip in support of exploration activities.

The seepage and ephemeral streams sampling programs are conducted annually to validate the Boston waste rock and ore management and closure plan. A survey of rinse pH and conductivity of the ore is carried out every ten years as part of this plan and was last completed in 2018 (SRK 2019). This report presents results from the 2021 seepage and ephemeral streams monitoring programs at the Boston site, as outlined in the *Water and Ore/Waste Rock Management Plan for the Boston Site* (SRK 2017) and Water License 2BB-BOS1727 (Nunavut Water Board 2017).

The report is organized as follows:

- Section 2 contains a summary of the monitoring requirements.
- Section 3 summarizes the results of the seepage monitoring at the Boston site.
- Section 4 summarizes the results of the ephemeral streams monitoring.
- Detailed technical memoranda for each of these monitoring programs are provided in Appendices A and B.

2 Monitoring Requirements

As a condition of Water Licence 2BB-BOS1727 (Part E, Item 2), Agnico Eagle Mines (AEM) is required to implement a water and ore/waste rock management plan that addresses the acid rock drainage (ARD) and metal leaching (ML) potential of the materials at the site (NWB 2017). AEM acquired the Hope Bay project, including the Boston site, in 2021 and has continued to maintain the Boston site in care and maintenance.

2.1 Waste Rock and Ore

Geochemical characterization of waste rock and ore materials has indicated that all waste rock and most of the ore is non-acid generating with some of the ore classified as having an uncertain potential for ARD (SRK 2009). Based on the uncertain classifications, the ore/waste rock management plan (SRK 2017) includes a commitment to monitor the oxidation of the ore by carrying out a survey of rinse pH and conductivity every ten years. This monitoring has been conducted in 2008 and 2018 and was not a requirement in 2021.

2.2 Seepage Monitoring

The objective of the seepage monitoring is to provide an indication of contact water quality from the waste rock (camp pad) and ore stockpiles. There are two seepage monitoring programs: seepage monitoring at station BOS-8 and a freshet seepage survey along the north and east sides of the camp pad, and the southern end of the airstrip. The differences in the monitoring programs are because each program was designed using different frameworks.

As stipulated in Water Licence 2BB-BOS1727 (NWB 2017) and referenced in SRK (2017), AEM monitors the seepage station BOS-8A, BOS-8B, BOS-8C, and BOS-8D (collectively referred to as BOS-8). In summary, NWB (2017) stipulates the sampling of water quality station BOS-8 and any opportunistic seeps initially during spring thaw and at a minimum frequency of monthly whenever flow is observed. Samples collected at BOS-8 are analyzed for pH, electrical conductivity (EC), total suspended solids (TSS), major anions (sulphate, chloride, ammonia), and total and dissolved trace metals by ICP.

A freshet seepage survey along the north and east sides of the camp pad and the full extent of the airstrip is to be completed in accordance with Section 5.2.1 of the Boston Water and Ore/Waste Rock Management Plan (SRK 2017). In summary, these areas of the pad are to be surveyed for seepage and samples collected opportunistically during freshet.

2.3 Ephemeral Streams

As outlined in the Hope Bay Project Water and Ore/Waste Rock Management Plan for the Boston Site (SRK 2017), five ephemeral streams (A to E) within the catchments of the Boston camp pad are monitored during spring freshet. The objectives of the program are to monitor drainage from the Boston ore stockpiles and camp pad before entering Aimaokatalok Lake.

3 Monitoring of Boston Seepage

Full details of the 2021 seepage monitoring programs are presented in Appendix A with sample locations presented in Figure 1 and data in Tables 2 to 4 of Appendix A.

3.1 Sampling and Testing Program

3.1.1 Seepage Monitoring at BOS-8

In 2021, AEM surveyed the BOS-8 area in June, July, and August and collected one sample from each of BOS-8A, BOS-8B, and BOS-8D on June 28, 2021. No seepage flow was observed in July and August. Field measurements of electrical conductivity (EC), pH, oxidation-reduction potential (ORP), and temperature were measured. Flow rate could not be measured due to insufficient flow.

As outlined in SRK (2017) opportunistic samples are to be collected from any flowing seeps identified in surveys of the north and east side of the camp pad, and the southern end of the airstrip. AEM conducted a seepage survey in these areas in 2021 but did not observe any flowing seeps and therefore did not collect any water quality samples.

The water quality samples were submitted by AEM to ALS Environmental (ALS) in Burnaby, British Columbia for pH, EC, hardness, total suspended solids (TSS), ammonia, sulphate, and dissolved and total metals. Nitrate, chloride, and total alkalinity were not analyzed. The field QA/QC program included one duplicate sample and one field blank. The test work program was managed by AEM.

3.2 Results

A summary of the water quality results are presented as follows:

- Laboratory pH values ranged from 7.9 to 8.0. Lab EC values were equivalent to field EC values. Values of EC were highest at BOS-8D (1,200 µS/cm) compared to BOS-8A (800 µS/cm) and BOS-8B (580 µS/cm). Similarly, concentrations of major ions (calcium, magnesium, sodium, and sulphate) were higher at BOS-8D (e.g. 180 mg/L calcium) compared to BOS-8A and BOS-8B (e.g. 97 and 68 mg/L calcium, respectively).
- Concentrations of sulphate ranged from 200 mg/L (BOS-8B) to 400 mg/L (BOS-8D).
- Concentrations of ammonia at BOS-8B (1.0 mg/L) were one to two orders of magnitude larger than stations BOS-8D (0.26 mg/L) and BOS-8A (0.014 mg/L), respectively. The ammonia concentration at BOS-8B was within the range of historical concentrations and was the highest ammonia concentration observed since 2015 (16 mg/L at BOS-8C).
- Concentrations of arsenic were highest at BOS-8B (1.5 mg/L), which were higher than BOS-8D (0.55 mg/L), and lowest at BOS-8A (0.045 mg/L).
- BOS-8D had the highest concentrations of manganese (0.10 mg/L) and nickel (0.46 mg/L) compared to BOS-8A (0.056 and 0.18 mg/L, respectively) and BOS-8B (0.027 and 0.020 mg/L, respectively). According to TMAC, in September 2018 ore material was disturbed while repairing a

berm adjacent to station BOS-8C (located approximately 20 m northwest of BOS-8D). This activity may have resulted in a flush of soluble oxidation products at BOS-8D (Table 3 and Table 4).

- Concentrations of cobalt and selenium were one order of magnitude higher at BOS-8B and BOS-8D (e.g. 0.0014 and 0.0023 mg/L selenium, respectively) compared to BOS-8A (e.g. 0.0005 mg/L selenium).
- Iron and lead concentrations were less than detection (0.01 and 0.00005 mg/L, respectively) for all samples.
- All concentrations for the aforementioned parameters are within the range of the historical concentrations.

Continued monitoring will allow for further trends in the seepage to be established.

4 Monitoring of Ephemeral Streams

Full details of the 2021 Boston ephemeral streams monitoring program are documented in Appendix B with sample locations presented in Figure 1 and data in Tables 2 and 3 of Appendix B.

4.1 Sampling and Testing Program

AEM inspected ephemeral streams A to E for flow on June 28, 2021. Flow was observed at stations A2 and C2 only. Field measurements included pH, electrical conductivity (EC), oxidation-reduction potential (ORP), temperature, and flow rate at stations A2 and C2. AEM collected and submitted water quality samples from stations A2 and C2 for laboratory testing to ALS Environmental (ALS) in Burnaby, British Columbia for pH, EC, hardness, total suspended solids, acidity, total alkalinity, anions (bromide, chloride, fluoride, and sulphate), nutrients (nitrate, nitrite, ammonia, and phosphorus), and dissolved metals (filtered and preserved in the field). The quality assurance and quality control (QA/QC) sampling program included the collection of one field duplicate and one field blank.

4.2 Results

Contaminants of concern as identified by the 2009 water and load balance (Supporting Document B of SRK 2009) include nitrate, sulphate, arsenic, copper, iron, nickel, and selenium.

Sulphate, iron, and nickel concentrations have oscillated for A2 and C2 since 2009. Chloride concentrations for ephemeral streams exhibit a decreasing trend. Nitrate concentrations have oscillated at A2 and have generally decreased at C2 since 2009. Copper, arsenic, and selenium have stable trends. Concentrations of all contaminants of concern were within the range of historical data.

Compared to SRK (2009) model predictions, the 2021 monitoring data were below maximum predicted values for chloride, nitrate, arsenic, copper, iron, nickel, and selenium at streams A2 and C2. At C2, sulphate concentrations observed in 2021 exceeded the maximum modeled value; however, concentrations are lower than 2018 and 2020 and within the same order of magnitude as the modeled values.

Ephemeral streams monitoring indicates that overall, geochemical conditions remain stable with some annual variability. SRK recommends continued monitoring of the ephemeral stream sampling sites as outlined in SRK (2017).

5 Conclusions

The seepage program monitors contact water from the camp pad and ore stockpiles while the ephemeral stream program monitors drainage from the Boston ore stockpiles and camp pad before entering Aimaokatalok Lake.

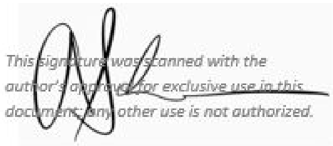
In 2021, AEM completed the required geochemical monitoring programs including i) monthly seepage surveys near BOS-8 located at the eastern edge of the camp pad and a freshet seepage survey along the northern and eastern edges of the camp pad and the full extent of the airstrip for opportunistic seepage samples and ii) opportunistic sampling of five ephemerals streams (A to E) within the catchment of the Boston camp pad. In total, AEM collected three seepage samples along the eastern side of the camp pad and two ephemeral streams samples from streams A2 and C2.

All seepage and ephemeral stream samples had pH values ranging from 7.8 to 8.0, indicating that the waste rock on the camp pad is not acidic. Monitoring of the seepage from the camp pad and the ore stockpiles indicates that water quality for the contaminants of concern is within the range of the historical data. The analysis of water quality data for ephemeral streams A2 and C2 indicate that overall, geochemical conditions remain stable with some annual variability. Specifically, concentrations of copper, arsenic, and selenium are stable, sulphate, iron, and nickel are oscillating, chloride are decreasing, and nitrate concentrations are oscillating at A2 and generally decreasing at C2. At C2, sulphate concentrations observed in 2021 exceeded the maximum modeled value; however, concentrations are lower than 2018 and 2020 and within the same order of magnitude as the modeled values.

SRK recommends continued annual monitoring according to the Water and Ore/Waste Rock Management Plan for the Boston Site (SRK 2017).

Closure

This report, 2021 Waste Rock and Ore Monitoring Report, Boston Camp, was prepared by



Amanda Schevers, GIT (BC)
Staff Consultant (Geochemistry)

and reviewed by

Lisa Barazzuol, PGeo (NT/NU)
Principal Consultant (Geochemistry)

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

References

[NWB] Nunavut Water Board, 2017. Water Licence No: 2BB-BOS1727. July 2017.

SRK Consulting (Canada) Inc., 2009. Water and Ore/Waste Rock Management Plan for the Boston Site Hope Bay Project, Nunavut. Report 1CH008.022 for Hope Bay Mining Ltd. July 2009.

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SRK Consulting (Canada) Inc., 2019. 2018 Water Rock and Ore Monitoring Report, Boston Camp, Hope Bay Project, Nunavut. Report 1CT022.027 for TMAC Resources Inc. March 2019.

Appendix A 2021 Boston Seepage Monitoring Memo

SRK Consulting (Canada) Inc.
1066 West Hastings Street, Suite 2200
Vancouver, BC V6E 3X2
Canada

+1 604 681 4196 office
+1 604 687 5532 fax

vancouver@srk.com
www.srk.com

FINAL

Technical Memo

February 3, 2022

To	Nancy Duquet Harvey, Agnico Eagle Mines Ltd.
From	Amanda Schevers and Lisa Barazzuol, SRK
Cc	
Subject	Results from the 2021 Boston Seepage Monitoring Program
Client	Agnico Eagle Mines Ltd.
Project	1CT022.073

1 Introduction

At the Boston site, ore and waste rock were generated as part of a 1996-1997 BHP Billiton underground exploration program. The ore was placed in several stockpiles on the camp pad and the waste rock was used to construct a camp pad, roads, and an airstrip at Boston. Since then, the site has been primarily in care and maintenance, with periodic use of the camp and airstrip in support of exploration activities.

The requirements for seepage monitoring at Boston camp are outlined in the in the *Water and Ore/Waste Rock Management Plan for the Boston Site* (SRK 2017). 2021 seepage monitoring activities include:

- Seepage monitoring at station BOS8.
- Opportunistic seepage monitoring along the toe of the north and east side of the camp pad, and the southern extent of the airstrip.

This memo presents the results of all Boston seepage samples collected in 2021 and fulfills the seepage monitoring requirements outlined in SRK (2017).

2 Methods

2.1 Sample Collection

2.1.1 Seepage Monitoring at BOS-8

The location of water quality monitoring station BOS-8 is defined in Water License 2BB-BOS1727 (Nunavut Water Board 2017). As outlined in the *Water and Ore/Waste Rock Management Plan for the Boston Site* (SRK 2017), Agnico Eagle Mines (AEM) monitors these seepage stations at freshet, and monthly thereafter and collects a sample if flowing seepage is observed. In 2021, AEM surveyed the area in June, July, and August and collected one sample each from BOS-8A, BOS-8B, and BOS-8D (Figure 1) on June 28, 2021. No seepage flow was observed in July and August. Field measurements of electrical conductivity (EC), pH, oxidation-reduction potential (ORP), and temperature were measured. Flow rate could not be measured due to insufficient flow.

Samples were collected by AEM from all three stations for laboratory analysis. The water quality samples were submitted by AEM to ALS Environmental (ALS) in Burnaby, British Columbia for pH, EC, hardness, total suspended solids (TSS), ammonia, sulphate, and dissolved and total metals. Nitrate, chloride, and total alkalinity were not analyzed. The field QA/QC program included one duplicate sample and one field blank. The test work program was managed by AEM.

2.1.2 Opportunistic Seepage Sampling

As outlined in SRK (2017) opportunistic samples are to be collected from any flowing seeps identified in surveys along the toe of the north and east side of the camp pad, and the southern extent of the airstrip. AEM conducted a seepage survey in these areas in 2021 but did not observe any flowing seeps and therefore did not collect any water quality samples.

Legend

- 2021 Seepage
- 2020 Seepage
- 2019 Seepage
- 2018 Seepage
- 2017 Seepage

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SRK JOB NO.: 1CT022.073

LAYOUT: 1CT022_073_2021_Boston_Seepage_Map

AGNICO EAGLE

2021 Seepage Monitoring

Hope Bay Gold Project

Seep Survey Locations
Boston Area

DATE:	APPROVED:	FIGURE:
Dec 2021	AJS	1

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2.2 Data Quality Assurance and Quality Control

2.2.1 2021 Data

Standard quality control checks were conducted on the ALS laboratory data as per SRK (2019) which describes SRK's expectations for laboratory geochemical data quality. One field duplicate (BOS8A-DUP) was analyzed to assess reproducibility of sampling and chemical homogeneity of the seepage water. Additionally, one field blank was analyzed to assess potential contamination that could result from sample collection, handling, and general conditions during sampling (e.g. blowing dust). Quality control checks and results are shown in Table 1. All data passed the QC checks except ion balances could not be assessed because total alkalinity and chloride data were unavailable. SRK accepted all data as reported.

Table 1: Summary of Quality Control Checks on Laboratory Data

QC Test	SRK QC Criteria	Results
Physical Test		
Field Blank (n=1)	Miniumum criteria is <2X DL, will accept <5X DL	All passed.
Method Blank (n=1) for TSS and Conductivity	<2X DL	All passed.
Field Duplicate (n=1)	For samples >10X DL should be within +/-30% RPD	All passed.
Lab Duplicate (n=1) for TSS, pH and Conductivity	For samples >10X DL should be within +/-20% RPD	All passed.
Field pH vs. Lab pH (n=3)	Difference should not be greater than 1 pH unit	All passed.
Field EC vs Lab EC (n=3)	For samples > 10X the detection limit (DL), % RPD should be within +/-30%	All passed.
Laboratory Control Samples (n=1) for TSS, pH and Conductivity	Within specified tolerance ranges.	All passed.
Anions and Nutrients		
Field Blank (n=1)	Miniumum criteria is <2X DL, will accept <5X DL	All passed.
Method Blank (n=1) for Total Ammonia and Sulfate (as SO4)	<2X DL	All passed.
Field Duplicate (n=1) for Total Ammonia and Sulfate (as SO4)	For samples >10X DL should be within +/-30% RPD	All passed.
Lab Duplicate (n=1) for Total Ammonia and Sulfate (as SO4)	For samples >10X DL should be within +/-20% RPD	All passed.
Ion Balance (n=3)	EC>100 uS/cm, % difference should be within +/-10%	Could not be assessed due to missing major anions (total alkalinity, chloride, and nitrate)

QC Test	SRK QC Criteria	Results
Laboratory Control Samples (n=1) for Total Ammonia and Sulfate (as SO4)	Within specified tolerance ranges.	All passed.
Trace Metals by ICP-MS		
Field Blank (n=1)	Miniumum criteria is <2X DL, will accept <5X DL	All passed.
Method Blank (n=1)	<2X DL	All passed.
Field Duplicate (n=1)	For samples >10X DL should be within +/-30% RPD	All passed.
Lab Duplicate (n=1)	For samples >10X DL should be within +/-20% RPD	All passed.
Total vs Dissolved Metals (n=3)	Total metals>dissolved metals. Total metals should be greater than dissolved metals, if not the % difference should be within +/-20%. ALS would use 10X DL	All passed.
Laboratory Control Samples (n=1)	Within specified tolerance ranges.	All passed.

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2.2.2 Historic Data

The historic seepage data set is comprised of 59 samples collected between 2008 and 2020, with the majority of samples analyzed for total metals rather than dissolved metals (Attachment 2). SRK collected three seepage samples in 2008 and based on QA/QC screening concluded that the data were acceptable (SRK 2009). All other historic samples were collected by Hope Bay Mining Ltd (HBML) or TMAC as part of the water licence monitoring program or the seepage monitoring program. SRK did not conduct QA/QC of the historic seepage data collected by HBML or TMAC prior to 2017 because the limited analytical suite precluded the calculation of ion balances and other QA/QC checks. SRK accepted all water licence monitoring data as reported.

3 Results

3.1 Field Observations

Field parameters for the three seepage samples collected in 2021 are presented in Table 2. Field pH ranged from 7.5 to 8.0. Field EC values ranged from 630 µS/cm at BOS-8B to 1,400 µS/cm at BOS-8D.

Table 2: 2021 Field Observations

Sample ID	Field pH	Field EC	ORP[1]	Temperature	Flow[2]	Comments
	s.u	µS/cm	mV	°C	L/s	
BOS8A	7.5	820	150	7.0	-	Visible flow into pool of water at toe of pad (ripples visible). Dry grass/willows in area. Some snow/ice ~10 m upstream on pad surface.
BOS8B	8.0	630	150	2.6	-	Shallow narrow channel.
BOS8D	7.9	1,400	160	3.5	-	Sheet flow emanating from toe of pad.

Source: \\srk.ad\dfs\na\van\Projects\01_SITES\Hope.Bay\1CT022.073_2021 Geochem Compliance\!080_Deliverables\2021 Boston Annual Report\Seepage_Memo\Working_File\[1CT022.073_2021_BostonSeep_REV01_ajs.xlsx]

Notes:

[1]Field calibrated ORP values

[2]Flow rate estimates could not be measured due to insufficient flow.

3.2 Laboratory Results

Table 3 and Table 4 present selected parameters from the 2021 Boston seepage data set and a comparison to a statistical summary of historical Boston seepage samples (2008 to 2020). The 2021 data is presented in Attachment 1 while the complete historical data set is documented in Attachment 2. Figure 2 to Figure 10 present sulphate, chloride, nitrate, ammonia, arsenic, copper, iron, nickel, and selenium concentrations observed since 2008. The following discussion presents dissolved parameters.

Concentrations in 2021 for the aformentioned parameters were within the range of the historical concentrations. A summary of the water quality results are presented as follows:

- Laboratory pH values ranged from 7.9 to 8.0. Lab EC values were equivalent to field EC values. Values of EC were highest at BOS-8D (1,200 µS/cm) compared to to BOS-8A (800 µS/cm) and BOS-8B (580 µS/cm). Similarly, concentrations of major ions (calcium, magnesium, sodium, and sulphate) were higher at BOS-8D (e.g. 180 mg/L calcium) compared to BOS-8A and BOS-8B (e.g. 97 and 68 mg/L calcium, respectively).
- Concentrations of sulphate ranged from 200 mg/L (BOS-8B) to 400 mg/L (BOS-8D).
- Concentrations of ammonia at BOS-8B (1.0 mg/L) were one to two orders of magnitude larger than stations BOS-8D (0.26 mg/L) and BOS-8A (0.014 mg/L), respectively. The ammonia concentration at BOS-8B was within the range of historical concentrations and was the highest ammonia concentration observed since 2015 (16 mg/L at BOS-8C).
- Concentrations of arsenic were highest at BOS-8B (1.5 mg/L), which were higher than BOS-8D (0.55 mg/L), and lowest at BOS-8A (0.045 mg/L).
- BOS-8D had the highest concentrations of manganese (0.10 mg/L) and nickel (0.46 mg/L) compared to BOS-8A (0.056 and 0.18 mg/L, respectively) and BOS-8B (0.027 and 0.020 mg/L, respectively). According to TMAC, in September 2018 ore material was disturbed while repairing a

berm adjacent to station BOS-8C (located approximately 20 m northwest of BOS-8D). This activity may have resulted in a flush of soluble oxidation products at BOS-8D (Table 3 and Table 4).

- Concentrations of cobalt and selenium were one order of magnitude higher at BOS-8B and BOS-8D (e.g. 0.0014 and 0.0023 mg/L selenium, respectively) compared to BOS-8A (e.g. 0.0005 mg/L selenium).
- Iron and lead concentrations were less than detection (0.01 and 0.00005 mg/L, respectively) for all samples.

Table 3: Summary of General Parameters, Major Dissolved Ions and Nutrients, 2021 and Historical Seepage Samples

Sample ID	Sample Date	Physical Tests			Major Ions and Nutrients[1]					
		pH	Conductivity	Total Suspended Solids	Sulphate	Calcium	Magnesium	Potassium	Sodium	Ammonia
		s.u.	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L as N
BOS8A	6/28/2021	7.9	800	5.4	330	97	36	4.1	14	0.014
BOS8B	6/28/2021	7.9	580	14	200	68	24	6.0	5.1	1.0
BOS8D	6/28/2021	8.0	1,200	130	400	180	45	10	20	0.26
Historic Seepage Data										
P5		7.0	360	3.0	69	35	9.2	1.6	4.1	0.008
P50		7.8	1,200	7.8	330	140	45	7.4	20	0.050
P95		8.0	2,600	53	660	340	100	21	96	6.5
Number of samples		62	62	48	62	19	19	19	19	59

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Notes:

[1]Dissolved concentrations presented for historic calcium, magnesium, potassium, and sodium statistics.

[2]Nitrate, chloride, and total alkalinity not analyzed in 2021.

Table 4: Comparison of Selected Trace Elements from 2021 and Historical Seepage Samples

Sample ID	Dissolved Metals										
	Aluminum	Arsenic	Cadmium	Cobalt	Copper	Iron	Lead	Manganese	Nickel	Selenium	Zinc
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
BOS8A	0.0034	0.045	0.000012	0.058	0.0056	<0.01	<0.00005	0.056	0.18	0.0005	0.0018
BOS8B	0.0048	1.5	0.000014	0.14	0.00035	<0.01	<0.00005	0.027	0.20	0.0014	0.0053
BOS8D	0.0039	0.55	0.0000095	0.42	0.0018	<0.01	<0.00005	0.10	0.46	0.0023	0.0010
Historic Seepage Data											
Dissolved Metals											
P5	0.0025	0.025	0.0000067	0.01	0.0014	0.01	0.00005	0.023	0.028	0.00022	***0.001***
P50	0.0047	0.11	0.000025	0.14	0.004	0.01	0.00005	0.11	0.33	0.0016	0.0024
P95	0.024	1.0	0.00027	1.1	0.0077	0.13	0.00027	0.48	1.7	0.017	0.030
Maximum	0.034	1.5	0.0005	1.2	0.0085	0.25	0.0005	1.4	1.8	0.04	0.041
Number of Samples	19	19	19	19	19	19	19	19	19	19	19
Total Metals											
P5	0.015	0.0045	0.000015	0.0022	0.0012	0.038	0.0001	0.019	0.011	0.00038	0.0037
P50	0.11	0.12	0.000050	0.051	0.0047	0.31	0.0005	0.15	0.13	0.0016	0.006
P95	1.1	1.1	0.0010	0.71	0.011	3.8	0.005	0.70	1.4	0.0077	0.087
Maximum	6.9	5.6	0.0020	1.4	0.045	16	0.022	2.0	4.0	0.017	0.10
Number of Samples	50	48	52	50	52	52	52	50	52	48	50

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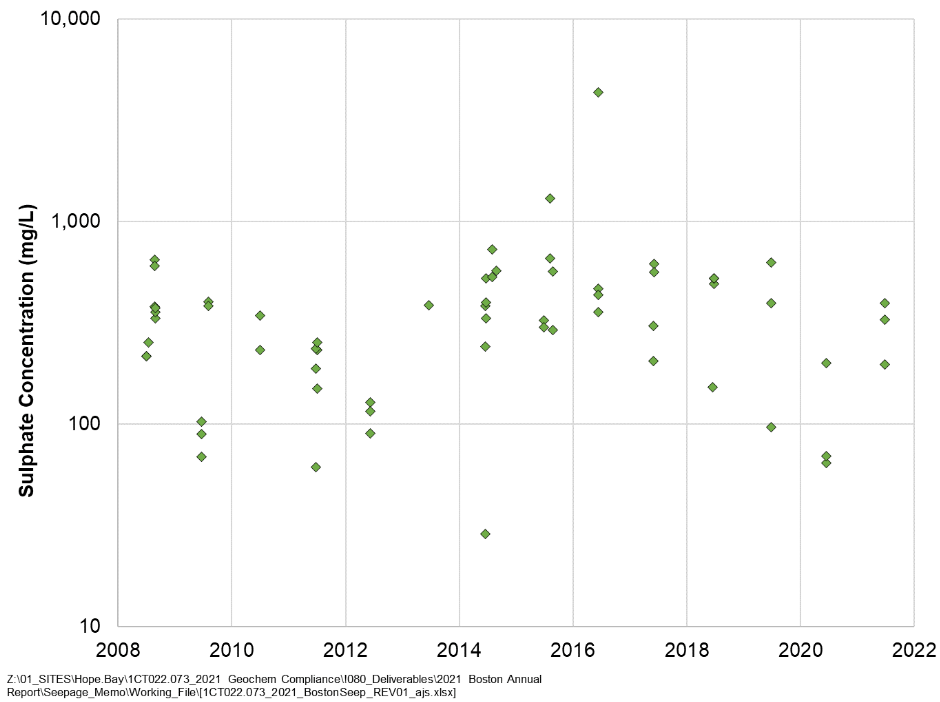

Figure 2: Sulphate concentrations in seeps at the Boston Camp since 2008

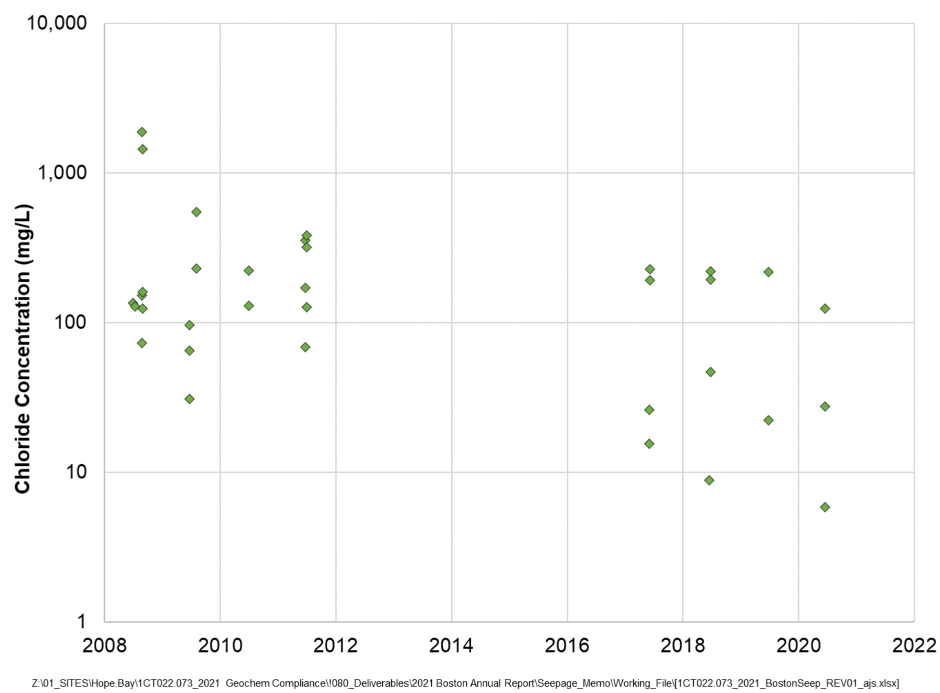

Figure 3: Chloride concentrations in seeps at the Boston Camp since 2008

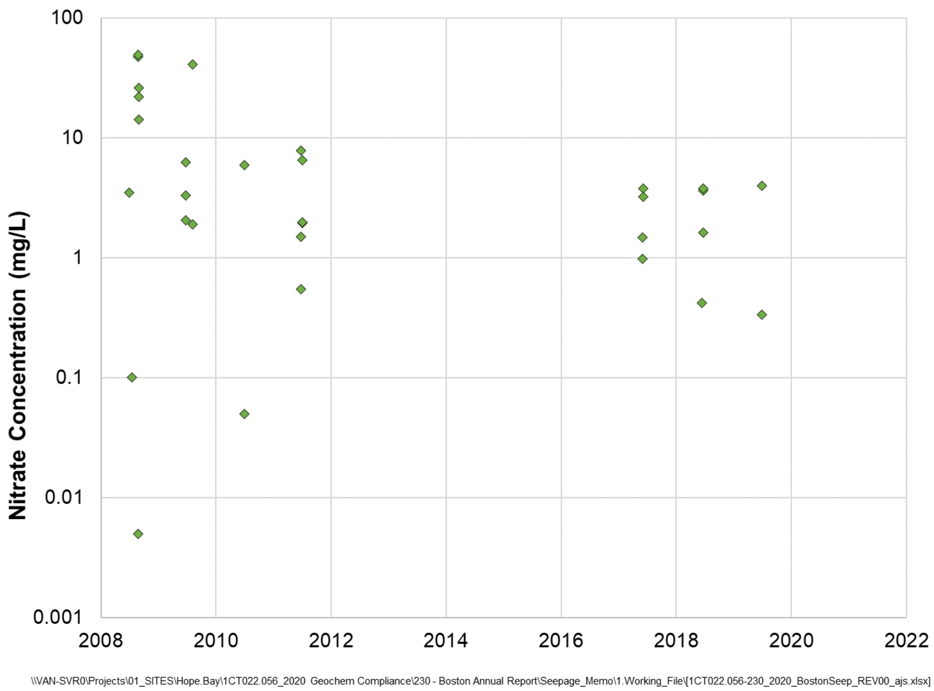

Figure 4: Nitrate concentrations in seeps at the Boston Camp since 2008

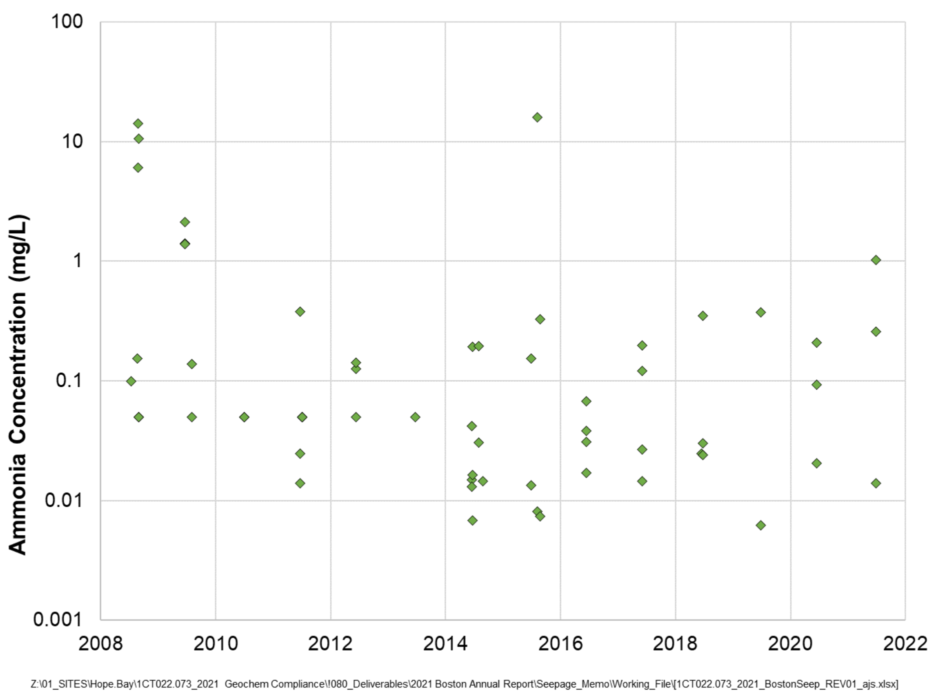

Figure 5: Ammonia concentrations in seeps at the Boston Camp since 2008

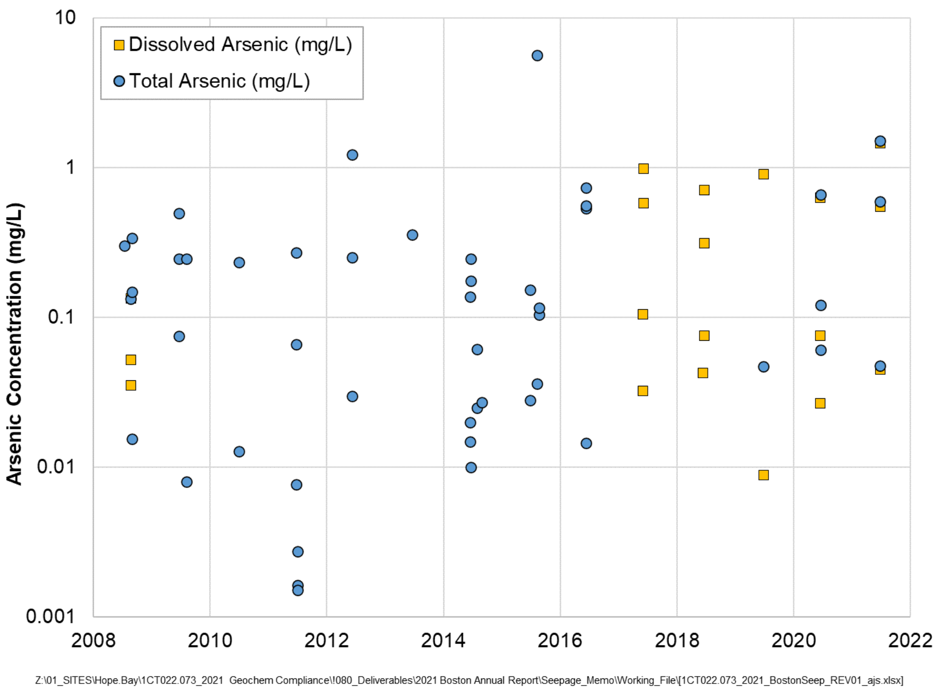

Figure 6: Arsenic concentrations in seeps at the Boston Camp since 2008

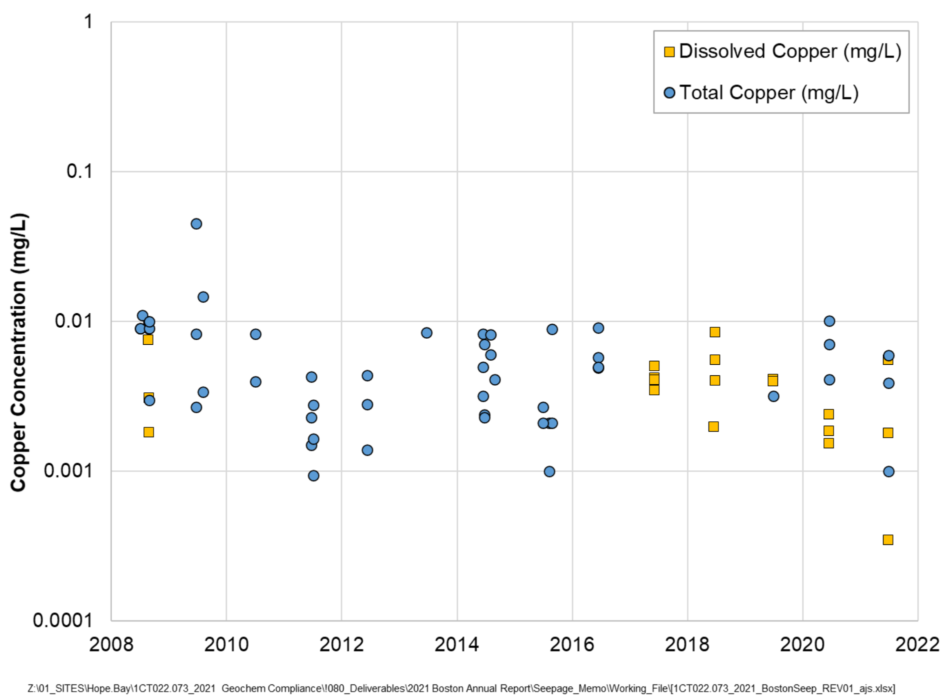

Figure 7: Copper concentrations in seeps at the Boston Camp since 2008

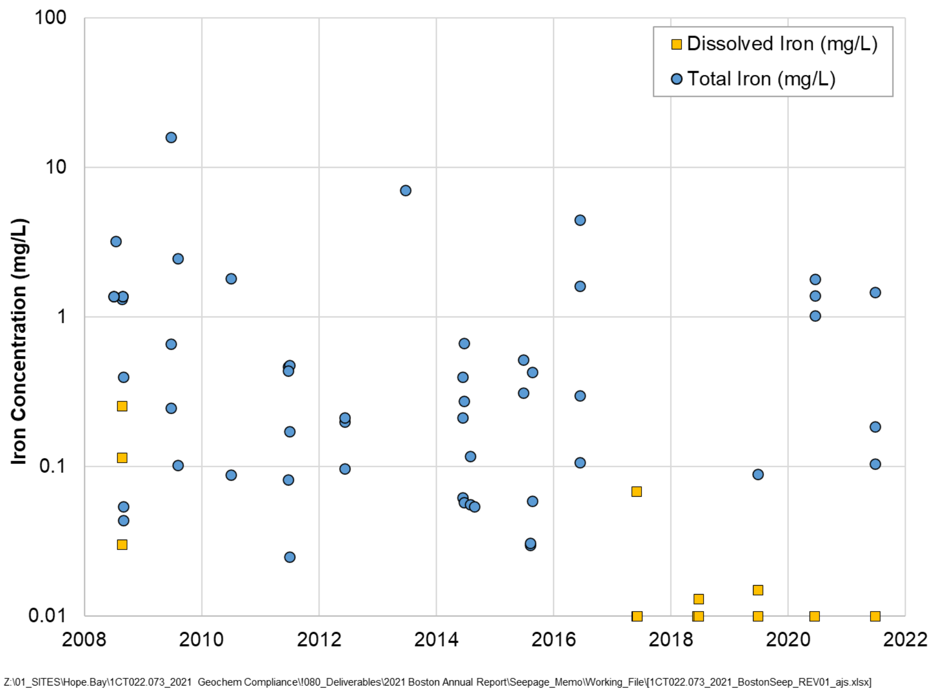

Figure 8: Iron concentrations in seeps at the Boston Camp since 2008

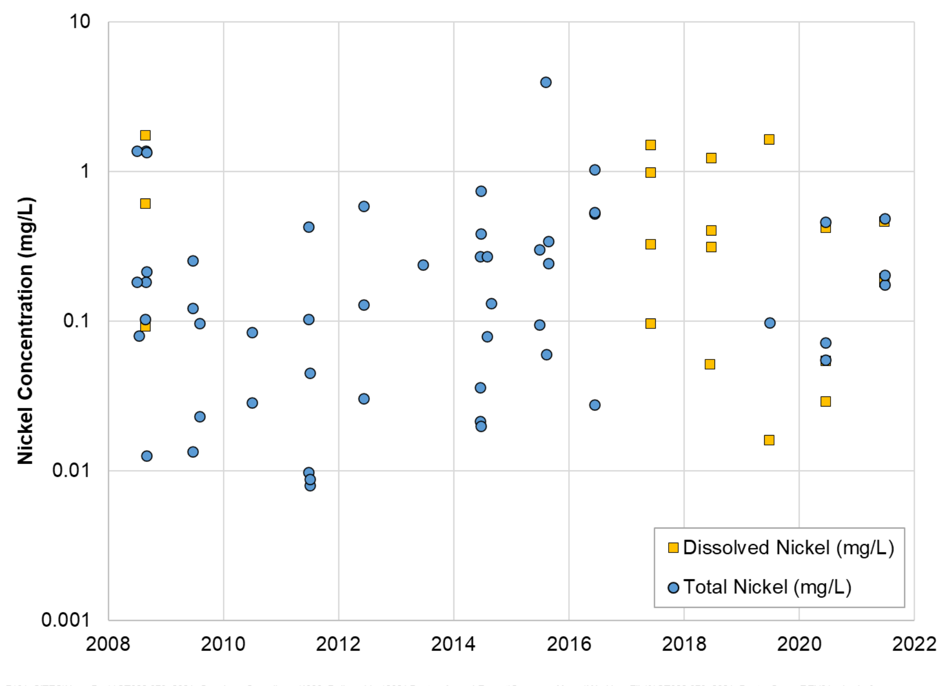

Figure 9: Nickel concentrations in seeps at the Boston Camp since 2008

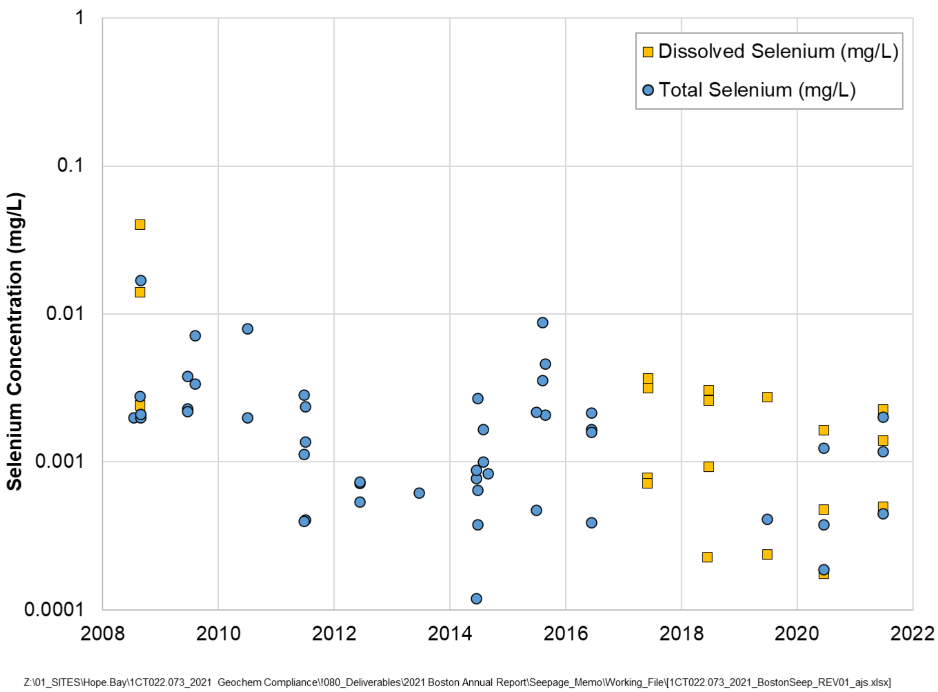

Figure 10: Selenium concentration in seeps at the Boston Camp since 2008

4 Conclusions and Recommendations

In 2021, AEM conducted the following seepage surveys as outlined in the *Water and Ore/Waste Rock Management Plan for the Boston Site* (SRK 2017):

- Three surveys of station BOS-8 were complete in June, July, and August. A total of three samples were collected from BOS-8A, BOS-8B, and BOS-8D in June and no seepage was observed in July and August.
- Freshet seepage survey of the north and east side of the camp pad, and the southern end of the airstrip. AEM did not observe flowing seepage and therefore did not collected any water quality samples.

All 2021 seepage samples were pH neutral (7.9 to 8.0). The seepage chemistry is summarized as follows:

- Lab EC values were equivalent to field EC values, with values lowest at BOS-8B (580 µS/cm) and highest at BOS-8D (1,200 µS/cm).
- Concentrations of sulphate ranged from 200 mg/L (BOS-8B) to 400 mg/L (BOS-8D).
- Concentrations of ammonia at BOS-8B (1.0 mg/L) were one and two orders of magnitude higher than stations BOS-8D (0.26 mg/L) and BOS-8A (0.014 mg/L), respectively. The ammonia

concentration at BOS-8B was the highest ammonia concentration observed since 2015 (16.0 mg/L at BOS-8C) and was within the range of historical concentrations.

- BOS-8D had the highest cobalt (0.45 mg/L), manganese (0.10 mg/L), nickel (0.46 mg/L), and selenium (0.0023 mg/L) and had a high concentration of arsenic (0.55 mg/L).
- BOS-8B had the highest concentrations of arsenic (1.5 mg/L) and had a high concentration of selenium (0.0014 mg/L).
- All concentrations for the aforementioned parameters are within the range of the historical concentrations.

Continued monitoring will allow for further trends in the seepage to be established.

Regards,
SRK Consulting (Canada) Inc.

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Amanda Schevers, GIT (BC)
Staff Consultant (Geochemistry)

Reviewed by

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Lisa Barazzuol, PGeo (NT/NU)
Principal Consultant (Geochemistry)

Attachments:

Attachment 1	2020 Field Observations and Water Quality Results
Attachment 2	Boston Seepage Data 2008-2020

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The opinions expressed in this document have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. While SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

References

[NWB] Nunavut Water Board, 2017. Water License No: 2BB-BOS1727. July 2017.

SRK Consulting (Canada) Inc., 2009. Geochemical Characterization of Historic Waste Rock and Ore Stockpiles at the Boston Deposit, Hope Bay Project, Nunavut. Report 1CH008.005 for Hope Bay Mining Ltd. April 2009.

SRK Consulting (Canada) Inc., 2017. Water and Ore/Waste Rock Management Plan for the Boston Site, Hope Bay Project, Nunavut. Report 1CT022.009 for Hope Bay Mining Ltd. January 2017.

SRK Consulting (Canada) Inc., 2019. Expectations for Laboratory Geochemical Data Quality. Internal Memo.

Attachment 1 2021 Field Observations and Water Quality Results

Sample ID	Unit	Detection Limit	BOS8A-DUP	BOS8A	BOS8B	BOS8D	BOS8-BLANK
Date			28-Jun-2021	28-Jun-2021	28-Jun-2021	28-Jun-2021	28-Jun-2021
Time			13:45	0.572916667	0.604166667	0.618055556	14:50
Easting			441232	441232	441264	441356	
Northing			7505523	7505523	7505469	7505403	
ALS Sample ID			YL2100668-001	YL2100668-002	YL2100668-003	YL2100668-004	YL2100668-005
Field Paramters							
pH	s.u			7.5	8	7.9	
Electrical Conductivity	µS/cm			817	625	1360	
Temperature	°C			7	2.6	3.5	
ORP	RmV			150	150	156	
Photos							
Flow	L/s		-	-	-	-	-
Duplicate			Y	-	-	-	-
Blank			-	-	-	-	Y
Physical Tests (Water)							
Conductivity	µS/cm	2	786	800	580	1240	2.3
Hardness (as CaCO3)	mg/L	0.5	389	395	276	635	<0.50
pH	pH units	0.1	7.9	7.89	7.9	7.97	5.92
Total Suspended Solids	mg/L	3	5.2	5.4	14.4	130	<3.0
Acidity (as CaCO3)	mg/L	2	#N/A	#N/A	#N/A	#N/A	#N/A
Total Alkalinity (as CaCO3)	mg/L	1	#N/A	#N/A	#N/A	#N/A	#N/A
Hardness (as CaCO3)	mg/L	0.6	#N/A	#N/A	#N/A	#N/A	#N/A
Total Dissolved Solids	mg/L	10	#N/A	#N/A	#N/A	#N/A	#N/A
Anions and Nutrients (Water)							
Ammonia, Total (as N)	mg/L	0.005	0.0101	0.0139	1.02	0.259	<0.0050
Sulfate (as SO4)	mg/L	0.3	330	329	198	396	<0.30
Bromide	mg/L	0.05	#N/A	#N/A	#N/A	#N/A	#N/A
Cchloride	mg/L	0.5	#N/A	#N/A	#N/A	#N/A	#N/A
Fluoride	mg/L	0.02	#N/A	#N/A	#N/A	#N/A	#N/A
Nitrate (as N)	mg/L	0.005	#N/A	#N/A	#N/A	#N/A	#N/A
Nitrite (as N)	mg/L	0.001	#N/A	#N/A	#N/A	#N/A	#N/A
Phosphorus, total	mg/L	0.002	#N/A	#N/A	#N/A	#N/A	#N/A
Total Metals (Water)							
Aluminum, total	mg/L	0.003	0.108	0.134	0.166	1.31	<0.0030
Antimony, total	mg/L	0.0001	0.00381	0.00388	0.0278	0.0282	<0.00010
Arsenic, total	mg/L	0.0001	0.0472	0.0478	1.52	0.594	<0.00010
Barium, total	mg/L	0.0001	0.00948	0.00954	0.00709	0.0251	0.00016
Beryllium, total	mg/L	0.00002	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Bismuth, total	mg/L	0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron, total	mg/L	0.01	0.058	0.059	0.142	0.184	0.034
Cadmium, total	mg/L	0.000005	0.0000121	0.0000365	0.0000165	0.0000101	0.0000082
Calcium, total	mg/L	0.05	97.1	98.4	68.3	179	0.12
Cesium, total	mg/L	0.00001	0.000059	0.000064	0.000699	0.00108	<0.000010
Chromium, total	mg/L	0.0005	0.00099	0.00119	0.00262	0.0286	<0.00050
Cobalt, total	mg/L	0.0001	0.0552	0.0561	0.147	0.426	<0.00010
Copper, total	mg/L	0.0005	0.00576	0.00596	0.001	0.00388	<0.00050
Iron, total	mg/L	0.01	0.1	0.105	0.185	1.47	<0.010
Lead, total	mg/L	0.00005	0.00015	0.000155	0.000275	0.00144	0.000068
Lithium, total	mg/L	0.001	0.0049	0.0049	0.0129	0.0388	<0.0010
Magnesium, total	mg/L	0.005	35.6	36.3	25.7	45.6	0.0173
Manganese, total	mg/L	0.0001	0.0522	0.0534	0.0294	0.112	0.00072
Molybdenum, total	mg/L	0.00005	0.000654	0.000663	0.00188	0.00292	<0.000050
Nickel, total	mg/L	0.0005	0.173	0.176	0.205	0.489	<0.00050
Phosphorus, total	mg/L	0.05	<0.050	<0.050	<0.050	<0.050	<0.050
Potassium, total	mg/L	0.05	3.89	3.97	6.14	9.39	<0.050
Rubidium, total	mg/L	0.0002	0.00166	0.0017	0.00606	0.00701	<0.00020

Date	Unit	Detection Limit	28-Jun-2021	28-Jun-2021	28-Jun-2021	28-Jun-2021	28-Jun-2021
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Northing			7505523	7505523	7505469	7505403	
ALS Sample ID			YL2100668-001	YL2100668-002	YL2100668-003	YL2100668-004	YL2100668-005
Field Paramters							
pH	s.u			7.5	8	7.9	
Electrical Conductivity	µS/cm			817	625	1360	
Temperature	°C			7	2.6	3.5	
ORP	RmV			150	150	156	
Photos							
Flow	L/s		-	-	-	-	-
Duplicate			Y	-	-	-	-
Blank			-	-	-	-	Y
Physical Tests (Water)							
Selenium, total	mg/L	0.00005	0.000423	0.000451	0.00118	0.00203	<0.000050
Silicon, total	mg/L	0.1	1.49	1.41	1.62	3.66	<0.10
Silver, total	mg/L	0.00001	0.000018	0.000016	<0.000010	0.000045	0.000011
Sodium, total	mg/L	0.05	13.3	13.5	5.25	19.3	0.458
Strontium, total	mg/L	0.0002	0.234	0.239	0.34	1.11	0.00029
Sulfur, total	mg/L	0.5	116	113	70.8	142	<0.50
Tellurium, total	mg/L	0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Thallium, total	mg/L	0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thorium, total	mg/L	0.0001	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tin, total	mg/L	0.0001	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Titanium, total	mg/L	0.0003	<0.00060	<0.00120	<0.00270	<0.0108	<0.00030
Tungsten, total	mg/L	0.0001	<0.00010	0.00015	0.00063	0.00104	<0.00010
Uranium, total	mg/L	0.00001	0.000153	0.000156	0.000089	0.000246	<0.000010
Vanadium, total	mg/L	0.0005	0.00086	0.00065	0.00199	0.0066	<0.00050
Zinc, total	mg/L	0.003	<0.0030	0.0099	0.0097	0.0034	0.0117
Zirconium, total	mg/L	0.0002	<0.00020	<0.00020	<0.00020	0.00029	<0.00020
Dissolved Metals (Matrix: Water)							
Aluminum, dissolved	mg/L	0.001	0.005	0.0034	0.0048	0.0039	<0.0010
Antimony, dissolved	mg/L	0.0001	0.00416	0.00406	0.0296	0.0297	<0.00010
Arsenic, dissolved	mg/L	0.0001	0.0456	0.0452	1.46	0.553	<0.00010
Barium, dissolved	mg/L	0.0001	0.00964	0.00967	0.007	0.0226	<0.00010
Beryllium, dissolved	mg/L	0.00002	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Bismuth, dissolved	mg/L	0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron, dissolved	mg/L	0.01	0.053	0.054	0.13	0.168	0.032
Cadmium, dissolved	mg/L	0.000005	0.0000089	0.0000123	0.0000136	0.0000095	<0.0000050
Calcium, dissolved	mg/L	0.05	96.1	97.4	68.3	179	<0.050
Cesium, dissolved	mg/L	0.00001	0.000057	0.000059	0.00069	0.000929	<0.000010
Chromium, dissolved	mg/L	0.0005	#N/A	#N/A	#N/A	#N/A	#N/A
Cobalt, dissolved	mg/L	0.0001	0.0597	0.0584	0.141	0.422	<0.00010
Copper, dissolved	mg/L	0.0002	0.00546	0.00557	0.00035	0.0018	<0.00020
Iron, dissolved	mg/L	0.01	<0.010	<0.010	<0.010	<0.010	<0.010
Lead, dissolved	mg/L	0.00005	<0.000050	<0.000050	<0.000050	<0.000050	0.000058
Lithium, dissolved	mg/L	0.001	0.0046	0.0047	0.0126	0.0376	<0.0010
Magnesium, dissolved	mg/L	0.005	35.4	36	24.4	44.9	0.0129
Manganese, dissolved	mg/L	0.0001	0.0559	0.0555	0.0266	0.103	0.00037
Mercury, dissolved	mg/L	0.000005	#N/A	#N/A	#N/A	#N/A	#N/A
Molybdenum, dissolved	mg/L	0.00005	0.000652	0.000616	0.00191	0.00296	<0.000050
Nickel, dissolved	mg/L	0.0005	0.183	0.183	0.195	0.462	<0.00050
Phosphorus, dissolved	mg/L	0.05	<0.050	<0.050	<0.050	<0.050	<0.050
Potassium, dissolved	mg/L	0.05	4.04	4.05	6.01	10	<0.050
Rubidium, dissolved	mg/L	0.0002	0.00164	0.00148	0.00548	0.00657	<0.00020
Selenium, dissolved	mg/L	0.00005	0.000452	0.000496	0.00139	0.00226	<0.000050
Silicon, dissolved	mg/L	0.05	1.17	1.18	1.21	1.97	<0.050

Date	Unit	Detection Limit	28-Jun-2021	28-Jun-2021	28-Jun-2021	28-Jun-2021	28-Jun-2021
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Field Paramters							
pH	s.u			7.5	8	7.9	
Electrical Conductivity	µS/cm			817	625	1360	
Temperature	°C			7	2.6	3.5	
ORP	RmV			150	150	156	
Photos							
Flow	L/s		-	-	-	-	-
Duplicate			Y	-	-	-	-
Blank			-	-	-	-	Y
Physical Tests (Water)							
Silver, dissolved	mg/L	0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Sodium, dissolved	mg/L	0.05	13.5	14	5.12	19.7	0.378
Strontium, dissolved	mg/L	0.0002	0.25	0.252	0.351	1.16	0.00022
Sulfur, dissolved	mg/L	0.5	111	116	70.7	139	<0.50
Tellurium, dissolved	mg/L	0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Thallium, dissolved	mg/L	0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thorium, dissolved	mg/L	0.0001	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tin, dissolved	mg/L	0.0001	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Titanium, dissolved	mg/L	0.0003	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Tungsten, dissolved	mg/L	0.0001	<0.00010	<0.00010	0.00061	0.00095	<0.00010
Uranium, dissolved	mg/L	0.00001	0.00014	0.000149	0.000087	0.000243	<0.000010
Vanadium, dissolved	mg/L	0.0005	<0.00050	<0.00050	0.00111	0.00056	<0.00050
Zinc, dissolved	mg/L	0.001	0.0018	0.0018	0.0053	<0.0010	0.0011
Zirconium, dissolved	mg/L	0.0003	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

Attachment 2 Boston Seepage Data 2008-2021

Year	Sample Code	Station Code	Date	Conductivity	Hardness (as CaCO3)	pH	Total Suspended Solids	Total Dissolved Solids	Acidity (as CaCO3)	Alkalinity, Total (as CaCO3)	Ammonia, Total (as N)	Bromide (Br)	Chloride (Cl)	Fluoride (F)	Nitrate (as N)	Nitrite (as N)	Phosphorus (P)-Total	Ortho Phosphate as P	Sulfate (SO4)	Dissolved Mercury Filtration Location	Dissolved Metals Filtration Location	Aluminum (Al)-Dissolved	Antimony (Sb)-Dissolved	Arsenic (As)-Dissolved	Barium (Ba)-Dissolved	Beryllium (Be)-Dissolved	Bismuth (Bi)-Dissolved	Boron (B)-Dissolved	Cadmium (Cd)-Dissolved	Calcium (Ca)-Dissolved
			Units	uS/cm	mg/L	s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
			LOR	2	0.5	0.1	3	10	1	1	0.005	0.05	0.5	0.02	0.005	0.001	0.002	0.001	0.3	n/a	n/a	0.001	0.0001	0.0001	0.00005	0.00002	0.00005	0.01	0.000005	0.05
2008	2008-BOS<001	2008-BOS<001	2008-08-23	1470	596	7.9	18.7	1110	12.2	162	0.155	<0.05	152	0.065	<0.005	0.0019	-	-	380	-	-	0.0146	0.00437	0.0521	0.0314	<0.001	<0.001	0.147	<0.0001	137
2008	2008-BOS<003	2008-BOS<003	2008-08-25	1890	901	7.71	<5	1490	6.4	76.7	6.04	<0.05	73	0.106	47.6	0.542	-	-	650	-	-	<0.005	0.0142	0.0353	0.011	<0.0025	<0.0025	0.295	<0.00025	202
2008	BOS-8	BOS-8A	2008-08-25	6720	2740	6.9	19	8200	19.1	42.8	14.2	3.4	1890	1.3	49.7	0.261	-	-	603	-	-	0.023	0.0206	0.134	0.126	<0.005	<0.005	0.43	<0.0005	888
2008	BOS-8A	BOS-8A	2008-06-30	1190	464	8	11	-	-	149	-	-	136	-	3.5	0.05	-	-	217	-	-	-	-	-	-	-	-	-	-	-
2008	BOS-8A	BOS-8A	2008-06-30	1190	464	8	11	-	-	149	-	-	-	-	-	-	-	-	217	-	-	-	-	-	-	-	-	-	-	-
2008	BOS-8A	BOS-8A	2008-07-14	1280	490	8.1	40	-	-	172	0.1	-	129	0.09	0.1	0.05	0.27	-	253	-	-	-	-	-	-	-	-	-	-	-
2008	BOS-8A	BOS-8A	2008-08-29	1330	548	8	-	-	-	130	0.05	-	124	-	22.1	0.05	0.08	-	333	-	-	-	-	-	-	-	-	-	-	-
2009	BOS-8A	BOS-8A	2009-06-21	483	161	8.04	19	260	-	111	1.41	-	30.9	0.073	2.07	0.05	0.186	0.186	69	-	-	-	-	-	-	-	-	-	-	-
2009	BOS-8A	BOS-8A	2009-08-04	1820	660	8.2	34	1110	-	188	0.138	-	231	0.061	1.91	0.05	0.161	0.161	402	-	-	-	-	-	-	-	-	-	-	-
2010	BOS-8A	BOS-8A	2010-07-01	1210	481	7.85	-	-	-	198	0.05	-	130	0.083	0.05	0.05	-	0.216	232	-	-	-	-	-	-	-	-	-	-	-
2011	BOS-8A	BOS-8A	2011-06-23	763	274	7.71	-	-	-	68.4	0.381	-	68.6	-	1.5	0.05	-	0.0593	188	-	-	-	-	-	-	-	-	-	-	-
2011	BOS-8A	BOS-8A	2011-07-03	1050	362	7.99	-	-	-	72	0.05	-	127	-	1.96	0.05	-	0.02	233	-	-	-	-	-	-	-	-	-	-	-
2012	BOS-8A	BOS-8A	2012-06-10	394	149	7.78	3	-	-	-	0.127	-	-	-	-	-	-	-	90.1	-	-	-	-	-	-	-	-	-	-	-
2013	BOS-8A	BOS-8A	2013-06-21	1320	687	8.28	15	-	-	-	0.05	-	-	-	-	-	-	-	387	-	-	-	-	-	-	-	-	-	-	-
2008	BOS-8B	BOS-8B	2008-08-29	1560	571	7.9	-	-	-	128	0.05	-	160	-	14.3	0.05	0.02	-	358	-	-	-	-	-	-	-	-	-	-	-
2009	BOS-8B	BOS-8B	2009-06-21	724	209	7.71	4	387	-	63.8	2.12	-	96.8	0.054	6.26	0.071	0.102	0.102	103	-	-	-	-	-	-	-	-	-	-	-
2009	BOS-8B	BOS-8B	2009-08-04	2800	956	7.73	3	1640	-	38.6	0.05	-	548	0.05	41	0.05	0.02	0.02	384	-	-	-	-	-	-	-	-	-	-	-
2010	BOS-8B	BOS-8B	2010-07-01	1520	583	7.48	-	-	-	58.2	0.05	-	224	0.05	5.95	0.05	-	0.103	343	-	-	-	-	-	-	-	-	-	-	-
2011	BOS-8B	BOS-8B	2011-06-23	1690	635	6.87	-	-	-	10.1	0.0246	-	355	-	7.87	0.05	-	0.0393	236	-	-	-	-	-	-	-	-	-	-	-
2011	BOS-8B	BOS-8B	2011-07-03	1850	708	7.6	-	-	-	38.4	0.05	-	383	-	6.52	0.05	-	0.02	254	-	-	-	-	-	-	-	-	-	-	-
2012	BOS-8B	BOS-8B	2012-06-10	462	168	7.73	3	-	-	-	0.142	-	-	-	-	-	-	-	128	-	-	-	-	-	-	-	-	-	-	-
2008	BOS-8C	BOS-8C	2008-08-29	4860	1890	7.4	-	-	-	47	10.6	-	1440	-	26.3	0.16	0.17	-	374	-	-	-	-	-	-	-	-	-	-	-
2009	BOS-8C	BOS-8C	2009-06-21	520	176	7.55	656	275	-	37.2	1.4	-	65.5	0.05	3.33	0.055	0.282	0.282	89.5	-	-	-	-	-	-	-	-	-	-	-
2011	BOS-8C	BOS-8C	2011-06-23	786	281	7.58	-	-	-	33.8	0.0139	-	171	-	0.549	0.05	-	0.0156	61.6	-	-	-	-	-	-	-	-	-	-	-
2011	BOS-8C	BOS-8C	2011-07-03	1450	502	7.51	-	-	-	29.8	0.05	-	320	-	1.98	0.05	-	0.02	150	-	-	-	-	-	-	-	-	-	-	-
2012	BOS-8C	BOS-8C	2012-06-10	358	124	6.4	3	-	-	-	0.05	-	-	-	-	-	-	-	116	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8-16JUN14a	BOS8	2014-06-16	683	346	7.93	<3	-	-	-	0.0149	-	-	-	-	-	-	-	242	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8-16JUN14b	BOS8	2014-06-16	1040	461	7.86	3.2	-	-	-	0.013	-	-	-	-	-	-	-	383	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8-16JUN14c	BOS8	2014-06-16	347	106	7.95	8.8	-	-	-	0.0421	-	-	-	-	-	-	-	28.7	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8-23JUN14a	BOS8	2014-06-23	974	537	8.03	<3	-	-	-	0.0164	-	-	-	-	-	-	-	333	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8-23JUN14b	BOS8	2014-06-23	1110	506	7.96	<3	-	-	-	0.0068	-	-	-	-	-	-	-	398	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8-23JUN14c	BOS8	2014-06-23	2160	1040	7.75	9.5	-	-	-	0.194	-	-	-	-	-	-	-	526	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8-31JUL14	BOS8	2014-07-31	1610	885	7.72	4.3	-	-	-	0.195	-	-	-	-	-	-	-	733	-	-	-	-	-	-	-	-	-	-	-
2015	BOS8A<09AUG15	BOS8	2015-08-09	1460	742	7.02	<3	-	-	-	0.0081	-	-	-	-	-	-	-	662	-	-	-	-	-	-	-	-	-	-	-
2016	BOS8A-12JUN16	BOS8	2016-06-12	951	416	7.72	<3	-	-	-	0.0308	-	-	-	-	-	-	-	359	-	-	-	-	-	-	-	-	-	-	-
2015	BOS8A-24AUG15	BOS8	2015-08-24	1490	721	7.16	12.1	-	-	-	0.0074	-	-	-	-	-	-	-	569	-	-	-	-	-	-	-	-	-	-	-
2015	BOS8A-29JUN15	BOS8	2015-06-29	944	426	8.03	<3	-	-	-	0.0134	-	-	-	-	-	-	-	325	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8A-31JUL14	BOS8	2014-07-31	1320	669	7.18	<3	-	-	-	0.0305	-	-	-	-	-	-	-	535	-	-	-	-	-	-	-	-	-	-	-
2015	BOS8C<09AUG15	BOS8	2015-08-09	2620	1370	7.6	<3	-	-	-	16	-	-	-	-	-	-	-	1300	-	-	-	-	-	-	-	-	-	-	-
2016	BOS8C-12JUN16	BOS8	2016-06-12	1610	739	7.9	28	-	-	-	0.0678	-	-	-	-	-	-	-	468	-	-	-	-	-	-	-	-	-	-	-
2015	BOS8C-24AUG15	BOS8	2015-08-24	1370	601	7.14	<3	-	-	-	0.33	-	-	-	-	-	-	-	292	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8C-28AUG14	BOS8	2014-08-28	1500	762	7.6	<3	-	-	-	0.0146	-	-	-	-	-	-	-	575	-	-	-	-	-	-	-	-	-	-	-
2015	BOS8C-29JUN15	BOS8	2015-06-29	1220	529	7.49	<3	-	-	-	0.153	-	-	-	-	-	-	-	301	-	-	-	-	-	-	-	-	-	-	-
2016	BOS8D-12JUN16a	BOS8	2016-06-12	1470	668	7.91	9.8	-	-	-	0.0383	-	-	-	-	-	-	-	4350	-	-	-	-	-	-	-	-	-	-	-
2016	BOS8D-12JUN16b	BOS8	2016-06-12	1470	669	7.94	10.1	-	-	-	0.017	-	-	-	-	-	-	-	434	-	-	-	-	-	-	-	-	-	-	-
2017	BOS8A<04JUN	BOS-8A	2017-06-04	811	0	7.61	<3.0	611	5.5	91.2	0.0145	<0.25	26.1	<0.10	1.48	<0.0050	0.0275	-	305	FIELD	-	0.0047	0.00691	0.105	0.0127	<0.00010	<0.000050	0.065	0.0000138	94.2
2017	2017-BOS<001	2017-BOS<001	2017-06-04	577	0	7.09	32.8	428	8.1	61	0.0267	<0.050	15.6	0.032	0.983	0.0028	0.0356	-	205	FIELD	-	0.0335	0.00407	0.0323	0.0106	<0.00010	<0.000050	0.087	0.0000367	62.2
2017	17-BOS<02	BOS-8B	2017-06-06	1830	968	8.03	6.7	1440	4.8	109	0.198	0	228	<0.20	3.81	<0.010	0.0314	-	619	FIELD	-	0.0025	0.0363	0.989	0.0188	<0.000020	<0.000050	0.203	0.0000353	264
2017	17-BOS<03	17-BOS<03	2017-06-06	1690	903	8.04	11.7	1250	4.6	108	0.122	0	192	<0.20	3.23	0.026	0.03	-	566	FIELD	-	0.0042	0.027	0.578	0.0256	<0.000020	<0.000050	0.205	0.0000299	239
2018	18-BOS<01	BOS8	2018-06-16	401	-	7.31	12.7	288	4.3	22	0.0246	-	8.88	0.024	0.42	0.0071	0.0155	-	152	-	-	0.0044	0.0025	0.0427	0.00445	<0.0001	<0.00005	0.025	<0.000005	50.8
2018	18-BOS<01	BOS8	2018-06-25	1200	666	7.81	4.1	967	4.5	129	0.0239	-	47.2	<0.1	1.62	<0.005	0.0384	-	493	-	-	0.0054	0.00648	0.0758	0.0191	<0.00002	<0.00005	0.078	0.0000247	166
2018	18-BOS<02	18-BOS<02	2018-06-25	1840	916	8.04	3.7	1500	2.8	90.1	0.349	-	220	<0.2	3.62	0.012	0.0507	-	527	-	-	0.002	0.038	0.707	0.0156	<0.00002	<0.00005	0.176	0.0000287	256
2018	18-BOS<03	18-BOS<03	2018-06-25	1640	826	8.05	3.3	1370	4	88.8	0.0302	-	194	<0.1	3.79	0.0172	0.0213	-	527	-	-	0.0043	0.0244	0.315	0.0254	<0.00002	<0.00005	0.178	0.0000313	226
2019	BOS8A	BOS-8A	2019-06-29	1030	544	7.8	<3	-	-	-	0.0062	-	-	-	-	-	-	-	395	-	-	-	-	-	-	-	-	-	-	-
2019	19-BOS<01	19-BOS<01	2019-06-29	1810	1010	8.04	<3	1680	3.4	100	0.372	<0.5	219	<0.2	3.99	0.017	0.0302	-	629	FIELD	FIELD	0.0025	0.0338	0.903	0.0176	<0.00002	<0.00005	0.189	0.0000319	278
2019	19-BOS<02	18-BOS<02	2019-06-29	394	185	7.98	11.9	299	1.7	70.5	<0.005	<0.05	22.3	0.049	0.335	<0.001	0.0078	-	97	FIELD	FIELD	0.0087	0.00278	0.00888	0.00950	<0.00002	<0.00005	0.045	0.0000069	47.0
2020	BOS8A	BOS8A	2020-06-18	224	96	7.48	38	-	-	-	0.0932	-	5.85	-	-	-	-	-	64.2	FIELD	FIELD	0.0069	0.00196	0.0269	0.00221	<0.0001	<0.00005	0.023	0.0000071	23.6
2020	BOS8C	BOS8C	2020-06-18	925	401	7.77	16.2	-	-	-	0.209	-	124	-	-	-	-	-	200	FIELD	FIELD	0.0036	0.0297	0.635	0.0105	<0.0001	<0.00005	0.147	0.0000135	114
2020	BOS8D	BOS8D	2020-06-18	317	129	7.59	60	-	-	-	0.0205	-	27.5	-	-	-	-	-	69.6	FIELD	FIELD	0.0186	0.00432	0.07580	0.00617	<0.0001	<0.00005	0.052	0.0000091	36.6
2021	BOS8A	BOS8A	2021-06-28	800	395	7.89	5.4	#N/A	#N/A	#N/A	0.0139	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	329	FIELD	FIELD	0.0034	0.00406	0.0452	0.00967	<0.000020	<0.000050	0.054	0.0000123	97.4
2021	BOS8B	BOS8B	2021-06-28	580	276	7.9	14.4	#N/A	#N/A	#N/A	1.02	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	198	FIELD	FIELD	0.0048	0.0296	1.460	0.0070	<0.000020	<0.000050	0.130	0.0000136	68
2021	BOS8D	BOS8D	2021-06-28	1240	635	7.97	130	#N/A	#N/A	#N/A	0.259	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	396	FIELD	FIELD	0.0039	0.0297	0.553	0.0226	<0.000020	<0.000050	0.168	0.0000095	179

Year	Sample Code	Station Code	Cesium (Ce)-Dissolved	Chromium (Cr)-Dissolved	Cobalt (Co)-Dissolved	Copper (Cu)-Dissolved	Iron (Fe)-Dissolved	Lead (Pb)-Dissolved	Lithium (Li)-Dissolved	Magnesium (Mg)-Dissolved	Manganese (Mn)-Dissolved	Mercury (Hg)-Dissolved	Molybdenum (Mo)-Dissolved	Nickel (Ni)-Dissolved	Phosphorus (P)-Dissolved	Potassium (K)-Dissolved	Rubidium (Rb)-Dissolved	Selenium (Se)-Dissolved	Silicon (Si)-Dissolved	Silver (Ag)-Dissolved	Sodium (Na)-Dissolved	Strontium (Sr)-Dissolved	Sulfur (S)-Dissolved	Tellurium (Te)-Dissolved	Thallium (Tl)-Dissolved	Thorium (Th)-Dissolved	Tin (Sn)-Dissolved	Titanium (Ti)-Dissolved	Tungsten (W)-Dissolved	Uranium (U)-Dissolved
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
			0.00001	**0.0001**	**0.0001**	**0.0002**	**0.01**	**0.00005**	**0.001**	**0.1**	**0.0001**	**0.000005**	**0.00005**	**0.0005**	**0.05**	**0.1**	**0.0002**	**0.00005**	**0.05**	**0.00001**	**0.05**	**0.0002**	**0.5**	**0.0002**	**0.00001**	**0.0001**	**0.0001**	**0.0003**	**0.0001**	**0.00001**
2008	2008-BOS<001	2008-BOS<001	-	0.0011	0.0113	0.00756	0.253	<0.0001	0.014	62.1	0.135	<0.00005	0.00278	0.0928	<0.3	14.8	-	0.0024	0.588	<0.00002	85.9	0.767	-	-	<0.0002	-	<0.0002	0.012	-	0.000186
2008	2008-BOS<003	2008-BOS<003	-	<0.0025	0.253	0.00183	<0.03	<0.00025	<0.025	96.6	0.374	<0.00005	0.00656	0.613	<0.3	17.9	-	0.014	1.21	<0.00005	50.5	0.553	-	-	<0.0005	-	<0.0005	0.012	-	0.000419
2008	BOS-8	BOS-8A	-	<0.005	1.02	0.0031	0.115	<0.0005	0.195	128	1.44	<0.00005	0.00385	1.75	<0.3	51	-	<0.04	3.88	<0.0001	182	7.26	-	-	<0.001	-	<0.001	<0.01	-	0.00019
2008	BOS-8A	BOS-8A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2008	BOS-8A	BOS-8A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2008	BOS-8A	BOS-8A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2008	BOS-8A	BOS-8A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2009	BOS-8A	BOS-8A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2009	BOS-8A	BOS-8A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2010	BOS-8A	BOS-8A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	BOS-8A	BOS-8A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	BOS-8A	BOS-8A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2012	BOS-8A	BOS-8A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2013	BOS-8A	BOS-8A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2008	BOS-8B	BOS-8B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2009	BOS-8B	BOS-8B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2009	BOS-8B	BOS-8B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2010	BOS-8B	BOS-8B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	BOS-8B	BOS-8B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	BOS-8B	BOS-8B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2012	BOS-8B	BOS-8B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2008	BOS-8C	BOS-8C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2009	BOS-8C	BOS-8C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	BOS-8C	BOS-8C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	BOS-8C	BOS-8C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2012	BOS-8C	BOS-8C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8-16JUN14a	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8-16JUN14b	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8-16JUN14c	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8-23JUN14a	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8-23JUN14b	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8-23JUN14c	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8-31JUL14	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	BOS8A<09AUG15	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	BOS8A-12JUN16	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	BOS8A-24AUG15	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	BOS8A-29JUN15	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8A-31JUL14	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	BOS8C<09AUG15	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	BOS8C-12JUN16	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	BOS8C-24AUG15	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	BOS8C-28AUG14	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	BOS8C-29JUN15	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	BOS8D-12JUN16a	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	BOS8D-12JUN16b	BOS8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2017	BOS8A<04JUN	BOS-8A	-	0.00014	0.141	0.00505	<0.010	<0.000050	0.005	40.3	0.112	<0.0000050	0.000868	0.326	<0.050	4.5	-	0.000781	1.36	<0.000010	14	0.25	111	-	<0.000010	-	<0.00010	<0.00030	-	0.000145
2017	2017-BOS<001	2017-BOS<001	-	0.00015	0.0716	0.00424	0.068	<0.000050	0.0012	28.4	0.285	<0.0000050	0.00074	0.0971	<0.050	5.53	-	0.000713	1.56	<0.000010	11.3	0.215	75.4	-	<0.000010	-	<0.00010	0.00079	-	0.000033
2017	17-BOS<02	BOS-8B	-	<0.00010	1.1	0.0035	<0.010	<0.000050	0.0524	75.2	0.3	<0.0000050	0.0024	1.51	<0.050	14.1	-	0.00367	2.33	0.000014	38.9	1.56	215	-	<0.000010	-	<0.00010	<0.00030	-	0.000284
2017	17-BOS<03	17-BOS<03	-	<0.00010	0.754	0.00411	<0.010	<0.000050	0.0483	74.5	0.208	<0.0000050	0.00288	0.99	<0.050	13.7	-	0.00314	2.35	0.000019	37.1	1.43	207	-	<0.000010	-	<0.00010	<0.00030	-	0.000295
2018	18-BOS<01	BOS8	-	<0.0001	0.0246	0.00198	<0.01	<0.00005	0.0022	13	0.0241	<0.000005	0.00036	0.0519	<0.05	1.68	-	0.000226	0.246	<0.00001	4.11	0.108	50.5	-	<0.00001	-	<0.0001	<0.0003	-	0.000035
2018	18-BOS<01	BOS8	-	<0.0001	0.109	0.00848	0.013	<0.00005	0.0069	61.4	0.111	<0.000005	0.0011	0.315	<0.05	6.27	-	0.000927	2.11	0.000012	24.8	0.42	160	-	<0.00001	-	<0.0001	<0.0006	-	0.000284
2018	18-BOS<02	18-BOS<02	-	<0.0001	0.956	0.00555	<0.01	<0.00005	0.0456	67.6	0.25	<0.000005	0.00313	1.23	<0.05	13.3	-	0.00305	1.93	0.000011	36.3	1.63	181	-	<0.00001	-	<0.0001	<0.0003	-	0.000247
2018	18-BOS<03	18-BOS<03	-	<0.0001	0.345	0.00406	<0.01	<0.00005	0.0399	63.5	0.133	<0.000005	0.00401	0.406	<0.05	10.9	-	0.00261	1.88	0.000014	31.3	1.44	168	-	<0.00001	-	<0.0001	<0.0003	-	0.000268
2019	BOS8A	BOS-8A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2019	19-BOS<01	19-BOS<01	-	<0.0001	1.21	0.00413	<0.01	<0.00005	0.0398	75.6	0.268	<0.000005	0.00284	1.64	<0.05	13.5	-	0.00273	1.98	<0.00001	36.8	1.61	211	-	<0.00001	-	<0.0001	<0.0003	-	0.000257
2019	19-BOS<02	18-BOS<02	-	0.00010	0.00320	0.00400	0.015	<0.00005	0.0046	16.5	0.0102	0.0000055	0.000931	0.0161	<0.05	2.31	-	0.000238	0.825	<0.00001	8.74	0.170	32.1	-	<0.00001	-	<0.0001	<0.0003	-	0.000042
2020	BOS8A	BOS8A	0.000038	0.0002	0.0208	0.00241	<0.01	<0.00005	0.0018	8.99	0.0356	<0.000005	0.000292	0.0544	<0.05	1.34	0.0008	0.000176	0.303	<0.00001	3.89	0.0587	23.2	<0.0002	<0.00001	<0.0001	<0.0001	<0.0003	0.0001	0.000024
2020	BOS8C	BOS8C	0	0.00035	0.34	0.00154	<0.01	<0.00005	0.0280	28.4	0.091	<0.000005	0.00232	0.42	<0.05	7.4	0.0	0.00163	1.70	<0.00001	12.5	0.73	74	<0.0002	<0.00001	<0.0001	<0.0001	<0.0003	0.00145	0.000116
2020	BOS8D	BOS8D	0.0	0.00031	0.01850	0.00187	<0.01	<0.00005	0.0079	9.2	0.0244	<0.000005	0.001580	0.0292	<0.05	2.26	0.00	0.000476	0.796	<0.00001	5.27	0.193	23.9	<0.0002	<0.00001	<0.0001	<0.0001	<0.0003	0.00148	0.000063
2021	BOS8A	BOS8A	0.000059	#N/A	0.0584	0.00557	0.01	0.00005	0.0047	36	0.0555	#N/A	0.000616	0.183	<0.050	4.05	0.00148	0.000496	1.18	<0.000010	14	0.252	116	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.000149
2021	BOS8B	BOS8B	0	#N/A	0.14	0.00035	0.01	0.00005	0.0126	24.4	0.027	#N/A	0.00191	0.20	<0.050	6.0	0.0	0.00139	1.21	<0.000010	5.1	0.35	71	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	0.00061	0.000087
2021	BOS8D	BOS8D	0.000929	#N/A	0.422	0.0018	0.01	0.00005	0.0376	44.9	0.103	#N/A	0.00296	0.462	<0.050	10	0.00657	0.00226	1.97	<0.000010	19.7	1.16	139	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	0.00095	0.000243

Year	Sample Code	Station Code	Vanadium (V)-Dissolved	Zinc (Zn)-Dissolved	Zirconium (Zr)-Dissolved	Aluminum (Al)-Total	Antimony (Sb)-Total	Arsenic (As)-Total	Barium (Ba) Total	Beryllium (Be)-Total	Bismuth (Bi)-Total	Boron (B)-Total	Cadmium (Cd)-Total	Calcium (Ca)-Total	Chromium (Cr)-Total	Cobalt (Co)-Total	Copper (Cu)-Total	Iron (Fe)-Total	Lead (Pb)-Total	Lithium (Li)-Total	Magnesium (Mg)-Total	Manganese (Mn)-Total	Mercury (Hg)-Total	Molybdenum (Mo)-Total	Nickel (Ni)-Total	Phosphorus (P)-Total	Potassium (K)-Total	Selenium (Se)-Total	Silicon (Si)-Total	Silver (Ag)-Total
			mg/L 0.0005	mg/L 0.001	mg/L 0.0003	mg/L 0.001	mg/L 0.0001	mg/L 0.0001	mg/L 0.00005	mg/L 0.00002	mg/L 0.00005	mg/L 0.01	mg/L 0.000005	mg/L 0.05	mg/L 0.0001	mg/L 0.0001	mg/L 0.0002	mg/L 0.01	mg/L 0.00005	mg/L 0.001	mg/L 0.1	mg/L 0.0001	mg/L 0.000005	mg/L 0.00005	mg/L 0.0005	mg/L 0.05	mg/L 0.1	mg/L 0.00005	mg/L 0.05	mg/L 0.00001
2008	2008-BOS<001	2008-BOS<001	<0.002	<0.002	-	0.377	0.00448	0.134	0.0342	<0.001	<0.001	0.158	<0.0001	136	0.0052	0.0147	0.01	1.32	0.00062	0.014	62	0.153	<0.00005	0.00226	0.104	<0.3	15.3	0.0028	1.42	0.000042
2008	2008-BOS<003	2008-BOS<003	<0.005	0.0068	-	0.11	-	-	0.032	0.002	-	0.17	0.001	112	0.005	0.052	0.009	1.38	0.005	-	40.5	0.224	-	0.005	0.183	-	12	-	-	0.005
2008	BOS-8	BOS-8A	<0.01	0.022	-	-	-	-	-	-	-	-	0.001	-	0.005	-	0.009	1.38	0.005	-	-	-	-	-	1.38	-	-	-	-	-
2008	BOS-8A	BOS-8A	-	-	-	0.11	-	-	0.032	0.002	-	0.17	0.001	112	0.005	0.052	0.009	1.38	0.005	-	40.5	0.224	-	0.005	0.183	-	12	-	-	0.005
2008	BOS-8A	BOS-8A	-	-	-	-	-	-	-	-	-	-	0.001	-	0.005	-	0.009	1.38	0.005	-	-	-	-	-	1.38	-	-	-	-	-
2008	BOS-8A	BOS-8A	-	-	-	0.94	0.003	0.301	0.0304	0.001	0.0001	0.12	0.0002	81.9	0.0192	0.0248	0.011	3.23	0.002	-	42.6	0.277	-	0.004	0.0805	-	13.7	0.002	-	0.0004
2008	BOS-8A	BOS-8A	-	-	-	0.15	0.0114	0.148	0.0281	0.001	0.0001	0.16	0.0002	132	0.0029	0.0503	0.009	0.398	0.0005	-	48.1	0.072	-	0.0059	0.215	-	12.3	0.002	-	0.0004
2009	BOS-8A	BOS-8A	-	-	-	0.268	0.00874	0.247	0.0127	0.001	-	0.096	0.0002	42.8	0.005	0.0603	0.0083	0.665	0.00085	0.01	16.3	0.146	0.0001	0.005	0.123	-	6.64	0.0023	-	0.0001
2009	BOS-8A	BOS-8A	-	-	-	0.426	0.00532	0.248	0.0598	0.001	-	0.214	0.00005	133	0.0062	0.0312	0.0147	2.46	0.00294	0.013	60.8	0.311	0.0001	0.005	0.097	-	17.3	0.0034	-	0.0001
2010	BOS-8A	BOS-8A	-	-	-	0.08	0.00496	0.235	0.0341	0.001	-	-	0.00005	109	0.005	0.0223	0.0083	1.82	0.00038	0.011	50.5	0.219	-	0.005	0.0843	-	12.6	0.002	-	0.0001
2011	BOS-8A	BOS-8A	-	-	-	0.167	0.0033	0.0664	0.0239	0.001	-	0.113	0.00005	60	0.005	0.0967	0.0043	0.469	0.00032	0.01	36.3	1.97	0.0001	0.005	0.104	-	8.93	0.00113	-	0.0001
2011	BOS-8A	BOS-8A	-	-	-	0.0461	0.00124	0.00274	0.0386	0.0005	-	0.0497	0.000015	79.1	0.00045	0.00064	0.00278	0.173	0.000114	0.005	38.1	0.0136	-	0.000604	0.00804	-	7.3	0.00041	-	0.000093
2012	BOS-8A	BOS-8A	-	-	-	0.132	0.00884	0.253	0.0075	0.001	-	0.067	0.000015	42.3	0.0014	0.0618	0.0044	0.199	0.00032	0.01	12.8	0.0573	0.00002	0.005	0.129	-	3.73	0.00072	-	0.00002
2013	BOS-8A	BOS-8A	-	-	-	0.292	0.00322	0.359	0.0355	0.001	-	0.118	0.000052	157	0.0041	0.114	0.0085	7.04	0.00137	0.01	57.6	0.695	0.00002	0.005	0.239	-	10.4	0.00062	-	0.000066
2008	BOS-8B	BOS-8B	-	-	-	0.04	0.0116	0.0155	0.0428	0.001	0.0001	0.15	0.0002	120	0.0019	0.0025	0.003	0.044	0.0001	-	58.6	0.002	-	0.0042	0.0127	-	18.7	0.0021	-	0.0004
2009	BOS-8B	BOS-8B	-	-	-	0.155	0.00833	0.0749	0.0289	0.001	-	0.078	0.0002	43.5	0.005	0.0093	0.0027	0.246	0.00036	0.01	22	0.198	0.0001	0.005	0.0135	-	9.53	0.0038	-	0.0001
2009	BOS-8B	BOS-8B	-	-	-	0.042	0.00318	0.00801	0.113	0.001	-	0.201	0.00008	210	0.005	0.0057	0.0034	0.103	0.00014	0.011	110	0.04	0.0001	0.005	0.0233	-	23.2	0.0072	-	0.0001
2010	BOS-8B	BOS-8B	-	-	-	0.051	0.0045	0.0128	0.0442	0.004	-	-	0.0002	107	0.005	0.0044	0.004	0.088	0.0004	0.024	63.3	0.0359	-	0.005	0.0287	-	14.6	0.008	-	0.0004
2011	BOS-8B	BOS-8B	-	-	-	0.099	0.0218	0.271	0.107	0.001	-	0.193	0.00005	171	0.005	0.245	0.0015	0.082	0.0001	0.051	35.8	0.188	0.0001	0.0081	0.43	-	12	0.00285	-	0.0001
2011	BOS-8B	BOS-8B	-	-	-	0.0145	0.00614	0.00164	0.0803	0.0005	-	0.128	0.000039	226	0.00018	0.00893	0.00165	0.478	0.00005	0.0387	48.7	0.0432	-	0.000609	0.0454	-	13.2	0.00238	-	0.000032
2012	BOS-8B	BOS-8B	-	-	-	0.122	0.00287	0.03	0.0119	0.001	-	0.079	0.000026	43.9	0.001	0.0138	0.0028	0.214	0.00027	0.01	19.3	0.146	0.00002	0.005	0.0305	-	5.38	0.00054	-	0.000038
2008	BOS-8C	BOS-8C	-	-	-	0.2	0.029	0.341	0.088	0.01	0.001	0.5	0.002	661	0.019	0.813	0.01	0.054	0.001	-	87	0.912	-	0.079	1.35	-	42.8	0.017	-	0.004
2009	BOS-8C	BOS-8C	-	-	-	6.91	0.00672	0.495	0.0496	0.001	-	0.095	0.0002	57.5	0.141	0.129	0.0452	16	0.0223	0.016	16.4	0.398	0.0001	0.005	0.254	-	4.94	0.0022	-	0.0001
2011	BOS-8C	BOS-8C	-	-	-	0.136	0.00073	0.00767	0.0382	0.001	-	0.078	0.00005	89.6	0.005	0.0028	0.0023	0.439	0.00045	0.011	19.6	0.0259	0.0001	0.005	0.0098	-	5.46	0.0004	-	0.0001
2011	BOS-8C	BOS-8C	-	-	-	0.0087	0.00214	0.00151	0.0612	0.0005	-	0.108	0.000014	161	0.00013	0.0013	0.00094	0.025	0.00005	0.0227	32.5	0.0109	-	0.000818	0.00885	-	9.15	0.00137	-	0.00001
2012	BOS-8C	BOS-8C	-	-	-	0.181	0.00179	1.23	0.0077	0.001	-	0.128	0.000054	34	0.001	0.123	0.0014	0.097	0.0001	0.01	8.26	0.063	0.00002	0.005	0.592	-	5.95	0.00074	-	0.00002
2014	BOS8-16JUN14a	BOS8	-	-	-	0.0311	0.00947	0.138	<0.02	<0.001	-	<0.1	0.00002	89.3	<0.001	0.132	0.005	0.062	<0.0005	0.0068	30	0.127	-	0.0012	0.272	-	4.7	0.00078	-	0.000021
2014	BOS8-16JUN14b	BOS8	-	-	-	0.036	0.00252	0.0148	0.027	<0.001	-	0.11	0.00003	100	<0.001	0.0143	0.0032	0.212	<0.0005	<0.005	51.4	0.171	-	<0.001	0.0361	-	10.5	0.00088	-	0.00005
2014	BOS8-16JUN14c	BOS8	-	-	-	0.0988	0.00105	0.02	0.034	<0.001	-	<0.1	0.000025	26.9	<0.001	0.00618	0.0083	0.398	<0.0005	<0.005	9.48	0.0413	-	<0.001	0.0216	-	3.1	0.00012	-	0.000842
2014	BOS8-23JUN14a	BOS8	-	-	-	0.0233	0.00918	0.175	0.025	<0.001	-	0.12	0.000037	136	<0.001	0.154	0.0071	0.667	<0.0005	0.0076	47.7	0.267	-	0.0017	0.384	-	7.7	0.00065	-	0.00003
2014	BOS8-23JUN14b	BOS8	-	-	-	0.0231	0.00201	0.01	0.032	<0.001	-	0.14	0.000017	111	<0.001	0.0019	0.0024	0.058	<0.0005	<0.005	55.7	0.0253	-	<0.001	0.0199	-	10.6	0.00038	-	<0.00002
2014	BOS8-23JUN14c	BOS8	-	-	-	0.105	0.0294	0.247	0.041	<0.001	-	0.25	0.000086	299	0.0026	0.576	0.0023	0.274	<0.0005	0.0492	71.2	0.277	-	0.003	0.744	-	16.9	0.00271	-	0.000114
2014	BOS8-31JUL14	BOS8	-	-	-	0.0579	0.0121	0.0615	0.032	<0.001	-	0.2	0.000039	227	0.0011	0.0588	0.0082	0.117	<0.0005	0.0134	77	0.0547	-	0.0019	0.272	-	5.3	0.001	-	<0.00002
2015	BOS8A<09AUG15	BOS8	-	-	-	0.0246	0.00498	0.0362	0.039	<0.001	-	0.27	0.000129	192	<0.001	0.0599	<0.001	<0.03	<0.0005	0.0348	64	0.0974	-	<0.001	0.0601	-	13.5	0.00357	-	<0.00002
2016	BOS8A-12JUN16	BOS8	-	-	-	0.0401	0.00139	0.0146	<0.02	<0.001	-	<0.1	0.0000295	91.5	<0.001	0.00817	0.0049	0.107	<0.0005	0.002	45.6	0.325	-	<0.001	0.0279	-	7.4	0.000389	-	0.000025
2015	BOS8A-24AUG15	BOS8	-	-	-	0.074	0.00548	0.105	0.025	<0.001	-	0.17	0.0000322	168	<0.001	0.0349	0.0089	0.431	<0.0005	0.0056	73.3	0.677	-	<0.001	0.245	-	12.9	0.00209	-	0.000032
2015	BOS8A-29JUN15	BOS8	-	-	-	0.0148	0.00208	0.0281	<0.02	<0.001	-	0.11	0.0000133	89.2	<0.001	0.0198	0.0027	0.313	<0.0005	0.0025	49.2	0.624	-	<0.001	0.0952	-	8.9	0.000472	-	<0.00002
2014	BOS8A-31JUL14	BOS8	-	-	-	0.0663	0.0032	0.0251	0.021	<0.001	-	0.16	0.000073	142	<0.001	0.0171	0.006	0.056	<0.0005	<0.005	75.9	0.701	-	<0.001	0.0793	-	13.2	0.00166	-	0.000026
2015	BOS8C<09AUG15	BOS8	-	-	-	0.0167	0.118	5.62	<0.02	<0.001	-	0.6	0.000061	346	<0.001	1.35	0.0021	0.031	<0.0005	0.0758	122	0.465	-	0.0056	3.98	-	31.8	0.00884	-	0.000031
2016	BOS8C-12JUN16	BOS8	-	-	-	0.541	0.0353	0.739	<0.02	<0.001	-	0.17	0.0000366	210	0.0136	0.82	0.0058	1.62	0.00061	0.0425	51.9	0.312	-	0.0025	1.03	-	11.8	0.00216	-	0.000163
2015	BOS8C-24AUG15	BOS8	-	-	-	0.021	0.0102	0.116	0.033	<0.001	-	0.22	0.0000753	185	<0.001	0.167	0.0021	0.059	<0.0005	0.0299	34	0.24	-	0.0016	0.344	-	15.1	0.00464	-	0.000028
2014	BOS8C-28AUG14	BOS8	-	-	-	0.0216	0.00317	0.0272	0.021	<0.001	-	0.14	0.000018	155	<0.001	0.0105	0.0041	0.054	<0.0005	<0.005	91	0.299	-	<0.001	0.132	-	12.7	0.00084	-	<0.00002
2015	BOS8C-29JUN15	BOS8	-	-	-	0.0285	0.0113	0.154	0.027	<0.001	-	0.26	0.0000601	157	<0.001	0.178	0.0021	0.521	<0.0005	0.0248	33.4	0.256	-	0.0032	0.302	-	12.8	0.00218	-	0.000065
2016	BOS8D-12JUN16a	BOS8	-	-	-	0.116	0.03	0.534	<0.02	<0.001	-	0.18	0.0000159	188	0.0026	0.431	0.005	0.298	<0.0005	0.0417	48.3	0.131	-	0.003	0.523	-	11	0.00167	-	0.000073
2016	BOS8D-12JUN16b	BOS8	-	-	-	1.24	0.0291	0.56	0.021	<0.001	-	0.18	0.0000261	186	0.0284	0.436	0.0091	4.49	0.00174	0.042	49.3	0.257	-	0.003	0.536	-	10.9	0.00159	-	0.000221
2017	BOS8A<04JUN	BOS-8A	<0.00050	0.0044	<0.000060	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2017	2017-BOS<001	2017-BOS<001	<0.00050	0.0056	0.00016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2017	17-BOS<02	BOS-8B	0.00142	0.0028	<0.00030	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2017	17-BOS<03	17-BOS<03	0.00076	0.0407	<0.00030	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	18-BOS<01	BOS8	<0.0005	0.0017	<0.00006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0155	-	-	-	-
2018	18-BOS<01	BOS8	<0.0005	0.0027	<0.0003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0384	-	-	-	-
2018	18-BOS<02	18-BOS<02	0.0009	0.002	<0.0003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0507	-	-	-	-
2018	18-BOS<03	18-BOS<03	<0.0005	0.0292	<0.0003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0213	-	-	-	-
2019	BOS8A	BOS-8A	-	-	-	0.0090	0.00401	0.0471	0.025	<0.0001		0.10	0.0000222	136	<0.001	0.0244	0.0032	0.089	<0.0005	0.0068	49.5	0.0286		0.0012	0.0979		6.4	0.000411		<0.00002
2019	19-BOS<01	19-BOS<01	0.00128	0.0024	<0.0003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2019	19-BOS<02	18-BOS<02	<0.0005	<0.001	<0.0003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2020	BOS8A	BOS8A	<0.0005	0.0021	<0.0002	0.4180	0.00264	0.0608	<0.02	<0.0001	-	<0.1	0.0000179	26	0.0055	0.0280	0.0071	1.020	0.00114	0.0020	9.2	0.0505	-	<0.001	0.0720	-	-2.0	0.000188	-	0.000036
2020	BOS8C	BOS8C	0.00072	<0.001	<0.0002	0.588	0.0321	0.663	<0.02	<0.0001	-	0.13	0.0000157	114	0.0153	0.356	0.0041	1.39	0.00074	0.0243	29.6	0.112	-	0.0025	0.46	-	8	0.00124	-	0.000032
2020	BOS8D	BOS8D	<0.0005	0.0015	<0.0002	0.944	0.00506	0.121	<0.02	<0.0001	-	<0.1	0.0000279	38.8	0.0118	0.0302	0.0101	1.79	0.00228	0.008	9.81	0.0483	-	0.0019	0.0553	-	2.5	0.000379	-	0.000081
2021	BOS8A	BOS8A	<0.00050	0.0018	<0.00030	0.1340	0.00388	0.0478	0.010	<0.000020	<0.000050	0.06	0.0000365	98	0.00119	0.0561	0.0060	0.105	0.000155	0.0049	36.3	0.0534		0.0007	0.1760	<0.050	4.0	0.000451	1.41	0.000016
2021	BOS8B	BOS8B	0.00111	0.0053	<0.00030	0.166	0.0278	1.52	0.00709	<0.000020	<0.000050	0.142	0.0000165	68.3	0.00262	0.147	0.001	0.185	0.000275	0.0129	25.7	0.0294		0.00188	0.205	<0.050	6.14	0.00118	1.62	<0.000010
2021	BOS8D	BOS8D	0.00056	0.001	<0.00030	1.3100	0.02820	0.5940	0.025	<0.000020	<0.000050	0.18	0.0000101	179	0.0286	0.4260	0.0039	1.470	0.00144	0.0388	45.6	0.1120		0.0029	0.4890	<0.050	9.4	0.002030	3.66	0.000045

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Year	Sample Code	Station Code	Sodium (Na)-Total	Strontium (Sr)-Total	Thallium (Tl)-Total	Tin (Sn)-Total	Titanium (Ti)-Total	Uranium (U) Total	Vanadium (V)-Total	Zinc (Zn)-Total
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
			0.05	0.0002	0.00001	0.0001	0.0003	0.00001	0.0005	0.001
2008	2008-BOS<001	2008-BOS<001	86.5	0.782	<0.0002	<0.0002	0.024	0.000173	0.0032	0.0037
2008	2008-BOS<003	2008-BOS<003	59	0.619	0.05	0.05	0.002	-	0.002	0.103
2008	BOS-8	BOS-8A	-	-	-	-	-	-	-	-
2008	BOS-8A	BOS-8A	59	0.619	0.05	0.05	0.002	-	0.002	0.103
2008	BOS-8A	BOS-8A	-	-	-	-	-	-	-	-
2008	BOS-8A	BOS-8A	69	0.694	0.0001	0.0004	0.013	0.0002	0.0075	0.099
2008	BOS-8A	BOS-8A	65	0.64	0.0001	0.0004	0.005	0.0003	0.002	0.008
2009	BOS-8A	BOS-8A	18.5	-	0.0001	0.05	0.0018	0.00028	0.0017	0.0071
2009	BOS-8A	BOS-8A	102	-	0.0001	0.05	0.0052	0.00015	0.0045	0.0318
2010	BOS-8A	BOS-8A	-	-	0.0001	0.05	0.0029	0.00018	0.0017	0.0049
2011	BOS-8A	BOS-8A	37	-	0.0001	0.05	0.001	0.00011	0.001	0.0068
2011	BOS-8A	BOS-8A	51.4	-	0.00005	0.0001	0.00066	0.000047	0.00021	0.0038
2012	BOS-8A	BOS-8A	11.9	-	0.0001	0.05	0.0029	0.00011	0.001	0.0042
2013	BOS-8A	BOS-8A	40.5	-	0.0001	0.05	0.0036	0.00058	0.0021	0.0079
2008	BOS-8B	BOS-8B	96	0.53	0.0001	0.0004	0.005	0.0002	0.0015	0.009
2009	BOS-8B	BOS-8B	36.5	-	0.0001	0.05	0.001	0.0001	0.001	0.0063
2009	BOS-8B	BOS-8B	180	-	0.0001	0.05	0.001	0.0001	0.0011	0.0091
2010	BOS-8B	BOS-8B	-	-	0.0004	0.05	0.0024	0.0004	0.002	0.016
2011	BOS-8B	BOS-8B	40	-	0.0001	0.05	0.0032	0.0001	0.001	0.0055
2011	BOS-8B	BOS-8B	54.7	-	0.00005	0.0001	0.00044	0.00002	0.00016	0.0055
2012	BOS-8B	BOS-8B	16	-	0.0001	0.05	0.001	0.0001	0.001	0.0057
2008	BOS-8C	BOS-8C	174	5.83	0.001	0.004	0.05	0.001	0.006	0.04
2009	BOS-8C	BOS-8C	11.1	-	0.0001	0.05	0.108	0.00011	0.0373	0.0717
2011	BOS-8C	BOS-8C	22.9	-	0.0001	0.05	0.0012	0.0001	0.001	0.004
2011	BOS-8C	BOS-8C	48.9	-	0.00005	0.0001	0.0003	0.00001	0.00011	0.003
2012	BOS-8C	BOS-8C	9.1	-	0.0001	0.05	0.0011	0.0001	0.001	0.0099
2014	BOS8-16JUN14a	BOS8	14.2	-	<0.0002	<0.0005	0.011	<0.0002	<0.001	<0.005
2014	BOS8-16JUN14b	BOS8	42	-	<0.0002	<0.0005	0.011	<0.0002	<0.001	<0.005
2014	BOS8-16JUN14c	BOS8	4.6	-	<0.0002	<0.0005	<0.01	<0.0002	<0.001	<0.005
2014	BOS8-23JUN14a	BOS8	26.5	-	<0.0002	<0.0005	0.014	0.00035	<0.001	0.0064
2014	BOS8-23JUN14b	BOS8	48.3	-	<0.0002	<0.0005	0.013	<0.0002	<0.001	<0.005
2014	BOS8-23JUN14c	BOS8	50.9	-	<0.0002	<0.0005	0.018	<0.0002	<0.001	0.0071
2014	BOS8-31JUL14	BOS8	44.4	-	<0.0002	<0.0005	0.019	0.00042	<0.001	0.0053
2015	BOS8A<09AUG15	BOS8	23.5	-	<0.0002	<0.0005	<0.01	<0.0002	<0.0005	0.0077
2016	BOS8A-12JUN16	BOS8	30	-	<0.0002	<0.0005	<0.01	0.00034	<0.0005	<0.005
2015	BOS8A-24AUG15	BOS8	53.7	-	<0.0002	<0.0005	<0.01	0.00062	0.00052	<0.005
2015	BOS8A-29JUN15	BOS8	32.6	-	<0.0002	<0.0005	<0.01	0.00024	<0.0005	<0.005
2014	BOS8A-31JUL14	BOS8	55.9	-	<0.0002	<0.0005	0.016	0.00067	<0.001	0.0053
2015	BOS8C<09AUG15	BOS8	46.6	-	<0.0002	<0.0005	<0.01	0.0003	0.0037	<0.005
2016	BOS8C-12JUN16	BOS8	28.2	-	<0.0002	<0.0005	0.011	0.00025	0.00394	<0.005
2015	BOS8C-24AUG15	BOS8	43.3	-	<0.0002	<0.0005	<0.01	<0.0002	<0.0005	0.0068
2014	BOS8C-28AUG14	BOS8	67.9	-	<0.0002	<0.0005	0.017	0.00042	<0.001	<0.005
2015	BOS8C-29JUN15	BOS8	28.7	-	<0.0002	<0.0005	<0.01	<0.0002	<0.0005	0.0051
2016	BOS8D-12JUN16a	BOS8	26.1	-	<0.0002	<0.0005	<0.01	0.00027	0.00138	0.0213
2016	BOS8D-12JUN16b	BOS8	25.8	-	<0.0002	<0.0005	0.02	0.00027	0.00691	0.0322
2017	BOS8A<04JUN	BOS-8A	-	-	-	-	-	-	-	-
2017	2017-BOS<001	2017-BOS<001	-	-	-	-	-	-	-	-
2017	17-BOS<02	BOS-8B	-	-	-	-	-	-	-	-
2017	17-BOS<03	17-BOS<03	-	-	-	-	-	-	-	-
2018	18-BOS<01	BOS8	-	-	-	-	-	-	-	-
2018	18-BOS<01	BOS8	-	-	-	-	-	-	-	-
2018	18-BOS<02	18-BOS<02	-	-	-	-	-	-	-	-
2018	18-BOS<03	18-BOS<03	-	-	-	-	-	-	-	-
2019	BOS8A	BOS-8A	21.1		<0.00001	<0.0005	<0.01	<0.0002	0.00054	<0.005
2019	19-BOS<01	19-BOS<01	-	-	-	-	-	-	-	-
2019	19-BOS<02	18-BOS<02	-	-	-	-	-	-	-	-
2020	BOS8A	BOS8A	3.9	0.0572	<0.00001	<0.0005	<0.01	<0.0002	0.00169	0.0075
2020	BOS8C	BOS8C	12.4	0.694	<0.00001	<0.0005	<0.01	<0.0002	0.00347	<0.005
2020	BOS8D	BOS8D	5.5	0.185	<0.00001	<0.0005	<0.01	<0.0002	0.00375	0.0142
2021	BOS8A	BOS8A	13.5	0.239	<0.000010	<0.00010	<0.00120	0.000156	0.00065	0.0099
2021	BOS8B	BOS8B	5.25	0.34	<0.000010	<0.00010	<0.00270	0.000089	0.00199	0.0097
2021	BOS8D	BOS8D	19.3	1.11	<0.000010	<0.00010	<0.0108	0.000246	0.00660	0.0034

Appendix B 2021 Boston Ephemeral Streams Monitoring Memo

SRK Consulting (Canada) Inc.
1066 West Hastings Street, Suite 2200
Vancouver, BC V6E 3X2
Canada

+1 604 681 4196 office
+1 604 687 5532 fax

vancouver@srk.com
www.srk.com

Technical Memo

February 23, 2022

To	Nancy Duquet Harvey, Agnico Eagle Mines Ltd.
From	Amanda Schevers, SRK
Cc	Lisa Barazzuol, SRK
Subject	Results from the 2021 Ephemeral Streams Monitoring Program, Boston
Client	Agnico Eagle Mines Ltd.
Project	1CT022.073

1 Introduction

At the Boston site, ore and waste rock were generated as part of a 1996-1997 BHP Billiton underground exploration program. The ore was placed in several stockpiles on the camp pad and the waste rock was used to construct a camp pad, roads, and an airstrip at Boston. The monitoring of ore/waste rock and associated runoff were defined in Water License 2BB-BOS1727 (Nunavut Water Board (NWB) 2017) and are referenced in the Hope Bay Project *Water and Ore/Waste Rock Management Plan for the Boston Site* (SRK 2017).

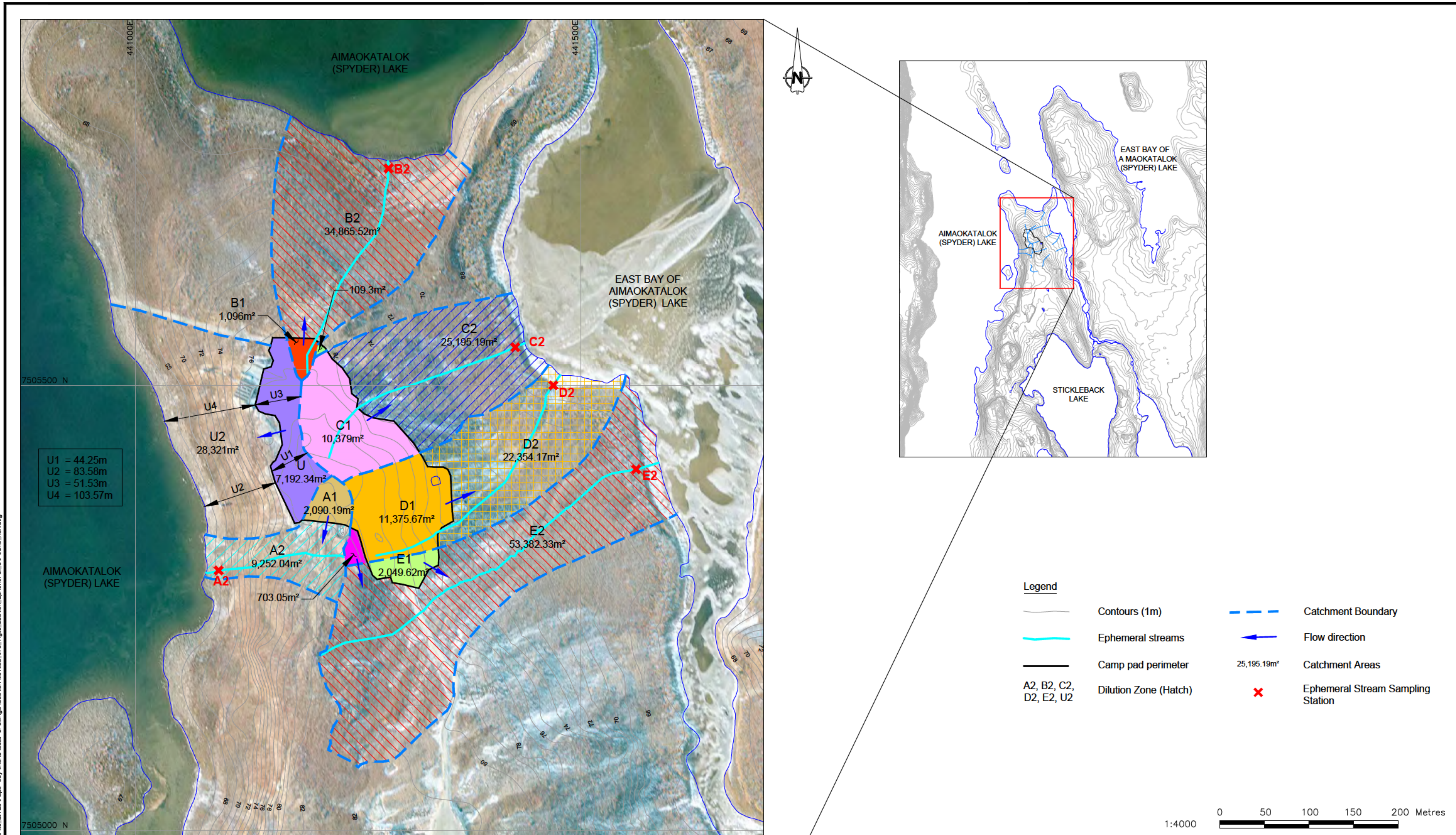
As recommended in the Hope Bay Project *Water and Ore/Waste Rock Management Plan for the Boston Site* (SRK 2017), ephemeral streams downgradient of the waste rock pile have been sampled during spring freshet since 2009 to monitor drainage downgradient of seepage from the Boston camp pad and to provide an indication of whether contaminants of potential concern from ore and waste rock piles are reaching the shoreline of Aimaokatalok Lake. This memo presents the results of the 2021 ephemeral streams monitoring program.

2 Methods

2.1 Sample Collection

Five ephemeral stream sites were identified in 2009, as shown in Figure 1. Agnico Eagle Mines (AEM) surveyed each stream for flow on June 28, 2021. Flow was observed at stations A2 and C2 only.

Field measurements included pH, electrical conductivity (EC), oxidation-reduction potential (ORP), temperature, and flow rate at stations A2 and C2. AEM collected and submitted water quality samples from stations A2 and C2 for laboratory testing to ALS Environmental (ALS) in Burnaby, British Columbia for pH, EC, hardness, total suspended solids, acidity, total alkalinity, anions (bromide, chloride, fluoride, and sulphate), nutrients (nitrate, nitrite, ammonia, and phosphorus), and dissolved metals (filtered and preserved in the field). The quality assurance and quality control (QA/QC) sampling program included the collection of one field duplicate and one field blank.



srk consulting

SRK JOB NO.: 1CT022.073

FILE NAME: 1CT022_073_fig01_Boston_Ephemeral_Streams_Mon.dwg

AGNICO EAGLE

Hope Bay Gold Project

2021 Ephemeral Streams Monitoring

Ephemeral Stream Monitoring Locations
Boston Area

DATE:	APPROVED:	FIGURE:
March 2021	AJS	1

2.2 Quality Assurance and Quality Control

Standard quality control checks were conducted on the ALS laboratory data as per SRK (2019) which describes SRK's expectations for laboratory geochemical data quality. One field duplicate (BOS-DUP, a duplicate of 21-EPH-A2) and one field blank were analyzed. Quality control checks and results are shown in Table 1. All data passed the QC checks and SRK accepted all data as reported.

Table 1: Summary of Quality Control Checks on Laboratory Data

QC Test	SRK QC Criteria	Results
Physical Test		
Field Blank (n=1)	Minimum criteria is <2X DL, will accept <5X DL	All passed.
Method Blank (n=1) for TSS, TDS, Total Alkalinity, Acidity (as CaCO3) and Conductivity	<2X DL	All passed.
Field Duplicate (n=1)	For samples >10X DL should be within +/-30% RPD	All passed.
Lab Duplicate (n=1) for TSS, TDS, Total Alkalinity, Acidity (as CaCO3) and Conductivity	For samples >10X DL should be within +/-20% RPD	All passed.
Field pH vs. Lab pH (n=0)	Difference should not be greater than 1 pH unit	All passed.
Field EC vs Lab EC (n=0)	For samples > 10X the detection limit (DL), % RPD should be within +/-30%	All passed.
Laboratory Control Samples (n=1) for TSS, TDS, Total Alkalinity, Acidity (as CaCO3), pH and Conductivity	Within specified tolerance ranges.	All passed.
Anions and Nutrients		
Field Blank (n=1)	Minimum criteria is <2X DL, will accept <5X DL	All passed.
Method Blank (n=1) for Total Ammonia, Total P, Br, Cl, F, NO3, NO2 and Sulfate (as SO4)	<2X DL	All passed.
Field Duplicate (n=1)	For samples >10X DL should be within +/-30% RPD	All passed.
Lab Duplicate (n=1) for Total Ammonia, Total P, Br, Cl, F, NO3, NO2 and Sulfate (as SO4)	For samples >10X DL should be within +/-20% RPD	All passed.
Ion Balance (n=2)	EC>100 uS/cm, % difference should be within +/-10%	All passed.
Laboratory Control Samples (n=1) for Total Ammonia, Total P, Br, Cl, F, NO3, NO2 and Sulfate (as SO4)	Within specified tolerance ranges.	All passed.
Trace Metals by ICP-MS		
Field Blank (n=1) for Dissolved	Minimum criteria is <2X DL, will accept <5X DL	All passed.
Method Blank (n=1) for Dissolved	<2X DL	All passed.
Field Duplicate (n=1) for Dissolved	For samples >10X DL should be within +/-30% RPD	All passed.
Lab Duplicate (n=1) for Dissolved	For samples >10X DL should be within +/-20% RPD	All passed.
Total vs Dissolved Metals (n=0)	Total metals>dissolved metals. Total metals should be greater than dissolved metals, if not the % difference should be within +/-20%.	No total metals
Laboratory Control Samples (n=1) for Dissolved	Within specified tolerance ranges.	All passed.

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3 Results

3.1 Field Observations

Table 2 presents a comparison of 2021 field parameters at A2 and C2 and the historic field data set. Field pH values were circumneutral. Field EC at C2 (660 µS/cm) was higher than A2 (240 µS/cm). The ORP value at A2 (370 mV) was 1.3 times greater than the historic high in 2014. All other field parameters are within the historical ranges. The flow rate at A2 was too low to quantify.

Table 2: Historic Field Observations (2009-2020)

Ephemeral Stream			Field pH	Field EC	ORP	Temperature	Flow
			s.u.	*µS/cm*	*mV*	*°C*	*L/s*
EPH-A2	Sample Year	2021	7.5	240	370	10	N/A
	Statistic	P5	7.5	130	34	4.2	0.053
		P50	7.8	260	110	10	0.074
		P95	8.1	570	260	18	0.39
		Sample Count	8	8	8	8	4
EPH-C2	Sample Year	2021	7.0	660	360	18	0.10
	Statistic	P5	6.5	96	70	2.7	0.30
		P50	7.2	820	150	13	2.0
		P95	7.5	1,100	340	20	5.4
		Sample Count	12	12	12	12	5

Source: \\van-svr0.van.na.srk.ad\projects\01_SITES\Hope.Bay\1CT022.073_2021 Geochem Compliance\!080_Deliverables\2021 Boston Annual Report\Ephemeral_Streams_Memo\Working_File\[1CT022.056-230_2020EphemeralStreams_Working_Rev04_AJS.xlsx]

3.2 Laboratory Results

A summary of water quality results for 2021 is provided in Table 3 and complete results are presented in Attachment 1. Parameters identified by SRK (2009) as potential parameters of concern are presented in Figure 2 to Figure 9. Values below the detection limit are graphed as equal to the detection limit. Lines are included in the figure for ease of trend identification; however, ephemeral stream flow paths and therefore sample locations can vary from year to year.

A summary of the 2021 water quality data at A2 and C2 is as follows:

- Sulphate concentrations were 37 and 230 mg/L at A2 and C2, respectively and were within the range of historical concentrations observed in previous years (Figure 2). Since 2009, sulphate concentrations have oscillated at A2 and C2.

- Chloride concentrations were 10 and 22 mg/L at A2 and C2, respectively and were within the historical range of concentrations. Chloride concentrations for ephemeral streams have exhibited a decreasing trend (Figure 3).
- Copper concentrations (0.0014 and 0.0021 mg/L at A2 and C2, respectively) were within the range of historical data (Figure 4). Overall, copper concentrations have been relatively stable.
- Nitrate concentrations were below the detection limit (0.005 mg/L) at A2 and C2. Nitrate concentrations have oscillated at A2 and have generally decreased at C2 since 2009 (Figure 5).
- Arsenic concentrations were within the range of historical concentrations at A2 (0.040 mg/L) and C2 (0.0028 mg/L). Overall, arsenic concentrations at A2 and C2 have remained stable since 2009 (Figure 6).
- Iron concentrations at A2 and C2 were within the range of historical data (0.034 and 0.042 mg/L, respectively) (Figure 7). Overall, iron concentrations at A2 and C2 have oscillated since 2009.
- Nickel concentrations (0.018 to 0.0089 mg/L at A2 and C2, respectively) (Figure 8) were stable and within the range of historical data. Nickel concentrations have oscillated since 2009.
- Selenium concentrations (Figure 9) were 0.00011 and 0.00015 mg/L for A2 and C2, respectively and were within the range of historical data. Values have remained stable since 2012.
- Concentrations of the remaining dissolved metals presented in Table 3 were within the range of historical data.

Table 3: Comparison of Selected Water Quality Results from 2021 and Historical Ephemeral Streams Samples

Sample ID		General Parameters			Anions and Nutrients					Dissolved Metals								
		pH	EC	TSS	Total Alkalinity	Ammonia	Nitrate	Sulphate	Chloride	Aluminum	Arsenic	Cadmium	Copper	Iron	Lead	Nickel	Selenium	Zinc
		s.u.	µS/cm	mg/L	mg/L as CaCO3	mg/L as N	mg/L as N	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2021 Samples																		
21-EPH-A2		8.0	230	<3	66	0.0099	<0.005	37	10	0.0052	0.04	<0.000005	0.0014	0.034	<0.00005	0.018	0.00011	0.0011
21-EPH-C2		7.8	640	<3	71	0.013	<0.005	230	22	0.014	0.0028	0.000011	0.0021	0.042	<0.00005	0.0089	0.00015	0.0052
Historic Ephemeral Streams Data																		
A2	P5	7.8	220	3.0	35	0.0050	0.00034	25	22	0.0033	0.0088	0.00001	0.00093	0.010	0.00005	0.0039	0.00010	0.0003
A2	P50	7.9	420	3.0	48	0.0071	0.035	39	45	0.0091	0.022	0.000005	0.0015	0.0005	0.00005	0.0092	0.0000015	0.0018
A2	P95	8.0	720	5.2	66	0.012	0.41	180	160	0.018	0.061	0.000010	0.0020	0.039	0.000089	0.017	0.00033	0.0027
A2	Maximum	8.0	740	5.9	67	0.013	0.47	240	180	0.020	0.075	0.000013	0.0022	0.052	0.0001	0.018	0.00046	0.0029
A2	Sample Count	8	8	6	8	8	8	8	8	8	8	8	8	8	8	8	8	8
C2	P5	7.3	180	3.0	32	0.012	0.025	32	17	0.012	0.00041	0.00005	0.0011	0.030	0.00005	0.0022	0.0010	0.0019
C2	P50	7.8	830	3.0	49	0.0099	0.26	230	64	0.014	0.0023	0.0000078	0.0018	0.023	0.00005	0.0079	0.00014	0.0019
C2	P95	8.0	1,100	100	71	0.065	2.2	370	180	0.020	0.028	0.000016	0.0025	0.11	0.000062	0.010	0.0010	0.0047
C2	Maximum	8.0	1,100	150	78	0.083	3.0	400	200	0.021	0.055	0.000020	0.0025	0.12	0.0002	0.010	0.0018	0.0071
C2	Sample Count	11	9	7	12	12	12	12	12	12	12	12	12	12	12	12	12	12

Source: \\van-svr0.van.na.srk.ad\projects\01_SITES\Hope.Bay\1CT022.073_2021 Geochem Compliance\!080_Deliverables\2021 Boston Annual Report\Ephemeral_Streams_Memo\Working_File\[1CT022.056-230_2020EphemeralStreams_Working_Rev04_AJS.xlsx]

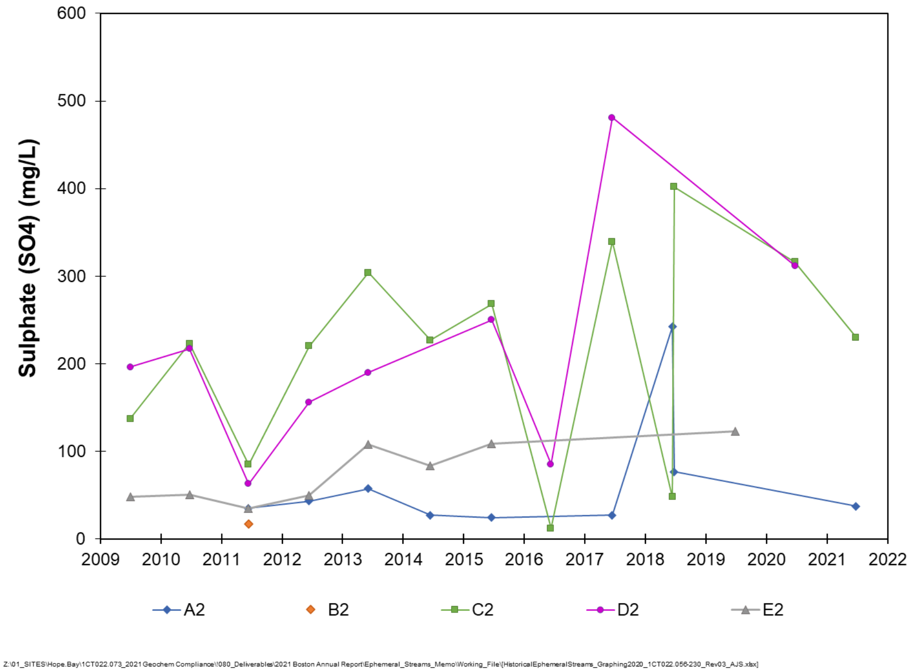


Figure 2: Ephemeral streams sulphate concentrations

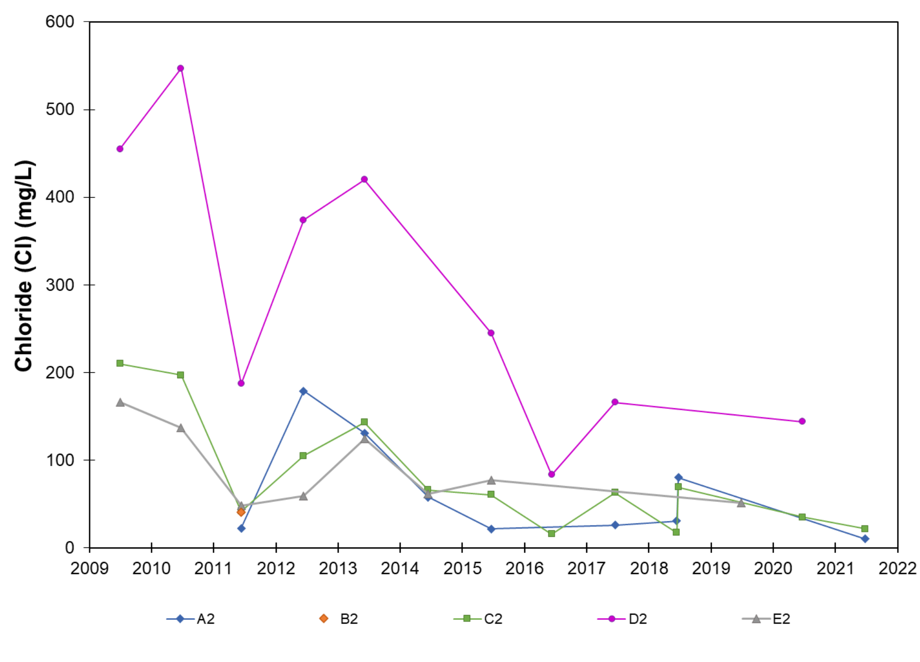


Figure 3: Ephemeral streams chloride concentrations

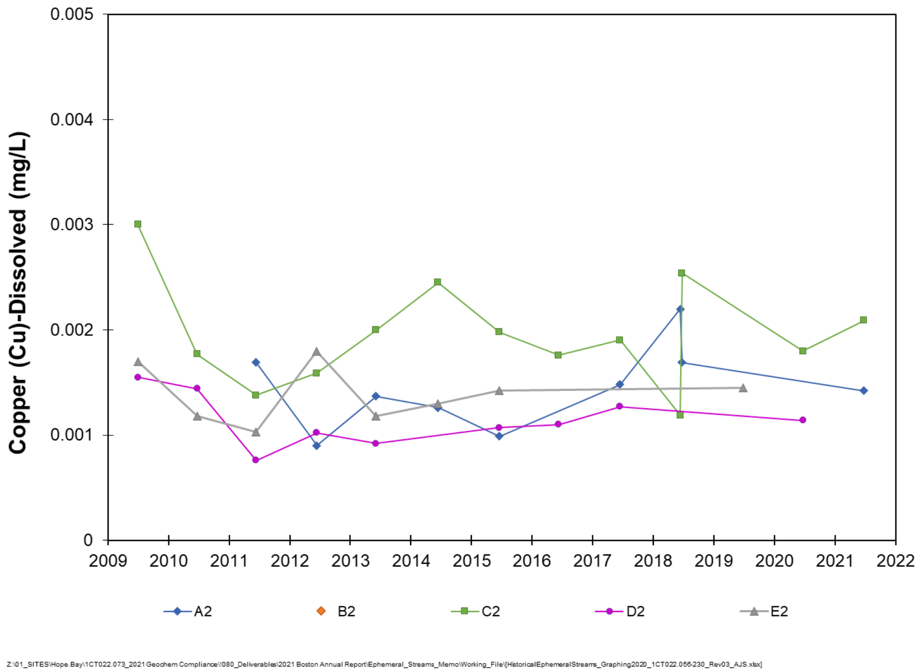


Figure 4: Ephemeral streams copper concentrations

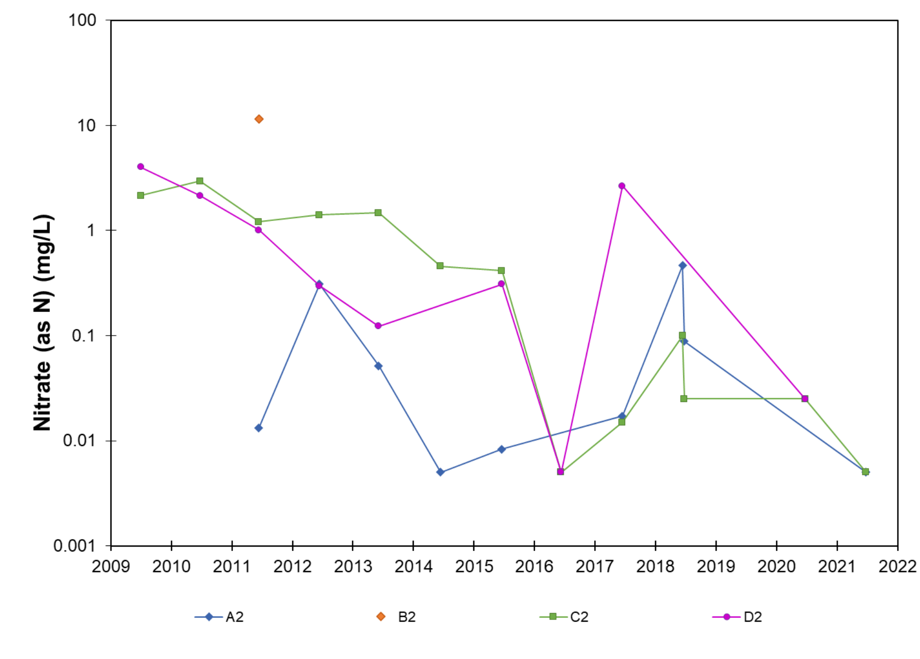


Figure 5: Ephemeral streams nitrate concentrations

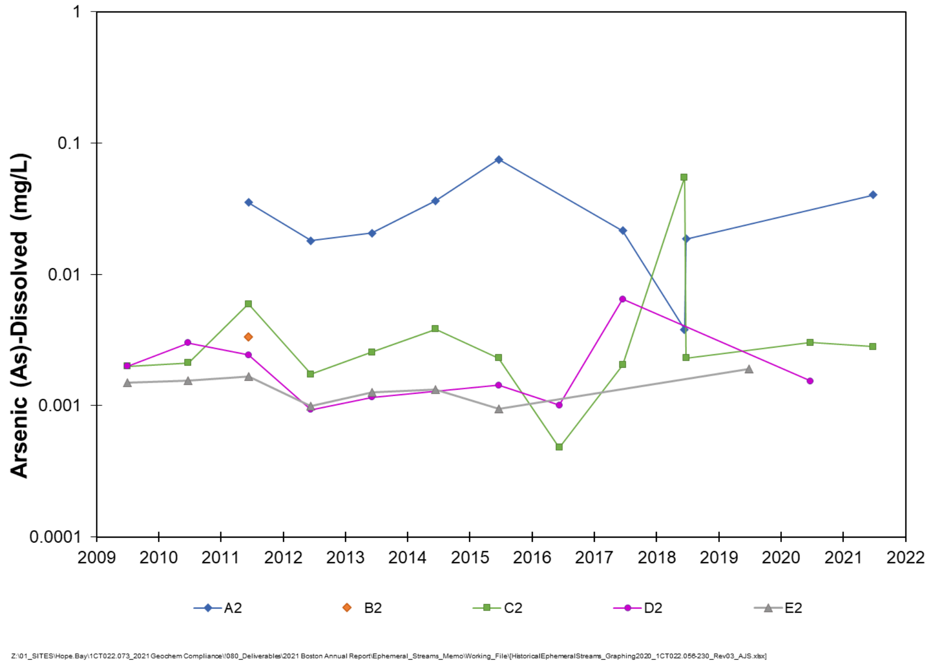


Figure 6: Ephemeral streams arsenic concentrations

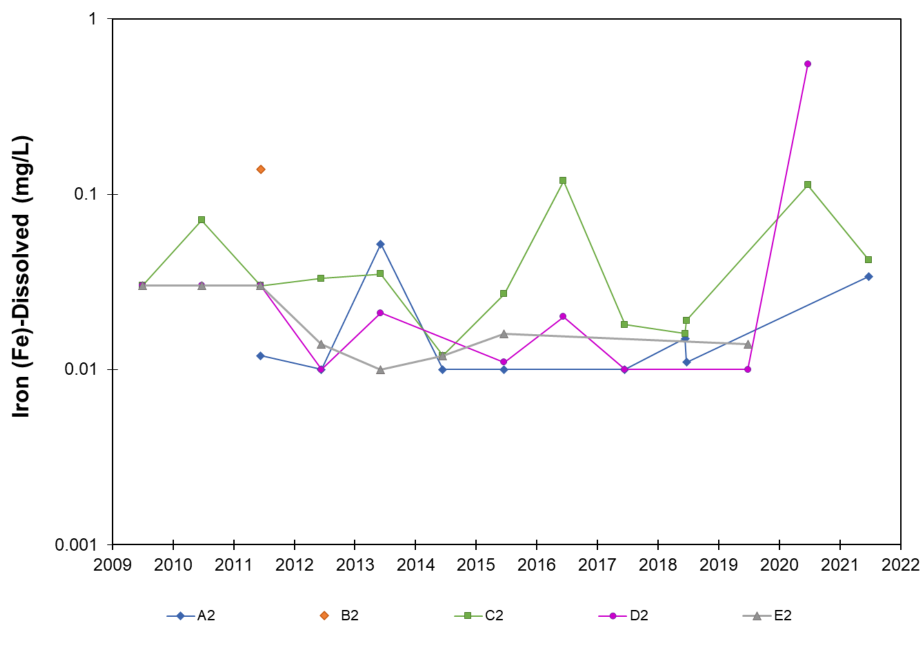


Figure 7: Ephemeral streams iron concentrations

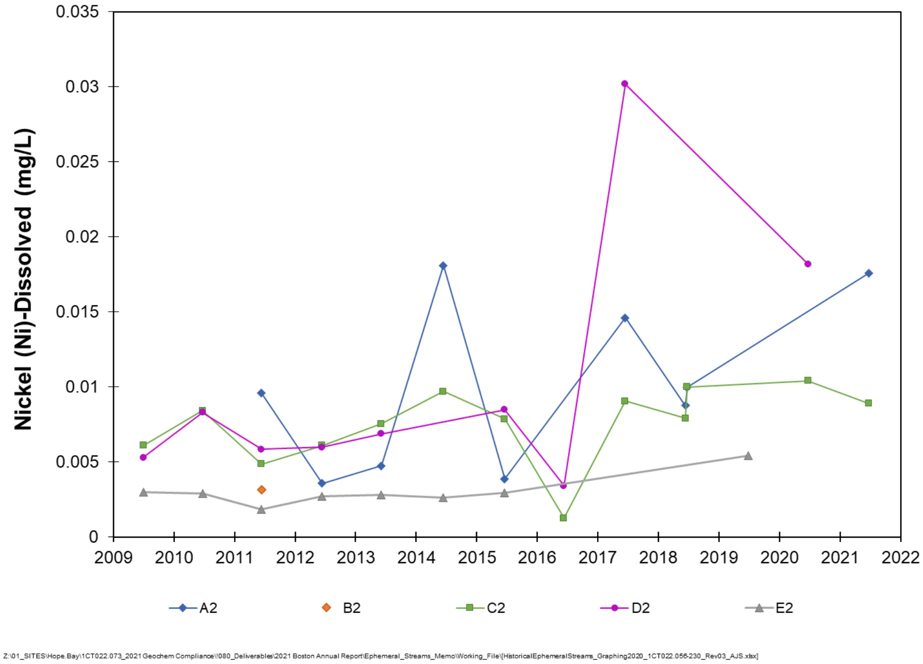


Figure 8: Ephemeral streams nickel concentrations

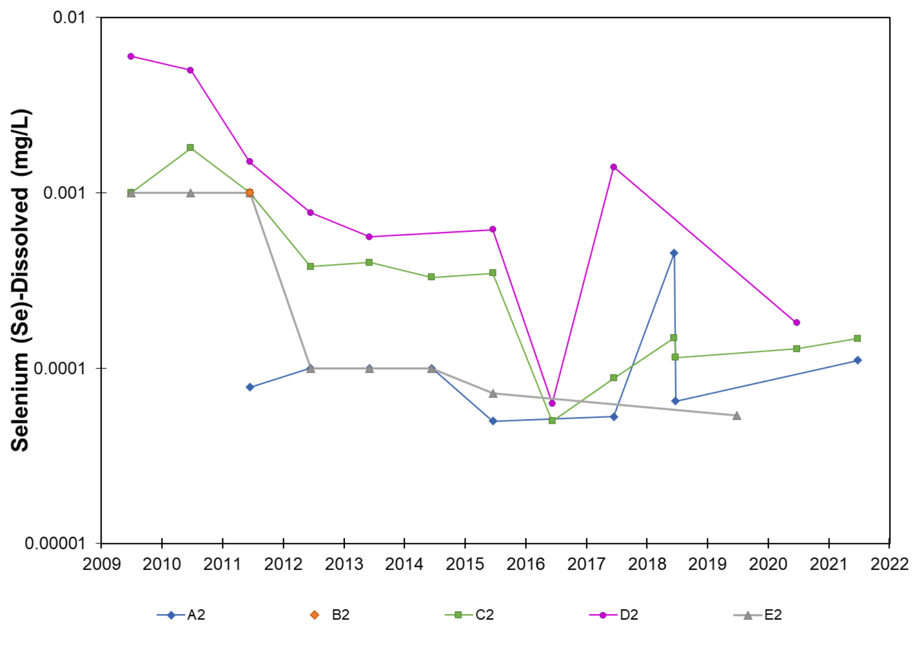


Figure 9: Ephemeral streams selenium concentrations

4 Discussion

As part of the closure plan study for Boston, seepage water quality estimates were input into a water and load balance to assess drainage from the camp pad. The results are documented in *Supporting Document B* of the 2009 *Boston Water and Ore/Waste Rock Management Plan* (SRK 2009). *Supporting Document B* documents the calculated average and maximum estimated concentrations of sulphate, chloride, nitrate, arsenic, copper, iron, nickel, and selenium in ephemerals streams related to weathering of the ore stockpile. Table 4 presents these model predictions for the ephemeral streams compared to the 2021 concentrations of these parameters.

At C2, sulphate concentrations observed in 2021 exceeded the maximum modeled value; however, concentrations are lower than 2018 and 2020 and within the same order of magnitude as the modeled values.

All other 2021 monitoring data were below maximum predicted values at streams A2 and C2.

Table 4: Comparison of 2021 Water Quality Results to Model Predictions (SRK 2009)

Parameters	Units	Predicted Value		Max Predicted Value		2021 Measured Values	
		A2	C2	A2	C2	A2	C2
Chloride	mg/L	95	144	357	559	10	22
Nitrate (as N)	mg/L	3.4	5.4	9.2	15	<0.005	<0.005
Sulphate	mg/L	70	110	120	190	37	<u>**230**</u>
Arsenic	mg/L	0.03	0.048	0.063	0.1	<u>0.04</u>	0.0028
Copper	mg/L	0.0026	0.0026	0.0033	0.004	0.0014	0.0021
Iron	mg/L	0.41	0.43	0.89	1.2	0.034	0.042
Nickel	mg/L	0.095	0.15	0.32	0.51	0.018	0.0089
Selenium	mg/L	0.0015	0.0021	0.0035	0.0053	0.00011	0.00015

Source: \\van-svr0.van.na.srk.ad\projects\01_SITES\Hope.Bay\1CT022.073_2021 Geochem Compliance\!080_Deliverables\2021 Boston Annual Report\Ephemeral_Streams_Memo\Working_File\[1CT022.056-230_2020EphemeralStreams_Working_Rev04_AJS.xlsx]

Notes:

Underlined values indicate measured values greater than the predicted value, and bolded values indicate measured values greater than the maximum predicted value

5 Conclusions and Recommendations

Nitrate, sulphate, arsenic, copper, iron, nickel, and selenium were identified by the water and load balance as potential contaminants of concern (SRK 2009) related to weathering of ore stockpiles at Boston. Monitoring of ephemeral streams A2, B2, C2, D2, and E2 was initiated in 2009 to validate the water and load balance and therefore, ore and waste rock management plan for the Boston Site (SRK 2017). In 2021, flow was observed, and samples collected on June 28 from ephemeral streams A2 and C2. Field parameters at A2 and C2 were not collected in 2021.

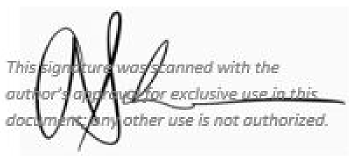
Field pH values were 7.0 to 7.5 and were within the range of historical data. The flowrate at C2 was within historical flow rates and the flow rate at A2 was too low to quantify.

Sulphate, nickel, and iron concentrations have oscillated since 2009 at A2 and C2. Chloride concentrations for ephemeral streams exhibit a decreasing trend. Copper, arsenic, and selenium have stable trends. Nitrate concentrations at A2 have oscillated and have generally decreased at C2 since 2009.

Compared to SRK (2009) model predictions, the 2021 monitoring data were below maximum predicted values for chloride, nitrate, arsenic, copper, iron, nickel, and selenium at streams A2 and C2 and sulphate at A2. At C2, sulphate concentrations observed in 2021 exceeded the maximum modeled values; however, concentrations were lower than 2020 and within the same order of magnitude as the modeled values.

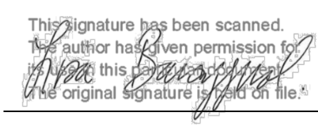
Sulphate and chloride are not attenuated by the tundra and the concentrations measured in 2021 validate the 2009 water and load balance. In general, ephemeral streams monitoring indicates that overall, the geochemistry of the ephemeral streams remains stable with some annual variability. SRK recommends continued monitoring of the ephemeral stream sampling sites as outlined in SRK (2017).

Regards,
SRK Consulting (Canada) Inc.



Amanda Schevers, GIT (BC)
Staff Consultant (Geochemistry)

Reviewed by



Lisa Barazzuol, PGeo (NT/NU)
Principal Consultant (Geochemistry)

Attachments:

Attachment 1 2021 Water Quality Results

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The opinions expressed in this document have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. While SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

References

Nunavut Water Board, 2017. Water Licence No: 2BB-BOS1727. July 2017.

SRK Consulting (Canada) Inc., 2009. Water and Ore/Waste Rock Management Plan for the Boston Site Hope Bay Project, Nunavut. Report 1CH008.022 for Hope Bay Mining Ltd. July 2009.

SRK Consulting (Canada) Inc., 2017. Water and Ore/Waste Rock Management Plan for the Boston Site, Hope Bay Project, Nunavut. Report 1CT022.009 for TMAC Resources Inc. January 2017.

SRK Consulting (Canada) Inc., 2019. Expectations for Laboratory Geochemical Data Quality. Internal Memo.

Attachment 1 2021 Water Quality Results

Sample			21-EPH-A2	21-EPH-C2	BOS-FB	BOS-DUP
Date			28-Jun-2021	28-Jun-2021	28-Jun-2021	28-Jun-2021
Time Sampled			13:45	14:40	13:45	13:45
Description of Location						Field duplicate of 21-EPH-A2
Field Measurements						
	Detection Limit	Unit				
pH		s.u.	7.5	7	-	-
Conductivity		µS/cm	240	660	-	-
ORP		mV	370	360	-	-
Temperature		ºC	10	18	-	-
Laboratory Measurements						
conductivity	2	µS/cm	229	636	2	228
acidity (as CaCO3)	2	mg/L	2.9	4.3	2.1	3.5
alkalinity, total (as CaCO3)	1	mg/L	66.1	71.2	1.7	64.8
hardness (as CaCO3), dissolved	0.6	mg/L	106	293	-0.6	104
pH	0.1	s.u.	7.99	7.82	6.88	7.98
solids, total suspended [TSS]	3	mg/L	-3	-3	-3	-3
ammonia, total (as N)	0.005	mg/L	0.0099	0.0132	-0.005	0.0117
bromide	0.05	mg/L	-0.05	-0.05	-0.05	-0.05
chloride	0.5	mg/L	9.98	21.6	-0.5	10
fluoride	0.02	mg/L	0.021	0.036	-0.02	0.021
nitrate (as N)	0.005	mg/L	-0.005	-0.005	-0.005	-0.005
nitrite (as N)	0.001	mg/L	-0.001	-0.001	-0.001	-0.001
phosphorus, total	0.002	mg/L	0.0135	0.0058	-0.002	0.0145
sulfate (as SO4)	0.3	mg/L	37.4	230	-0.3	37.3
aluminum, dissolved	0.001	mg/L	0.0052	0.0137	-0.001	0.0043
antimony, dissolved	0.0001	mg/L	0.0016	0.00094	-0.0001	0.00162
arsenic, dissolved	0.0001	mg/L	0.0403	0.00281	-0.0001	0.0394
barium, dissolved	0.0001	mg/L	0.00428	0.0219	-0.0001	0.00438
beryllium, dissolved	0.0001	mg/L	-0.0001	-0.0001	-0.0001	-0.0001
bismuth, dissolved	0.00005	mg/L	-0.00005	-0.00005	-0.00005	-0.00005
boron, dissolved	0.01	mg/L	0.047	0.07	0.034	0.046
cadmium, dissolved	0.000005	mg/L	-0.000005	0.0000105	-0.000005	-0.000005
calcium, dissolved	0.05	mg/L	28.7	66.2	-0.05	28
cesium, dissolved	0.00001	mg/L	-0.00001	-0.00001	-0.00001	-0.00001
chromium, dissolved	0.0005	mg/L	-0.0005	-0.0005	-0.0005	-0.0005
cobalt, dissolved	0.0001	mg/L	0.00077	0.00029	-0.0001	0.00076
copper, dissolved	0.0002	mg/L	0.00142	0.00209	-0.0002	0.00136
iron, dissolved	0.01	mg/L	0.034	0.042	-0.01	0.031
lead, dissolved	0.00005	mg/L	-0.00005	-0.00005	-0.00005	-0.00005
lithium, dissolved	0.001	mg/L	0.0048	0.0016	-0.001	0.0048
magnesium, dissolved	0.005	mg/L	8.43	31	0.0088	8.22
manganese, dissolved	0.0001	mg/L	0.00496	0.00998	0.00037	0.00513
mercury, dissolved	0.000005	mg/L	-0.000005	-0.000005	-0.000005	-0.000005
molybdenum, dissolved	0.00005	mg/L	0.000311	0.000314	-0.00005	0.000302
nickel, dissolved	0.0005	mg/L	0.0176	0.00889	-0.0005	0.0175
phosphorus, dissolved	0.05	mg/L	-0.05	-0.05	-0.05	-0.05
potassium, dissolved	0.05	mg/L	1.14	4.79	-0.05	1.13
rubidium, dissolved	0.0002	mg/L	0.00054	0.00237	-0.0002	0.00054
selenium, dissolved	0.00005	mg/L	0.000111	0.000148	-0.00005	0.000141
silicon, dissolved	0.05	mg/L	0.246	1.23	-0.05	0.223
silver, dissolved	0.00001	mg/L	-0.00001	-0.00001	-0.00001	-0.00001
sodium, dissolved	0.05	mg/L	4.56	17.6	0.37	4.48
strontium, dissolved	0.0002	mg/L	0.171	0.274	-0.0002	0.17
sulfur, dissolved	0.5	mg/L	11.8	79.1	-0.5	12
tellurium, dissolved	0.0002	mg/L	-0.0002	-0.0002	-0.0002	-0.0002
thallium, dissolved	0.00001	mg/L	-0.00001	-0.00001	-0.00001	-0.00001
thorium, dissolved	0.0001	mg/L	-0.0001	-0.0001	-0.0001	-0.0001
tin, dissolved	0.0001	mg/L	-0.0001	-0.0001	0.00025	-0.0001
titanium, dissolved	0.0003	mg/L	-0.0003	-0.0003	-0.0003	-0.0003
tungsten, dissolved	0.0001	mg/L	-0.0001	0.00047	-0.0001	-0.0001
uranium, dissolved	0.00001	mg/L	0.000017	0.000026	-0.00001	0.000017
vanadium, dissolved	0.0005	mg/L	-0.0005	-0.0005	-0.0005	-0.0005
zinc, dissolved	0.001	mg/L	0.0011	0.0052	-0.001	0.0056
zirconium, dissolved	0.0002	mg/L	-0.0002	-0.0002	-0.0002	-0.0002

Appendix H
Updated Management Plans

AGNICO EAGLE

Hope Bay Project
Groundwater Management Plan

Hope Bay, Nunavut

March 2022

Hope Bay Project Groundwater Management Plan

Plain Language Overview:

This Groundwater Management Plan describes how Agnico will manage and work to minimize water that flows into the mine to protect workers, the environment, and ensure the mine can keep operating.

Hope Bay, Nunavut

Publication Date: March 2022

Hope Bay Project
181 University Avenue
Suite 300, PO Box 33
Toronto, Ontario, M5H 3M7
Phone: 647-480-3106

Revisions

Revision #	Date	Section	Changes Summary	Author	Approver
00	June 2016	Entire Document	Initial Document	SRK	TMAC
01	August 2016	Section 2.2	Updated clarification of possible increased groundwater inflow to the mine		
		Section 6	Updated remedial stage actions for mine inflow management		
		Section 5.2	Updated water quality testing requirements		
		Section 2.3.1, Table 2 and Section 8	Addition of management response for mine inflows exceeding 3,000 m^3/day		
02	November 2017	Entire Document	Transfer to new template	SRK	TMAC
		Section 1	Updated this section to consider all mines, i.e., Doris, Madrid, and Boston mines. Added objective of avoiding taliks or subpermafrost where mining is planned to remain encapsulated in permafrost. Updated Table 1. Compiled in Table 3 the roles and responsibilities for this plan.		
		Module A	Corrected a typo error with the groundwater pumping rate expressed in m^3/quarter, in the SPT3 row.		
		Module B	Developed a specific MIMP for the Madrid mines		
		Module C	Developed a specific MIMP for the Boston mine		
03	March 2020	Section 2.1	Updated to include aspects of mine water treatment	TMAC	TMAC
04	March 2022	Throughout	Updated references to AEM, updated to consider current mining practices	AEM	AEM

Contents

Tables

Glossary

Term	Definition
ARD	Acid rock drainage
AEM	Agnico Eagle Mines
AEMP	Aquatic effects monitoring program
EC	Electrical conductivity
GWMP	Groundwater management plan
L/s	Litres per second
m^3/day	Cubic meter of water per day (equivalent to 1,000 litres per day)
MIMP	Mine inflow management program
MMER	Metal mining effluent regulations
NIRB	Nunavut impact review board
NWB	Nunavut water board
QA/QC	Quality assurance / quality control
RBDS	Roberts Bay Discharge System
SOP	Standard operating procedure
SPT	Specific performance thresholds
TIA	Tailings impoundment area
TDS	Total dissolved solids
TMAC	TMAC Resources Inc.
TSS	Total suspended solids
WAD	Weak acid dissociable
WMP	Water management plan
WTP	Water Treatment Plant

1 Introduction

This *Hope Bay Project Groundwater Management Plan* (the Plan) has been prepared by Agnico Eagle Mines (Agnico) in accordance with various water licences held by TMAC associated with developments throughout the Hope Bay region.

The Plan is intended primarily for use by TMAC and its contractors to ensure that best practices for minimizing potential environmental impacts and potential environmental liabilities with respect to groundwater management are followed, and that the conditions of water licences are met.

This Plan is structured in a manner such that one document pertaining to groundwater management is approved and implemented across all Agnico Hope Bay project sites, while still addressing site- and licence-specific needs: the main document outlines Agnico's approach to groundwater management as it pertains to all Agnico Hope Bay developments; subsequent modules provide details for each site and the associated water licence. In the event of a new water licence, or an existing licence amendment, only the specific modules pertaining to that licence and site will need to be revised. This is intended for consistency and efficiency across operations and for compliance management.

1.1 Objectives

The Hope Bay Project is being developed in permafrost, talik (i.e., unfrozen ground formed by lakes) and subpermafrost (i.e., the non-frozen ground below the permafrost). No groundwater interaction will be encountered in permafrost zones but mining in taliks or subpermafrost will result in groundwater inflows from defined geological features or open drill holes. The mine inflows will be made up of fresh water from lake infiltrations and hypersaline water from the surrounding rock, with a water quality dominated by high salinity, specifically chloride. Groundwater will be collected in underground sumps and pumped to surface, from where it will be discharged to a marine outfall diffuser in Roberts Bay, either directly, or via the Tailings Impoundment Area (TIA). The estimated mine inflows (quantity and quality) are not expected to cause safety concerns or environmental impacts. To ensure this, Agnico will actively manage and mitigate inflows to protect workers, the environment, and ensure the mine can keep operating. The objectives of the GWMP are to:

- Avoid taliks or subpermafrost in areas where mining is planned to remain encapsulated in permafrost;
- Minimize influence of mining in taliks on lake water levels; and
- Integrate the mine inflow volumes and chemistry, and resulting loading into the Water Management Plan (WMP).

This is accomplished by:

- Describing issues related to groundwater flow into the mines; and
- Outlining management responses, mitigations and adaptive management measures taken to protect workers and the environment, and to minimise operational impacts.

1.2 Relevant Legislation and Guidance

Table 1.1 provides a summary of federal and territorial regulations, and associated guidelines, governing the Hope Bay Groundwater Management Plan.

Table 1.1: List of federal and territorial regulations governing the Hope Bay Project Groundwater Management Plan

Regulation	Year	Governing Body	Relevance
Nunavut Mine Health and Safety Act (S.N.W.T, 1994, c.25)	1994	Government of Nunavut	Regulate the operations of underground mines, including the management of incoming water.
Mine Health Safety Regulations (R-125-95)	1995	Department of Justice of the Northwest Territories Government	
Nunavut Waters Regulations	2013	Nunavut Water Board (NWB)	License for mining and milling undertaking to use water and deposit of waste in relation to the construction, operation, closure and reclamation.
Environmental Protection Act	2011	Government of Nunavut (GN), Department of Environment (DOE), Environmental Protection division	Legislation to authorize discharge of water.
Environmental Rights Act	2011	GN, DOE, Environmental Protection division	Grants all residents the ability to launch an investigation.
Metal and Diamond Mining Effluent Regulations (SOR/2002-222)	2018	Federal Department of Fisheries and Oceans & Environment Canada	Outlines requirements for mine-related discharges.
Guideline	**Year**	**Governing Body**	**Relevance**
Canadian Environmental Quality Guidelines	1999	Canadian Council of Ministers of the Environment (CCME)	Provides guidance on water quality for the protection of aquatic life; both freshwater and marine.

1.3 Related Documents

Table 1.2 provides a summary of documents related to the Hope Bay Groundwater Management Plan.

Table 1.2. List of documents related to the Hope Bay Project Groundwater Management Plan

Document Title	Year	Relevance
Hydrogeological Modeling of the Proposed Doris North Project	June 2015	Documents the hydrogeological data and results of modelling designed to estimate inflows into the Doris underground mine during operations.
Doris North Project – Water and Load Balance	June 2015	Evaluation and predictions of water quantity and quality at the Doris North project, including alternative discharge scenarios for groundwater and TIA effluent.
Response to NRCan IR-3 & AANDC IR#13: Estimation of the Time Required for the Underground Mine to Fill	Dec. 2015	Provides an estimate of the time for reflooding the Doris underground mine once dewatering stops.
Appendix V3-4B issued for the FEIS of the Phase 2 Hope Bay Project.	Nov. 2017	Documents the hydrogeological data and results of modelling designed to estimate inflows into the Madrid and Boston underground mines during operations.
Hope Bay Project – Water and Load Balance	Nov. 2017	Evaluation and predictions of water quantity and quality at the Hope Bay project, including mining at Doris, Madrid, and Boston, as well as alternative discharge scenarios for groundwater and TIA effluent.
Hope Bay Project Doris and Madrid Water Management Plan	Mar. 2020	Describes the water management procedures including discharge from the TIA and associated water quality criteria.
Aquatic Effects Monitoring Plan	Oct. 2018	Describes the monitoring of the fisheries habitat.
Quality Assurance and Quality Control Plan	Mar. 2020	Sampling practices document that is reviewed and approved by the NWB.

1.4 Plan Management

This Plan is reviewed annually and updated as needed. Revisions can be triggered by activities such as changes in the mine plan, operational performance, personnel or organizational structure, mine ownership, regulatory or social considerations, and life cycle or design philosophy. Personnel responsible for implementing and updating the Plan are identified in Table 1.3.

Table 1.3. Roles and Responsibilities

Role	Responsibility
Mine General Manager	• Overall responsibility for and implementation of this management plan; • Provide the on-site resources to operate, manage, and maintain the groundwater management infrastructure, such as sumps, pumps, ponds and holding tanks; • Provide input on modifications to design and operational procedures to improve operational performance.
Mine Superintendent	• Conduct regular inspections of the groundwater management facilities such as sumps and audits of the maintenance records; • Responsible for tracking water movements from all underground sumps to the main underground sump • Responsible for contacting Dewatering Supervisor regarding the final destination of groundwater to surface (ie WTP, TIA) to ensure compliance with all licence requirements • ; • Report irregularities identified during visual inspections to Engineering as it relates to inflows and to the Maintenance Department as it relates to maintenance.
Mine Engineering Superintendent	• Maintain records of underground inflows and their locations • Track discrete underground inflows, their locations, and flow rates; • Plan and design underground infrastructure relating to collection and movement of groundwater. • Coordinate with the Maintenance Manager and Process Manager responsible for water movements between the various water management facilities to ensure compliance with all licence requirements; • Audit of groundwater management tracking records and all associated required reporting. • Understand water inflows resulting from mining activities through hydrogeological investigations • Mitigate impacts from water inflows resulting from mining activities such as implementation of grouting programs, monitoring diamond drill hole interceptions.
Environmental Superintendent	• Review and update this management plan as required • Collect water quality samples from sumps, backfilled stopes and WTP during periods of discharge; • Monitor water quality in the sumps (i.e. calcium chloride concentrations); • Maintain records of water quality sampling results.
Maintenance Superintendent	• Ensures dewatering supervisor provides direction to the mine regarding the destination of the groundwater at surface (ie WTP, TIA etc) to ensure compliance with all licence requirements • Conduct regular inspection of the piping and pumps associated with the water movement underground

2 Groundwater Management Issues

2.1 Mine Inflow Rates

The mine inflow rates may exceed the predicted inflows.

2.1.1 Management Action

Mine inflow thresholds are set for each mine, beyond which adaptive management needs to occur to mitigate increasing flow volume. Rates are reassessed as part of the annual review process of this Plan as understanding of the system increases.

Risk assessments are used to guide development plans, and control measures are put in place as outlined in Section 3. Management actions (i.e., control measures) are implemented based on a Mine Inflow Management Program (MIMP), as outlined in Section 4.

2.2 Mine Inflow Chemistry

The chemistry of discharged mine water may diverge from the predicted water quality.

2.2.1 Management Action

Operations induced water quality changes are managed to the extent practical. The use of calcium chloride is minimized to the extent possible in underground sumps and mine water is internally recycled for drilling purposes to reduce the amount of additional calcium chloride introduced to the mine.

Blasting practices are continuously reviewed to evaluate opportunities to reduce nitrates from blast residues in the mine water.

A series of long and shallow sumps (horizontal flow settlers) are utilized to aid in settling of coarse suspended solids. The system has been designed to act as primary treatment for coarse suspended solids prior to water being pumped to surface for secondary and tertiary treatment at the Water Treatment Plant.

Mine inflow quality is monitored in accordance with Section 5 of this Plan. If mine water discharge exceeds MDMER water quality criteria, discharge to Roberts Bay occurs via the TIA and/or with treatment.

Saline mine water may only be discharged together with tailings from, or within, 300 m of the South Dam provided the freezing point depression is less than 0.5°C. If the freezing point depression exceeds 0.5°C, saline mine water may be discharged with tailings at other designated tailings discharge points or directly into the Reclaim Pond.

2.3 Mine Discharge

The discharge rate from the mine may exceed the maximum acceptable inflow for a given period.

2.3.1 Management Action

The pumping designs comprise a primary set of pump(s) that can accommodate the design capacity, plus standby pump(s). Standby pump(s) are required to ensure that the full design capacity is available when pumps require servicing or when pumps have mechanical issues. As a result there is capacity to pump water in excess of the design capacity if necessary.

If groundwater pumping exceeds the maximum acceptable inflow into the mine for a prolonged period, the Nunavut Water Board is notified and the analyses and assessment described in the Aquatic Effects Monitoring Plan (AEMP) are carried out.

2.4 Lake Water Levels

The level of lakes located directly above underground mines may be affected by mining.

2.4.1 Management Action

Adaptive management strategies are implemented based on the MIMPs to limit the effects from mining to groundwater in taliks.

Lake water levels are monitored as outlined in the AEMP.

3 Inflow Control Measures

Potential inflow assessment and inflow control measures are put in place to anticipate and help limit the inflows from fractures, faults, or drill holes (referred to as “features” in the following discussion). These measures aim to:

- Protect worker health and safety;
- Prevent negative impacts due to mine inflow; and
- Provide improved working conditions for operations.

3.1 Risk Assessment

Risk assessments are used to guide development plans, with control measures worked into the mine schedule. Before planning a new development heading or any type of excavation, an assessment is made using the available information. Appropriate mitigation measures can be applied, if possible, before mining occurs (pre-grouting) or during mining activities (grouting being the main item in terms of adaptive management). Modifications to the mine design or the schedule can also be made when it is suspected that existing grouting capabilities won’t allow for proper control of suspected water inflows.

The data sources used as part of the risk assessment are updated regularly. Mining allows Agnico to continuously refine the 3D geology models of the mines and assess the probability of intercepting a significant water bearing structure.

The Diamond Drillhole Database (DDH) provides information about location, measured water inflow and status of grouting. The holes are displayed on all the development layouts issued by the Engineering department.

Hydrogeological studies are carried out as necessary to provide additional insight on the flow, flow direction, pressure regimen and to help identify recharge or drainage patterns. Water quality is also considered in these studies. Hope Bay documents the geological model and pertinent hydrogeological information in a Ground Control Management Document.

3.2 Inflow Control Measures

Inflow control measures such as grouting aim at plugging or significantly reducing the water flowing from a feature. As defined in the MIMP, they are meant to provide a response to a specific indicator.

These measures include:

- Probe drilling: In conformity with the Mine Health and Safety Act and Regulations, holes can be drilled prior to development when approaching an area with high water inflow potential. This precautionary measure will help inform further actions to mitigate the risk posed by sudden and incontrollable inflow. Potential actions being redesign of the excavation, change of location, pre-grouting or any combination of the three.
- Pre-grouting: Will be done based on probe holes results for larger areas like stopes or major infrastructures. Pre-grouting is also done on a smaller scale during lateral development when expecting significant inflow or mining in the vicinity of a known water bearing structure.
- Grouting: Grouting can be done post-excavation to control water inflow or to complement pre-grouting. Note that all water-making DDH are plugged (Margo plug) and then grouted.
- Isolation of the area: If deemed necessary, the appropriate strategy may be to isolate a specific area. In accordance with the Mine Health and Safety Act and Regulations, a suitable isolation barrier will be designed and constructed under the direction and guidance of a qualified engineer, with approval of the Mines Inspector.

4 Mine Inflow Management and Monitoring Program

The Mine Inflow Management Programs (MIMP) are decision-based frameworks specific to each mine aimed at preventing negative impacts from underground inflows; they complement the site Water Management Plans (Agnico 2022a). The MIMPs of the Doris, Madrid, and Boston mines are presented respectively in Module A, B and C.

4.1 Specific Indicators

Specific Indicators are used to assess performance of the system and trigger management actions. They are defined as:

Total Mine Inflow

- Daily flow measured at the main sump flow metering point.

Point Source Inflow

- Estimate of flow from a specific geological feature (structure/joint set) or drill hole; and
- Estimate of flow from a limited, specific mine area (i.e. heading or stope).

4.2 Specific Performance Thresholds

Specific Performance Thresholds (SPTs) are inflow rate-based decision points, triggering an escalating level of actions to manage the total mine discharge volumes and/or localised inflows. To ensure SPTs are appropriate, the inflows are measured such that the behaviour of the inflow system can be assessed as mining progresses and the SPTs are re-evaluated as part of the review process.

4.3 Specific Responses

Given that the mine inflow is expected to come from defined geological features or open drill holes in taliks, rather than dispersed inflow through the general rock mass, “Point Source” inflow monitoring is an important part of the continuing underground inflow characterisation as it relates to the understanding of the hydrogeological system and interaction with the mine development. Consequently, the SPTs and responses are set to assess the effectiveness of control measures and outline a review process for on-going management.

5 Monitoring and Evaluation

5.1 Inflow Quantification Monitoring

Monitoring underground flows aids in providing a feedback loop for evaluation of the effectiveness of the control measures and the accuracy of the predictive zone mapping. The accuracy and detail of the monitoring is a key component in the Plan review and evaluation process, so is included in the daily reporting structure of the underground management team (i.e. part of the Mine Supervisor daily report).

Underground flow monitoring includes pre- and post-grout flow measurements and flow feature description.

5.1.1 Pre-Grout Flow Measurement

Pre-grout flow measurement is needed to both aid in characterizing the feature and to support verifying the effectiveness of the grouting program. When possible, inflow from specific features or stopes is measured by monitoring pumping rates at the nearest collection sump. If inflow rates exceed pumping rates, this is noted as a rise in sump level, and another pump is mobilised to increase pumping capacity. These observations are documented by the Mine Supervisor and the Engineering department in the daily mine reports. If the inflow is unable to be estimated by sump level or pumping flow rate, a visual assessment will be made by the Engineering department and recorded in the Water Survey Database (Water Tracker).

5.1.2 Post-Grout Flow Measurement

Post-grout flow measurement is the primary means of verifying the effectiveness of the grouting program. Measurement techniques are the same as for pre-grouting.

The results and observations of the post-grouting measurements are considered as part of the review phases in the MIMP and the review of inflow control procedures.

5.1.3 Flow Feature Description

Detailed geological and geotechnical mapping is carried out using predetermined codes for specific rock types and conditions. To make the mapping of inflow features accessible for the review and evaluation process, a descriptive code system is incorporated into the site mapping codes. These coded features are added to the site geological/geotechnical mapping database for review and visualisation using standard reporting and modelling tools for the project.

5.2 Mine Inflow Quality Monitoring

During periods of mine water discharge, either directly to Roberts Bay, or to the TIA, mine water is sampled as follows:

- Weekly at the mine water discharge point (TL-12) for chloride, total dissolved solids (TDS), and nitrate;
- Monthly at the mine water discharge point (TL-12) , for total ammonia-N, nitrate-N, nitrite-N, pH, EC, ICPMS metals, alkalinity, acidity, sulphate, total suspended solids (TSS), major ions and total and weak acid dissociable (WAD) CN; and
- Twice annually from backfilled stopes, for total ammonia-N, nitrate-N, nitrite-N, pH, EC, ICPMS metals, alkalinity, acidity, sulphate, and total and WAD CN.

The Environmental Superintendent is responsible for conducting and documenting inflow water quality sampling. A record of this sampling and results of this analysis will be maintained on site.

5.3 Annual Geotechnical Inspection

A geotechnical inspection of the underground workings will be conducted by a qualified Geotechnical Engineer between July and September each year. The inspection will consider the groundwater conditions underground and groundwater inflow in the underground mine workings.

6 Adaptive Management

The review process outlined in the MIMP allows for performance (ingress control) to be assessed relative to the expanding knowledge of the site hydrogeological system. The following adaptive changes to inflow control measures could include:

- Review of discretionary vs. mandatory pre-grouting planning;

- Confirmation that pre-grouting plans are adequate for anticipating and preventing inflow;
- Modifications to pre-grouting plans or procedures to provide better inflow control;
- Changes to grouting techniques and materials;
- Modifying and/or adjusting the mine plan to avoid areas of concern; and
- Isolation of mining sections to avoid areas of concern.

7 Documentation and Reporting

Documenting inflows, adhering to inflow control measures, and consistent recording of grouting operations allow for an accurate assessment of the effectiveness of the ingress prediction and controls. Records pertaining to inflows and grouting are maintained and reviewed as part of the Plan review and evaluation process.

7.1 Inflow Inspections and Documentations

The underground operational crews are responsible for regular inspections of safely accessible non-working areas and providing daily reports of active work areas. Non-working areas are inspected monthly, or as necessary, if combined flows from those areas are observed to increase at main collection sumps.

Where new inflow or a change in inflow higher than 250 m^3/day is encountered, a description of the feature and related inflow characteristics are documented as part of the Mine Supervisor's daily report. This report includes:

- Description of features encountered;
- Inflow rates;
- Location; and
- Immediate mitigation actions taken, if applicable.

Active areas are inspected daily by Mine department employees and Supervisors. Observations are documented on the Work cars (employees) and the Daily report (Supervisors). The Engineering department performs monthly water inflow surveys that covers both active and non-working areas.

7.2 Grouting Logs

Grouting operations are documented to record the specific work done to stop/reduce inflows and to provide data for the Plan evaluation process. To capture the required data, the following details are logged during grouting events:

- Grout zone, location in mine plan, date, time, shift, crew members, and pre-grouting flow from numbered holes;
- Observations (i.e., geology, features, inflow) from the probe drilling completed in the zone;

- Materials used (type and volume); and
- Injection data such as packer position, pressures at start and end of each hole, flow rate development, and especially any cross-hole grout flow observed to come out of other holes or fractures as this gives an indication of fracture connectivity.

8 Contingencies

In circumstances of ensuring safety of workers and facilities, short term pumping of greater volumes with standby pumps might be required. If groundwater pumping rate and duration are greater than criteria specified in the MIMPs, the Nunavut Water Board is notified, and the analyses and assessment described in the AEMP are carried out and reported quarterly. Pumping will be directed to the TIA as opposed to directly to Roberts Bay. The TIA has sufficient holding capacity for storing one year of mine inflow at the maximum predicted rate for the Doris mine (1,095,750 m^3/year) or about one year and a half at the maximum predicted rate for the Madrid mines (632,000 m^3/year). The holding capacity of the TIA will be confirmed with the TIA Engineer of Record prior to pumping of groundwater to the TIA.

If excess inflow to the mine occurs and Agnico is unable to reduce total inflow to below the SPT-3 level within a reasonable period, the mines will have emergency storage capacity to store excess inflow if required. Underground sumps or lower parts of the mines can be use temporarily to manage and store groundwater, assuming it does not pose a safety risk.

9 References

SRK Consulting (Canada) Inc. 2015a. Hydrogeological Modeling of the Proposed Doris North Project, Hope Bay, Nunavut. Report Prepared for TMAC Resources Inc., 1CT022.002.200.1000. June 2015.

SRK Consulting (Canada) Inc. 2015b. Doris North Project – Water and Load Balance. Report prepared for TMAC Resources Inc., 1CT022.002.200.700, June 2015.

SRK Consulting (Canada) Inc., 2017a.Hydrogeological Characterization and Modeling of the Proposed Boston, Madrid South and Madrid North Mines, Hope Bay Project. Report Prepared for TMAC Resources Inc., 1CT022.013. November 2017.

SRK Consulting (Canada) Inc., 2017b. Madrid-Boston Project Water and Load Balance, Hope Bay Project. Report Prepared for TMAC Resources Inc., 1CT022.013. November 2017.

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Agnico Eagle Mines Ltd.., 2022b. Quality Assurance and Quality Control Plan, Hope Bay Nunavut. March 2020.

TMAC Resources Inc., 2017d, Madrid—Boston of the Hope Bay Project, FINAL ENVIRONMENTAL IMPACT STATEMENT, Volume 3, Project Description and Alternatives. December 2017.

HOPE BAY PROJECT GROUNDWATER MANAGEMENT PLAN

HOPE BAY, NUNAVUT

Module A: Doris Mine Inflow Management Plan (MIMP)

Conformity Table

Licence	Part	Item	Topic	Report Section
2AM-DOH1335	E	4	The Licensee shall implement the Plan entitled Hope Bay Project Groundwater Management Plan as approved by the Board. The Plan shall be reviewed annually in order to capture any revisions or updates necessary to adapt to changing circumstances regarding groundwater inflows and discharge rates.	1.4

A1 Doris MIMP

Table A.1 presents the Mine Inflow Management Program for the Doris mine. SPT-3 is set to be lower than the predicted maximum mine inflow of 3,000 m^3/d or 1,095,750 m^3/year. The maximum inflow rate was estimated based on the hydrogeological model developed for the Doris Mine in 2015 (SRK, 2015a). The modelling considered the site hydrogeological testing, mine design (3D geometry and void volumes), and sequencing (when tunnels and stopes are developed and then backfilled).

Discharge from the mine is at a rate of 3,000 m^3/day directly to Roberts Bay via the RBDS Pumphouse, or if required via the TIA. This discharge can be intermittent and occur any time of the year as the mine sumps fill naturally.

Table A.1: Doris Mine Inflow Management Program (MIMP)

Specific Indicators	Specific Performance Thresholds	Specific Responses
Mine inflows measured as: **Total Mine Inflow** • Daily flow measured at the main portal flow metering point **Point Source Inflow** • Estimate of flow from specific geological feature (structure/joint set) or area • Estimate of flow from a limited, specific mine area (i.e. heading or stope)	**SPT-1** • Total mine pumping rate exceeds 1,000 m^3/day • Point source inflow exceeds 250 m^3/day (~1.25 Lps) for > 3 days	**Notification** • Agnico Management **Review** • Identify inflow point sources/areas and correlate to mine plan and MIMP • Review of pre-grouting work carried out (QA/QC of work to date) • Review inflow management records for development in affected areas • Review inflow records versus geological model and mine layout to assess correlation • Review lake level monitoring data • Review records of mine pumping rates and discharge chemistry **Evaluation** • Review of UG inflow monitoring data to be undertaken by qualified professional and appropriate recommendations to be developed • Review must consider the risk narrative (i.e. impact on Doris Lake water level and site discharge water quality objectives) • Determine if lake level fluctuations exceed natural variability **Action** • Point source flow feature/area to be assessed by Agnico geological staff and compared to current geological model with objective to improve ability to predict significant inflow areas and correlation to pre-grouting planning • Review of inflow control plan to see if techniques, coverage, materials, etc. should be modified or enhanced • Supplemental grouting of source to reduce inflow
	SPT-2 • Total mine pumping rate exceeds 2,000 m^3/day • Point source inflow exceeds 500 m^3/day (~3 Lps) for > 3 days	**Notification** • As in SPT-1 **Review** • As in SPT-1 • Review of geological model versus underground mapping and any new drilling data available • Review probe drilling procedures and control measures in MIMP **Evaluation** • Review of underground inflow monitoring data to be undertaken by qualified professional, and appropriate recommendations to be developed • Review must consider the effectiveness of predictive and control measures to date **Action** • As in SPT-1 • Update MIMP to integrate recommendations from review of prediction and control measures
	SPT-3 • Total mine pumping rate exceeds 2,500 m^3/day • Point source inflow exceeds 800 m^3/day (~6 Lps) for > 3 days	**Notification** • As in SPT-2 **Review** • As in SPT-2 **Evaluation** • Detailed review of all inflow events/sources to be undertaken by qualified professional, in addition to a 3rd party grouting specialist to provide peer review on control program • Review of underground water management plan to deal with unexpected inflows that may exceed total mine discharge rate of 3,000 m^3/day **Action** • As in SPT-2 • Provide update to MIMP based on outcome of Peer Review • assess potential impacts on Site Water Management Plan • assess potential change in risk narrative • Determine if mitigation measures required to maintain Doris Lake levels • If groundwater pumping exceeds 3,000 m^3/day for a prolonged period, specifically 270,000 m^3/quarter, the Nunavut Water Board will be notified and the analyses and assessment described in the Aquatic Effects Monitoring Plan (AEMP) will be carried out and reported quarterly

Note: Notification to the Mines Inspector is conducted as per the NWT Mine Health and Safety Act and Regulations Part XVI Reportable Incidents and Dangerous Occurrences Section 16.01 and 16.02. Notification to the Mines Inspector of a “dangerous occurrence” involving an inrush of water will include an oral report within 24 hours of the dangerous occurrence and a written report within 72 hours.

HOPE BAY PROJECT GROUNDWATER MANAGEMENT PLAN

HOPE BAY, NUNAVUT

Module B: Madrid Mine Inflow Management Plan (MIMP)

Conformity Table

Licence	Part	Item	Topic	Report Section
2AM-DOH1335	E	4	The Licensee shall implement the Plan entitled Hope Bay Project Groundwater Management Plan as approved by the Board. The Plan shall be reviewed annually in order to capture any revisions or updates necessary to adapt to changing circumstances regarding groundwater inflows and discharge rates.	1.4
2BB-MAE1727	D	4	The Licensee shall submit to the Board for approval in writing, sixty (60) days prior to the commencement of underground workings at Madrid South, a Groundwater Management Plan.	Not applicable at this time.

B1 Madrid MIMP

Table B.1 presents the Mine Inflow Management Program for the Madrid North and Madrid South mines combined. SPT-3 is set to be lower than the predicted maximum mine inflow of 1,730 m^3/d or 631,882 m^3/year. The maximum inflow rate was estimated based on the hydrogeological model developed for the Madrid North and Madrid South Mine (SRK, 2017a). The modelling took into account the site hydrogeological testing, the mine design based on prefeasibility conditions and the mine production plan (TMAC 2017d).

The combined discharge from the Madrid North mine and Madrid South mine is to be at a rate of 3,000 m^3/day to Roberts Bay via the RBDS Pumphouse, or if required via the TIA. This discharge can be intermittent and occur any time of the year as the mine sumps fill naturally.

Table B.1: Madrid Mine Inflow Management Program (MIMP)

Specific Indicators	Specific Performance Thresholds	Specific Responses
Mine inflows measured as: **Total Mine Inflow** • Daily flow measured at the main portal flow metering point **Point Source Inflow** • Estimate of flow from specific geological feature (structure/joint set) or area • Estimate of flow from a limited, specific mine area (i.e. heading or stope)	**SPT-1** • Total mine pumping rate exceeds 600 m^3/day • Point source inflow exceeds 250 m^3/day (~1.25 Lps) for > 3 days	**Notification** • Agnico Management **Review** • Identify inflow point sources/areas and correlate to mine plan and MIMP • Review of pre-grouting work carried out (QA/QC of work to date) • Review inflow management records for development in affected areas • Review inflow records versus geological model and mine layout to assess correlation • Review lake level monitoring data • Review records of mine pumping rates and discharge chemistry **Evaluation** • Review of UG inflow monitoring data to be undertaken by qualified professional and appropriate recommendations to be developed • Review must consider the risk narrative (i.e. impact on Patch and Wolverine Lake water level and site discharge water quality objectives) • Determine if lake level fluctuations exceed natural variability **Action** • Point source flow feature/area to be assessed by Agnico geological staff and compared to current geological model with objective to improve ability to predict significant inflow areas and correlation to pre-grouting planning • Review of inflow control plan to see if techniques, coverage, materials, etc. should be modified or enhanced • Supplemental grouting of source to reduce inflow
	SPT-2 • Total mine pumping rate exceeds 1,200 m^3/day • Point source inflow exceeds 500 m^3/day (~3 Lps) for > 3 days	**Notification** • As in SPT-1 **Review** • As in SPT-1 • Review of geological model versus underground mapping and any new drilling data available • Review probe drilling procedures and control measures in MIMP **Evaluation** • Review of underground inflow monitoring data to be undertaken by qualified professional, and appropriate recommendations to be developed • Review must consider the effectiveness of predictive and control measures to date **Action** • As in SPT-1 • Update MIMP to integrate recommendations from review of prediction and control measures

	SPT-3
	• Total mine pumping rate exceeds 1,500 m^3/day
	
	• Point source inflow exceeds 800 m^3/day (~6 Lps) for > 3 days
		Notification
		• As in SPT-2
		Review
		• As in SPT-2
		Evaluation
		• Detailed review of all inflow events/sources to be undertaken by qualified professional, in addition to a 3rd party grouting specialist to provide peer review on control program
		• Review of underground water management plan to deal with unexpected inflows that may exceed total mine discharge rate of 1,730 m^3/day
		Action
		• As in SPT-2
		• Provide update to MIMP based on outcome of Peer Review
		  – assess potential impacts on Site Water Management Plan
		  – assess potential change in risk narrative
		• Determine if mitigation measures required to maintain Patch and/or Wolverine Lake levels
		• If groundwater pumping exceeds 1,730 m^3/day for a prolonged period, specifically 158,000 m^3/quarter, the Nunavut Water Board will be notified and the analyses and assessment described in the Aquatic Effects Monitoring Plan (AEMP) will be carried out and reported quarterly

Note: Notification to the Mines Inspector is conducted as per the NWT Mine Health and Safety Act and Regulations Part XVI Reportable Incidents and Dangerous Occurrences Section 16.01 and 16.02. Notification to the Mines Inspector of a “dangerous occurrence” involving an inrush of water will include an oral report within 24 hours of the dangerous occurrence and a written report within 72 hours.

HOPE BAY PROJECT GROUNDWATER MANAGEMENT PLAN

HOPE BAY, NUNAVUT

Module C: Boston Mine Inflow Management Plan (MIMP)

Conformity Table

Licence	Part	Item	Topic	Report Section
2AM- BOS1835	D	13	The Licensee shall, for all plans submitted under this Licence, implement the plan as approved by the Board in writing. Any changes to the plans deemed significant shall be considered as an amendment to the plan(s) or as a modification and must be submitted to the Board for approval in writing. The Board has approved under this Water Licence 2AM-BOS1835, the following plans for implementation under the relevant sections in the Licence:	This Plan
		e.	*Hope Bay Project Groundwater Management Plan (March 2022)*	

C1 Boston MIMP

Table C.1 presents the Mine Inflow Management Program for the Boston mine. The Madrid-Boston mine plan assumes mining in Boston will be limited to resources encapsulated in permafrost (TMAC 2017d). The spatial distribution of permafrost is based on the analyses of isotherms measured from thermistors at 08SBD381A, 08SBD382, and 10WBW004 (SRK 2017a).

Table C.1: Boston Mine Inflow Management Program (MIMP)

Specific Indicators	Specific Performance Thresholds	Specific Responses
Mine inflows measured as: **Point Source Inflow** • Estimate of flow from probe drillhole or specific geological feature (structure/joint set) in new development. • Estimate of flow from a limited, specific mine area (i.e. heading or stope)	**SPT-1** • Point source inflow greater than 30 m^3/day (~0.3 Lps) for > 3 days	**Notification** • Agnico Management **Review** • Identify inflow point sources/areas and correlate to mine plan and MIMP • Review underground thermal measurements (QA/QC of monitoring to date) • Review drilling records in affected areas • Review permafrost model, geological model and mine layout to assess correlation with observed inflow **Evaluation** • Review of UG inflow and thermal monitoring data to be undertaken by qualified professional and appropriate recommendations to be developed • Review must consider the risk narrative (i.e. impact on site water management objectives) **Action** • Point source flow feature/area to be assessed by Agnico to confirm inflow is generated from talik or subpermafrost • Modification to mine plan to keep Boston development in permafrost if inflow is confirmed to come from talik or subpermafrost • Inflow control (i.e., supplemental grouting of source inflow or installation of a borehole plugin device) or exclusion measures (i.e. isolation of the area concerned)
	SPT-2 • Point source inflow greater than 60 m^3/day (~0.6 Lps) for > 3 days	**Notification** • As in SPT-1 **Review** • As in SPT-1 • Review of geological model versus underground mapping and any new drilling data available • Review probe drilling procedures and control measures in MIMP **Evaluation** • Review of underground inflow monitoring data to be undertaken by qualified professional, and appropriate recommendations to be developed • Review must consider the effectiveness of predictive and control measures to date • Action • As in SPT-1 • Update MIMP to integrate recommendations from review of prediction and control measures
	SPT-3 • Point source inflow greater than 360 m3/day (~4.2 Lps) is observed in a new development	**Notification** • As in SPT-2 **Review** • As in SPT-2 **Evaluation** • Detailed review of all inflow events/sources to be undertaken by qualified professional, in addition to a 3rd party grouting specialist to provide peer review on control program • Review of water management plan to deal with unexpected inflows. **Action** • As in SPT-2 • Provide update to MIMP based on outcome of Peer Review – assess potential impacts on Site Water Management Plan – assess potential change in risk narrative • Pump excess groundwater to surface to contact water ponds or directly to water truck for transport to Doris RBDS Pumphouse. Dispose of via RBDS Pumphouse to Roberts Bay. • If groundwater pumping exceeds 360 m3/day for a period of 30 days, the Nunavut Water Board will be notified and mining of the area concerned will stop.

Note: Notification to the Mines Inspector is conducted as per the NWT Mine Health and Safety Act and Regulations Part XVI Reportable Incidents and Dangerous Occurrences Section 16.01 and 16.02. Notification to the Mines Inspector of a “dangerous occurrence” involving an inrush of water will include an oral report within 24 hours of the dangerous occurrence and a written report within 72 hours.

Operations, Maintenance and Surveillance Manual: Hope Bay Doris Tailings Impoundment Area

AGNICO EAGLE

Revision 4

Hope Bay, Nunavut

February 2022

Operations, Maintenance and Surveillance Manual: Hope Bay Doris Tailings Impoundment Area

Plain Language Overview:

This Tailings Impoundment Area (TIA) Operation, Maintenance and Surveillance Manual (OMS Manual) is also known as the Tailings Management Plan. This OMS Manual describes how AEM will manage and monitor the tailings impoundment area, including the impoundment dams, tailings and water pump and pipeline systems. This document describes how tailings deposition will be carried out and demonstrates how AEM will ensure the TIA remains safe. This document should be read in conjunction with the latest North Dam and South Dam monitoring Standard Operating Procedures (SOPs).

Hope Bay, Nunavut

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Hope Bay Project
c/o #18 Yellowknife Airport
100 McMillan Drive
Yellowknife, NT X1A 3T2
Phone: 867-873-4767
Fax: 867-766-8667

Revisions

Revision #	Date	Section	Changes Summary	Author	Approver
0	June 2016	Entire Document	Initial Document	SRK	TMAC
1	August 2016	Entire Document	References added	SRK	TMAC
		Section 1.5, Table 3	List updated		
		Section 2.1, Table 4	List updated		
		Section 3.3.5, 3.10	Added contingency pumping for excess mine water		
		Section 3.4.3, Section 3.8, Table 6	Removed optionality of constructing Interim Dike; Added construction timing of Interim Dike		
		Section 4.4	Added approval process for alternate chemical dust suppressants		
		Section 4.5	Reference water management during Care and Maintenance		
		Section 5.3.1	Added Figure 12 pertaining to shoreline protection measures		
		Section 6.4, 6.5.4	Added tailings geochemical monitoring		
		Section 6.5.3	Referenced TIA water quality monitoring		
		Section 7	List updated		
		Figures	Added new Figure 12 and renumbered remaining Figures 13 through 17		
		Appendix A	Included appendix information previously omitted		
2	November 2017	Entire Document	Changes made to account for Phase 2 TIA requirements	SRK	TMAC
3	August 2020	Entire Document	Document format updated. Updates post construction of the Phase 1 South Dam. Report still accounts for Phase 2 requirements. Updates to meet new Mining Association of Canada (MAC) guidelines.	SRK	TMAC
4	February 2022	Entire Document	Updated to include AEM Governance of Critical Infrastructure , change of ownership, TARP levels	AEM	AEM

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Useful Definitions

AEP	annual exceedance probability
ARD	acid rock drainage
CDA	Canadian Dam Association
DSI	dam safety inspection
DSR	dam safety review
EOR	engineer of record
FEIS	final environmental impact statement
FSL	full supply level
GCL	geosynthetic clay liner
IDF	inflow design flood
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
KIA	Kitikmeot Inuit Association
MAAT	mean annual air temperature
MAP	mean annual precipitation
MAR	mean annual runoff
MMDER	Metal and Diamond Mining Effluent Regulations
NIRB	Nunavut Impact Review Board
NWB	Nunavut Water Board
OMS	operations, maintenance and surveillance
PAG	potentially acid generating
PGA	peak ground acceleration
PMF	probable maximum flood
ROQ	run-of-quarry
SOP	standard operating procedures
SRK	SRK Consulting (Canada) Inc.
TIA	tailings impoundment area
TMA	tailings management area
TMS	tailings management system
TMAC	TMAC Resources Inc.
TPD	tonne per day
WAD	weak acid dissociable
WMMP	wildlife monitoring and management plan

1 Introduction

This operations, maintenance, and surveillance (OMS) manual is for the Doris Tailings Impoundment Area (TIA). It was prepared by SRK Consulting (Canada) Inc. and updated by Agnico Eagle Mines Limited (AEM) and in accordance with various water licences held by AEM and associated with developments throughout the Hope Bay region.

Objectives

This manual outlines the framework and procedures AEM and its contractors will use to ensure

- operation, maintenance, surveillance of the TIA are carried out safely,
- best practices for minimizing potential environmental impacts and liabilities with respect to the Doris TIA are followed, and
- the water licence conditions are met.

Structure

This document is structured to can act as one primary document pertaining to the Doris TIA. The goal is that this one document can then be approved and implemented to address the site- and licence-specific operation, maintenance and surveillance needs. It incorporates Industry Standards as well as AEM Corporate Standard and Policy on Tailings Management

Note: In the event of a new water licence or an existing licence amendment, only the portions of this manual pertaining to that licence will need to be revised in this TIA OMS Manual.

Contents

In addition, this manual defines and describes the

- roles and responsibilities of personnel assigned to the TIA;
- procedures and processes for managing change;
- key components of the TIA;
- procedures required to operate, monitor the performance of, and maintain the TIA to ensure that it functions in accordance to its design, meets regulatory and corporate policy obligations, and links to emergency planning and response; and
- requirements for analysis and documentation of the performance of the TIA.

1.1 Managing Updates

When to Update

The procedures required to operate and maintain the TIA can change with time. Because this manual is a controlled document, it should be thought of as a living document that will be updated to reflect those changes.

Annual Updates

This manual should be updated annually, with input from AEM site staff, and based on recommendations from

- the engineer of record's (EOR) dam safety inspection (DSI), and/or
- from third-party dam safety reviews (DSR).

Other Update Triggers

Revisions can be triggered by activities such as

- changes in dam classification,
- operational performance,
- personnel or organizational structure,
- mine ownership,
- regulatory or social considerations, and
- life cycle or design philosophy.

Person(s) Responsible

AEM in general—specifically, the Environmental Superintendent

Update Procedure

Updates to this OMS manual are carried out annually as follows:

Step	Action
1	The RP is to submit proposed changes to the EOR for review and authorization.
2	If changes are related to TIA design elements as stipulated in Section 3 (specifically 3.10), submit them to the design engineer for review and approval.
3	The RP is responsible to communicate any changes that are going to be made to this OMS by e-mail to the control copy distribution list; for all areas regardless of if they fall under the 'design' or 'operation' categories.

4	Once approved, incorporate changes into the manual. Revisions to the OMS are to be clearly documented in the revision control table (found at the beginning of this OMS. Once revisions have been made, the updated versions are to be distributed to all parties listed in Section 2.1 and placed on Intelex. Out-of-date materials are to be removed and archived.

Control Copy Locations and Responsibility

Control copies of this manual are printed and available at these locations. The latest version is available on Intelex

Copy Location	Position
site main office	mine general manager
environmental department	environmental superintendent
Mill	Mill Superintendent
Site Incident Command Center	H&S superintendent
external	Design Engineer (SRK)
External	Engineer of Record

Uncontrolled Copies

Printed copies of the OMS Manual found at other locations will be considered uncontrolled versions.

1.2 Related Documents

The documents below should be used in conjunction with this manual.

Operating Procedures	• **North Dam Monitoring: Standard Operating Procedures – Revision 3 (2020)** – North Dam Monitoring Standard Operating Procedures (SOP) (SRK 2020a) • **South Dam Monitoring: Standard Operating Procedures – Revision 1 (2020)** – South Dam Monitoring Standard Operating Procedures (SOP) (SRK 2020b) • **Tailings Deposition Plan** • **Process Plant SOPs relating to Power Outage, Loss of tailings, Plant Shutdown** • **Pigging/Flushing Tailings Line**
Emergency Planning	• **Emergency Response Plan (2021)** – Describes Incident Command System and actions relating to all surface emergencies. • **Dam Emergency Plan (2022)** – Describes emergency response related to TIA components
Design Documentation	• **Preliminary Tailings Dam Design (2007)** – North Dam design documentation (SRK 2007) • **North Dam As-Built Report (2012)** – North Dam as-built documentation (SRK 2012) • **TIA Interim Dike – Filtering Requirements (2015)** – Filter design for the Interim Dike (SRK 2015d) • **Doris Tailings Impoundment Area Interim Dike Filter Trade-off Study (2016)** – Memo clarifying the purpose of the Interim Dike and a trade-off study of two different filter designs (SRK 2016). Interim dike not part of Phase 2 plans. • **Doris Tailings Management System Phase 2 Design, Hope Bay Project (2017)** – Report documents TMAC's proposed changes to currently permitted TMS to accommodate additional volume of tailings produced as part of Phase 2 development (SRK 2017b) • **Engineering Drawings for the South Dam – Phase 1 (2017)** – South Dam – Phase 1 Issued For Construction Engineering Drawings • **Doris Tailings Management System Phase 2 Design (2017)** – Report overviews the Phase 2 design of the Doris Tailings Management System and Facility (SRK 2017b). • **South Dam Design Report (2019)** – formal documentation for the South Dam design (SRK 2019b) • **South Dam Phase 1 As-Built Report (2019)** – South Dam as-built documentation (SRK 2019a)
Environmental	• **Climate and Hydrological Parameters Summary Report (2017)** – Climate and hydrological parameters and analysis for the Doris and Boston sites (SRK 2017c)
Water Management	• **Doris and Madrid Water Management Plan (2022)** – Describes the water management procedures including discharge from the TIA and associated water quality criteria (AEM 2022a)

	• **Groundwater Management Plan (2022)** – Describes the groundwater inflow predictions and associated management procedures for handling this water (AEM 2022d) • **Groundwater Inflow and Quality Model (2015)** – Describes results of hydrogeological modeling to estimate the potential quantity and quality of groundwater flow into the mine (SRK 2015c) • **Site-Wide Water and Load Balance (2022)** – Water and load balance to evaluate water management needs and predict water quality at the Project and downstream receptors (SRK 2022)
Tailings and Waste Management	• **Doris North Project Tailings Management System Design (2015)** – South Dam and Interim Dike design and tailings management plan (SRK 2015a) • **Geochemical Characterization of Tailings from the Doris Deposits and FEIS Characterization (2015)** – Geochemical characterization of the tailings to be deposited into the TIA (SRK 2015b) • **Hope Bay Waste Rock and Ore Management Plan (2022)** – Management plans for waste rock and ore at the Hope Bay project sites (AEM 2022c) • **Monthly Dashboards (SRK)**

2 Roles and Responsibilities

2.1 Governance and Individual Responsibilities

Agnico Eagle is committed to the protection of the public, the environment and its personnel. The company has developed a governance policy for its critical infrastructure to ensure their management in an appropriate and responsible manner. The primary elements of the policy are:

- The development of specific roles with specific responsibilities;
- Regular and consistent reporting;
- Accountability at all levels, from operations to corporate;
- The use of Best Available Technology (BAT) and Best Applicable Practices (BAP); and
- The use of a risk-based approach to manage the risks associated with critical infrastructure

The persons responsible for operations, maintenance, surveillance, emergency preparedness, and emergency response along with the governance policy are listed below and in Appendix A, which also provides the site management structure.

Accountable Executive Officer (AEO)	As emphasized by MAC (2017), the accountability for decisions related to tailings management rests with the Owner's Board of Directors or Governance Level. The Board of Directors or Governance Level is expected to designate an Accountable Executive Officer (AEO) for tailings management. More specifically, the following responsibilities are assigned to the AEO: • Needs to be aware of key outcomes of water management risk assessment and of how these risks are being managed • Has accountability and responsibility for putting in place appropriate management structure • Assign responsibility and appropriate budgetary authority for tailings management • Define the personnel duties, responsibility and reporting relationships, supported by job description and organisational charts to implement the tailings management system through all stages in the facility life cycles Provide assurance to AEM and its Community of Interest that tailings are managed responsibly
Mine General Manager	• Identify the scope of work and budget requirement for all aspects of tailings management

	• Approve budget for OMS related activity • Establish an organisational structure with Roles and Responsibilities that meets the Governance Standard on Critical Infrastructure • Identify and retain a Responsible Person (RP) • Liaise with independent reviewer (MDRB) as required
General Superintendents	Ensure the OMS responsibilities delegated to the departments they oversee are carried out as described in this section of the OMS Manual
Engineer of Record (EoR)	The function of EoR is to support AEM in ensuring that mine waste and water management infrastructure are designed and operated properly. The owner, in assuring that these facilities are safe, has the responsibility to identify and retain an EoR, who provides technical direction on behalf of the owner. Having an EoR for mine waste and water infrastructure is recognized as one of the best practices for responsible management of mine waste and water management facilities. • Support and give technical advice to the RP and the AEO on geotechnical and operational challenges • Participate if possible, in Dam Safety Inspections and associated reports for tailings facilities that include retention structures/dams • Verify if the tailings storage facility (TSF), waste rock storage facility (WRSF), and Water Retaining Infrastructures are designed and are operating in accordance with the best standards in the industry and the AEM corporate standards • Verify if the waste and water management plans are developed and followed to ensure safety of the operation and the business; • Review and provide agreement on the procedural documents related to waste and water management (including OMS, ERP and TARP); • Be available for the Independent Review (IR) Panel; • Participate in IR meetings and assist the RP in their preparation if required; • Participate in the facility's risk assessments; • Be available for dam safety reviews; • Identify other internal or external professionals (such as hydrogeologists, geologists, hydrologists, etc.) to provide their support when required; • Propose a schedule of site visits and required meetings during the course of the year.
Responsible Person	The Responsible Person(s) identifies the scope of work and budget requirements (subject to final approval) for all aspects of tailings management, including the Engineer of Record (EoR), and will delegate specific tasks and responsibilities for aspects of tailings management to qualified personnel." The RP is directly responsible for the management of

	critical infrastructure on a specific site with the objective of compliance with the Governance. The management of critical infrastructure includes design, construction, operation and closure. • Ensure the implementation and sustainability of the Governance model at the site level; • Management of critical infrastructure, as well as appurtenant structures that may affect the critical infrastructure; • The management of personnel, budget and external resources for the critical infrastructure (external resources include the Design Engineer (DE), Independent Review Board (IRB) and any other necessary consultants/contactors); • Close collaboration with the EoR and communication with the Design Engineer and Independent Review Board IRB); • Preparation for, and coordination of, IRB meetings and site visits; • Preparation for, and coordination of, annual geotechnical inspections; • Responding to, and implementation of, the recommendations of the IRB; • Annual review and up-date of the OMS Manual in collaboration with the EoR; • Continued application of the requirements of the OMS; • In collaboration with the EoR, preparation of an annual report on the status of the critical infrastructure; • Management of all documents and data related to design, construction, operation, closure, surveillance and monitoring in a secure, accessible and permanent manner; • Revise and update the OMS Manual to reflect as-built conditions and any other changes. Review and update the OMS manual into Intelex. Maintain up to date distribution list of the OMS Manual
Independent Review Board (IRB) (To be established in 2022)	IR Panels are a mechanism to obtain independent, expert commentary, advice, guidance and where appropriate, recommendations to assist owners/operators in identifying, understanding, and managing risks associated with TSF, WRSF, WSF, HLF and water-retaining infrastructures. The Independent Reviewer(s) does not have decision-making authority. Accountability and responsibility for decisions rests with AEM. • Review mine waste management strategy (including tailings and waste rock storage facilities); • Review water management infrastructure designs and performance (including water retaining infrastructures); • Review on-going construction works and monitoring data; • Comment on implementation progress of proposed mine waste

	management improvement measures; • Provide opinions and guidance to the operation on the physical integrity, safety, behavior, and performance of the confinement systems for mine waste and water retaining infrastructures; and • Comment on management systems, emergency preparedness and overall management approach of the different mine waste management facilities and water retaining infrastructures.
Design Engineer	• Advise on contemplated changes to the structure operation • Advise on structure performance and mitigation work as required • Present during independent review board meeting to provide input and context on the structure performance
Process Operations Superintendent	The Process Plant Department is the owner of the process plant. They work in close collaboration with the other stakeholder to ensure the success of tailings management. The Process Plant Superintendent is in charge of the Process Plant and ensure that: • The Process Plant team as sufficient resource (qualified workforce, material, budget, training) to fulfill the OMS obligation defined in this manual • A structure is in place that define the R&R, qualification, training requirement and a staffing strategy to fulfill the obligation of the OMS Manual • The process plant operates and maintain the infrastructure required to produce and transport (i.e pump) the tailings to tailings management area • The process plant tracks the parameter and characteristic of the tailings produced to ensure that targets are reached • The process plant operates the reclaim water system and track the water consumption to ensure that targets are reached • The process plant stops the transport of tailings if required in case of upset or emergency condition
Environment Superintendent	The Environment Department ensures compliance with Environment Regulation and the Water License and is the owner of the water & tailings management infrastructures outside of the process plant. They ensure reporting and liaison with the NIRB, NWB, NGO's and other government agencies. The Environment Superintendent is in charge of the Environment Department and ensure that: • The Environment team as sufficient resource (qualified workforce, material, budget, training) to fulfill the OMS obligation defined in this manual

- A structure is in place that define the R&R, qualification, training requirement and a staffing strategy to fulfill the obligation of the OMS Manual
- Environment review monitoring data for compliance with Water License and regulations and to determine dike performance with respect to design parameters
- The Environment team carry out the surveillance of the structures as required in the OMS Manual (visual inspection and instrument monitoring)
- The Environment team identify and perform the maintenance work (predictive, preventive and corrective) on the earthwork and instrumentation system
- The Environment team review and analyse the surveillance data to evaluate dike performance with respect to design parameters and that surveillance reporting is distributed

Maintenance Superintendent

The Maintenance Department has the workforce and equipment to manage road, electricity and dewatering at the Hope Bay Site. They fulfill the planning done in collaboration with the Environment team to ensure the fulfilment of the OMS requirement. The Maintenance Superintendent is in charge of the Site Services Department and ensure that :

- The Site Services team has sufficient resources (qualified workforce, material, budget, training) to fulfill the OMS obligation defined in this manual
- A structure is in place that defines the R&R, qualification, training requirement and a staffing strategy to fulfill the obligation of the OMS Manual
- Site Services maintain access to the structure and tailings management systems. This include making road repairs, controlling dust and managing snow and water.
- Site Services install, operate, maintain and monitor all the components of pumps and piping system associated with water management. They also perform operation, maintenance and surveillance work on the piping system. This work is planned in collaboration with the Environment Department.
- Update and maintain a list of operational pumping equipment

The Maintenance Department has the workforce and equipment to maintain mobile equipment and pump. They fulfill maintenance of some of the mechanical equipment component of the dewatering dike as requested by the E&I department. The Maintenance Superintendent is in charge of the Maintenance Department and ensure that :

	• Ensure preventive, predictive and corrective maintenance is carried out regularly on pumping equipment related to water management as requested by E&I • Keep records of maintenance performance on pumping equipment
Dewatering Supervisors	The Dewatering Supervisor is responsible to ensure that: • The surveillance of the structures is carried out as required in the OMS Manual (visual inspection and instrument monitoring) • The Dewatering and Special Projects Supervisor identify and perform the maintenance work (predictive, preventive and corrective) on the earthwork and instrumentation system in collaboration with the Maintenance Department • Maintenance Department install, operate, maintain and monitor all the components of pumps and piping system associated with water management. They also perform operation, maintenance and surveillance work on the piping system. This work is planned in collaboration with the Maintenance Department.
Health and Safety Superintendent	The Health and Safety Department is responsible to update and manage the site wide emergency response plan. The Health and Safety Superintendent is in charge of the Health and Safety Department and ensure that : • The emergency response plan is updated and is aligned with the OMS manual • The trigger to raise an emergency defined in the OMS manual and the communication pathway to do so is understood and aligned with the ERP

2.2 Contact Information

Environment and Critical Infra VP / Accountable Executive Officer	Michel Julien |michel.julien@agnicoeagle.com 416-947-1212 x3738 514-244-5876
Engineer of Record (EoR) / Technical Specialist, Environmental Management	Thomas Lepine | thomas.lepine@agnicoeagle.com 418-473-8077
Design Engineer	John Kurylo, Msc (DIC), Peng | jkurylo@skr.com 604-235-8541

Independent Review Board	To be established in 2022
Mine General Manager	Eric Steinmetzer | eric.steinmetzer@agnicoeagle.com 867-988-6882 x 104 819-763-0187
General Superintendent	TBD
Process Operations Superintendent/ **Lab & metallurgy Superintendent**	TBD Jamie Power | jamie.power@agnicoeagle.com 867-988-6882 x 145
Technical Services Superintendent/ Engineering Superintendent	Philemon Desrochers-Gagnon | philemon.desrochers@agnicoeagle.com 867-988-6882 x106 819-355-0815 Philippe Lapointe | philippe.lapointe@agnicoeagle.com 867-988-6882 x106 819-860-2898
Environment Superintendent (Responsible Person)	Nancy Duquet-Harvey | nancy.harvey@agnicoeagle.com 867-988-6882 x102 819-856-4385
Maintenance Superintendent/ **Interim maintenance Superintendent**	TBD Cody Kerr | cody.kerr@agnicoeagle.com 867-988-6882 x131
Health and Safety Manager/ **Assistant Health and Safety Superintendent**	TBD Brad Towle | brad.towle@agnicoeagle.com 867-988-6882 x138

2.3 Communications, Reporting and Tracking

Communication Procedures	It is extremely important that monitoring and management policies are communicated to all interested parties involved with the maintenance and surveillance of the site. The Responsible Person must ensure that all the issues, concerns, or incidents are reported promptly. The Responsible Person must ensure clear, concise, and consistent communication so that emergency preparedness and response plans are effective, and the public is kept aware of possible hazards associated with the site, of its maintenance, and of its surveillance programs.
Documentation	The surveillance and inspection reports should be prepared under the supervision of the Environmental Superintendent and reviewed by a qualified person. After being reviewed, records of all surveillance and inspection activities should be kept on file for future reference.
General Guidance	See Section 1.1 for additional details on the 'Control Copy Locations and Responsibility' for the OMS manual.
Document Control	All reports of activities completed on site must be submitted to the Responsible Person who will then notify the EOR and specialist consultants if further assessments are required. It is AEMs responsibility to ensure the following documents are securely stored and accessible to personnel involved in implementing requirements found in this OMS Manual: • As-built documentation related to the site • Records of all maintenance activities • Previous site inspection summary reports • Record of staff training • Relevant incident reports
OMS Reporting and Tracking	Observations made during general and geotechnical inspections must be recorded in field books or on digital tablets or computers. For hardcopy documents, digital scans of the used pages of the field books should be made for safekeeping. Copies of field notes or field books should be stored at a designated location when not in use. It is the responsibility of: • Any personnel visiting the site to report any observed issues that require maintenance or repairs to the Responsible Person (by letter or electronic mail), within one day. • The geotechnical inspector to prepare a memorandum for each geotechnical inspection, describing the observations made during the site visits, as well as any recommendations for maintenance activities to be completed. Electronic and hard copies of the geotechnical inspections and maintenance events should be submitted to the Responsible Person no longer than 90 days following the completion of the inspection or maintenance event.

	The reports must include: • Tabular summaries of all data generated • A description of any restoration or reclamation work carried out (or since the previous inspection) • Results of any studies associated with restoration and reclamation • A report on any inspection of site • Any other details requested by the Site Manager or Responsible Person or the EoR.
Tailings Spills and Pipeline Repairs	All tailings line repairs, spills or leaks of any tailings line should be documented and reported to the Responsible Person. This reporting should include: • A description of the repair or damage • Photos of the location • A coordinate (or a figure mark-up) to show the location of the repair or damage

Hard copies of all documents produced in the reporting and tracking process should be stored at the project safe-keeping location. All hard copy documents should be scanned and turned into electronic records at least annually. All electronic documents should be saved on a safe computer or network drive.

2.4 Competencies and Training

Objectives	Relative to carrying out operations, maintenance, and surveillance activities for the TIA, AEM ensures site personnel • have a clear understanding of and adequate competency for their roles and responsibilities, • receive appropriate training, and • are kept abreast of updates to this manual. **Note:** Procedures for meeting these objectives follow.
Role-Specific Competencies	AEM works to ensure personnel • have the tailings management experience specific their job descriptions prior to appointment (especially those identified in Section 2.1); • participate, if necessary, in training to remedy any deficiencies in competency (such as on-line tailings management courses offered by Edumine); and

	• receive on-the-job training for relevant tasks such as those outlined in appropriate standard operating procedures (SOPs).
Site Orientation	All personnel are required to receive a site orientation that provides them with an understanding of • the general TIA management principles and • visual indications of the TIA performance.
On-going OMS Training	AEM develops and requires personnel to attend • a detailed, annual site-specific TIA orientation and training module based on this manual and • if necessary, following the dam safety inspection (DSI), a workshop conducted by the geotechnical engineer that focusses on findings of the inspection.

3 Tailings Facility Description

3.1 Project Summary

Location	The Hope Bay Project (the Project), owned and operated by AEM, is found • 705 km northeast of Yellowknife, • 153 km southwest of Cambridge Bay in Nunavut Territory, and • east of Bathurst Inlet (Figure 1).
Mineralization Areas	The Project is a gold mining and milling undertaking that consists of three distinct areas of known mineralization plus extensive exploration potential and targets (Figure 2): Doris, Madrid, and Boston.
Project Phases	**Phase 1: Doris Project** • Currently being carried out under an existing water licence • includes mining and infrastructure **Phase 2: Madrid-Boston Project** • License issued December 2018 • includes mining and infrastructure • Madrid and Boston located 10 and 60 km due south of Doris, respectively (SRK 2017a)
Processing Methods	Ore processing includes cyanidation and flotation methods, with two separate streams of tailings being produced, both captured under the tailings management system (TMS).

Cyanidation Tailings

Cyanidation tailings are detoxified (cyanide destruction) then filtered and blended with waste rock then returned underground as backfill.

Flotation Tailings

Floatation tailings are produced at the Doris processing facility and deposited in the Doris TIA.

Tailings Deposition

Phase 1

Phase 1 TMS (SRK 2015b) design realizes subaerial deposition of about 2.5 Mt of tailings into the Doris TIA. This area was a natural lake (Tail Lake), which is listed on Schedule 2 of the MDMER.

Phase 2

Phase 2 development expands the TIA to accommodate 18 Mt of tailings (Figure 3).

TIA Impoundment

To ensure environmental containment, the TIA is impounded through three dams: North Dam, South Dam, and West Dam (Figure 3).

North Dam

- functions as a water retaining dam
- constructed in 2012 (SRK 2012) as a water retaining frozen core dam

South and West Dams

- have tailings deposited against their upstream face to keep the Reclaim Pond away from the structures (Figure 3)
- designed as frozen foundation rock fill dams incorporating a geosynthetic clay liner (GCL)
- Phase 1 of the South Dam was constructed in 2018 (SRK 2019a)

South Dam is part of Phase 1 and will be raised as part of the Phase 2 development. The West Dam is a new structure. As of this version of this OMS, the West Dam was not yet needed for containment, and therefore has not yet been constructed.

TIA Closure Process

The TIA closure procedure has three core stages.

Stage	Description
Isolation Cover	The TIA will be closed by applying a 0.3 m quarry rock isolation cover that • mitigates tailings dust and • prevents tailings contact with terrestrial wildlife.
Water Discharge	Once the cover is applied, water discharge from the TIA must meet environmental discharge criteria, as

	demonstrated in the water quality modeling (SRK 2017a).
North Dam Breach	When water quality is confirmed, the North Dam will be breached, thus returning the natural outflow to its pre-mining elevation.

3.2 Project History Highlights

Exploration

1964

Work at the Project site began. The first exploration focused on showings at Ida Point, Ida Bay, and Roberts Lake to the north. Three exploration companies continued work until exploration drilling started.

1992

Drilling led to the first site infrastructure at Boston in the form of an exploration camp on the northeastern shores of Aimaokatalok Lake.

1996 -1997

Underground development was carried out at Boston to extract a bulk sample.

1999

Exploration drilling expanded to Madrid and Doris. A new exploration camp was constructed on the eastern shore of Windy Lake.

2006

The project certificate (NIRB No. 003) was obtained to start a mine at Doris.

2007

The water licence (2AM-DOH0713) for Doris was issued.

Construction

2007

Construction began but slowed as the Project transitioned in ownership.

2010

Construction resumed.

2011

Construction of the North Dam starts (until spring)

2012

Construction of the North Dam finished.

The Project was placed in care and maintenance before starting commercial production.

2013

Another ownership change happened, which resulted in recommencement of construction, with planned commercial production scheduled for early 2017.

2016

The water license was amended for the Doris Project (2AM-DOH1323 – Amendment 1).

2018

Construction of Phase 1 of the South Dam

The current water license was amended for the Doris Project (2AM-DOH1335 – Amendment 2).

2019

Ongoing development at the Doris North, as well as the Madrid areas.

3.3 Site Conditions

Climate

Mean Annual Air Temperature

For the period 1981 to 2016, the mean annual air temperature is estimated to be

- −11.9°C at Doris,
- −11.7°C at Boston,
- −13.9°C at Cambridge Bay A,
- −10.3°C at Kugaluktuk A, and
- −10.9°C at Lupin A.

Wind at Doris and Boston

- predominately a west wind direction at Doris and west-northwest at Boston
- highest wind speeds between December to April, with a predominant westerly wind direction (general site trend)
- velocity subsides with a tendency to be on the East-West axis but with no predominant direction otherwise from May to October (site trend)
- westerly in November and December (general site trend)

Precipitation

- rainfall and snowfall
- 89 mm mean annual rainfall for both Doris and Boston
- 120 mm mean annual snowfall (snow water equivalent)
- 210 mm estimated mean annual precipitation (water equivalent)

Lake Evaporation Estimation

- 284 mm/year at Doris

	• 291 mm/year at Boston **Reference:** (SRK 2017c)
Permafrost	The Project is in a region of the Canadian Arctic that is underlain by continuous permafrost with the following parameters: • 570 m estimated continuous permafrost depth (SRK 2017a) • −8°C near surface temperature • 0.5–1.0 m thick typical active layer, depending on surface ground conditions (SRK 2015a)
Regional Geology	**Bathurst Block** The Project area is in the faulted Bathurst Block, forming the northeast part of the Slave Structural Province, a geological sub-province of the Canadian Shield. **Archean Hope Bay Greenstone Belt** The region is underlain by the late Archean Hope Bay Greenstone belt that is • 7-20 km wide, • more than 80 km long in a north-south direction, and • made up of mafic meta-volcanic (meta-basalts) and meta-sedimentary rocks that are bound by Archean granite intrusive and gneisses. **Greenstone Package** The Greenstone packages • was deformed during multiple events and • is transected by major north-south trending shear zones. **Note:** The zones appear to exert a significant control on the occurrence of mineralization, particularly where major flexures are apparent and coincident with anti-forms (SRK 2015a).
Hydrology	The TIA is in a sub-basin of the Doris Lake drainage basin. • The catchment naturally drains northwest towards Doris Lake. • Flows are consistent with all drainage basins within the Project area. • Peak flows occur during freshet. • The mean annual runoff (MAR) volume from this basin is 640,000 m^3 (SRK 2017a).
Hydrogeology	**Groundwater Flow** Groundwater flow in a continuous permafrost environment is limited to shallow seasonal flow that takes place within the active layer and deep groundwater flow that • takes place below the permafrost and in taliks (permafrost free zones) under larger water bodies and

- has elevated salinity, since the groundwater is ancient trapped seawater (connate water).

Relative to Mining

The Doris Mine will include mining in permafrost, as well as mining in the Doris Lake talik.

- Peak groundwater inflow to the mine is predicted to be 3,000 m^3/day.
- This water will be managed via the TIA and/or direct discharge to the ocean (SRK 2015c, 2017a).
- If predicted mine inflow exceeds 3,000 m^3/day, the excess inflow will be temporarily stored in designated areas of the mine or pumped to the TIA.
- Excess pump capacity will be available to divert excess flow to the TIA (TMAC 2017b).

Talik

The TIA hosts a talik; however, it is not known whether it is an open or closed talik. The permafrost free zone is expected to decrease as tailings freeze-back occurs (SRK 2015a).

3.4 Communities of Interest (COI) Perspectives

The Hope Bay project and corresponding TIA are in a remote area of the Kitikmeot Region; the western part of Nunavut and the central part of the Canadian Arctic. Access to site is done almost entirely via plane but could also be access via boat in the summer or over ice in the winter. Most project impacts in Nunavut are predicated for the Kitikmeot region, that benefits from the location of the Hope Bay project in the region (TMAC 2017d).

As outlined in the Final Environmental Impact Statement (FEIS) (TMAC 2017d) the project development along the Hope Bay Belt cannot be done in isolation. Many partnerships are required and AEM has been supported in its development goals by meaningful partnerships with two major Inuit organizations, Nunavut Tunngavik Inc. (NTI) and the Kitikmeot Inuit Association (KIA). The NTI is the partner organization that coordinates and manages Inuit responsibilities set out in the Nunavut Agreement. NTI holds the surface title and mineral rights to Inuit-Owned Lands (IOL) in Nunavut, including the surface rights over the entire Hope Bay Property and mineral rights over selected portions of the Property. The KIA administers the surface rights and the Inuit Impact and Benefits Agreement (IIBA) associated with AEM's activities at the Property. The Kitikmeot Inuit Association (KIA) and AEM will continue to share in existing and future benefits through partnerships and agreements already in place including the Framework Agreement, the Inuit Impact Benefits Agreement (IIBA) and the Commercial Lease. Both organizations fill important roles on behalf of Inuit and they ensure, along with AEM, that the existing Framework Agreement and other, future agreements as required, will provide continued social and economic benefits for Nunavummiut, Nunavut and Canada, while effective stewardship of the land is maintained.

As outlined in AMEC (2005), the region has seven communities. The Kitikmeot communities would be most impacted (beyond the immediate personnel on site) from the TIA and Hope Bay project as a whole. Cambridge Bay is the largest and is the regional centre and transportation hub. Kugluktuk, the second largest community, is situated 450km south west of Cambridge Bay. Gjoa Haven, Taloyoak and Kugaaruk are located in the eastern part of the Region. The two smallest communities, Bathurst Inlet and Umingmaktok, south of Cambridge Bay, are the nearest communities to the TIA. Bathurst Inlet is approximately 150 km southwest and Umingmaktok is approximately 75 kms west-southwest from the TIA.

As outlined in FEIS Land Use volume, the Hope Bay Project has the potential to have an adverse effect on commercial land and resource use, and on local land use activities and knowledge. Commercial land users are mainly those engaged in the tourism industry (lodge operators, tour guides). Inuit (i.e., local land users) engaged in land use and harvesting activities depend on the land and environment to support their livelihoods. Traditional knowledge informs the ways in which Inuit engage with the land and environment and is continually evolving in response to changing landscapes. Because of the physical presence of the Project, changes to levels of noise, dust, and visual aesthetics—and potential changes to the abundance, distribution and quality of animals and plants that are harvested—the Project has the potential to adversely affect land use. Land use interests that are not associated with traditional activities, such as non-commercial land use (e.g., recreational use by southerners), are considered to occur as a commercial land use in conjunction with lodge operators and tour guides and is assessed as such. Therefore, non-commercial land uses are not considered further (TMAC 2017d).

3.5 Relevant Legislation and Guidance

Jurisdiction	Government of Canada and Kitikmeot Inuit Association
Governing Bodies	Authorities involved with permitting and regulating the design, construction, operation, maintenance, surveillance, and closure of the tailings impoundment area include the following groups: • Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) • Kitikmeot Inuit Association (KIA) • Nunavut Impact Review Board (NIRB) • Nunavut Water Board (NWB) • Workers Safety and Compensation Commission Chief Mines Inspector (per the Mine Health and Safety Act) and its associated regulations (Government of Nunavut, 1995)
Regulating Authorities	Use of the TIA is authorized by the following: • Doris North Project NIRB Project Certificate No. 003 (NIRB 2006) • Doris North Project Type A Water Licence 2AM-DOH1335 – Amendment No. 2 (NWB 2018) • KIA Commercial Lease #KTCL#313D001 (KIA 2015) • Schedule 2 of the Metal and Diamond Mining Effluent Regulations (MDMER)
Governance of Manual's Contents	**Canadian Dam Association (CDA)** • Dam Safety Guidelines (CDA 2013) – Guidance related to design and operation of dams • Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams (CDA 2014) – Guidance related to design, operation and closure of tailings dams **Mining Association of Canada (MAC)** • A Guide to the Management of Tailings Facilities, Third Edition (2017) – Guidance related to the management of Tailings Facilities **Nunavut Water Board (NWB)** • Audit and Assessment of Tailings Facilities (2011) – Guidance for audit and inspection of tailings facilities • Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities (2011) – Guidance for structure and content of tailings OMS manuals • Management of Tailings Facilities (2011) – Guidance for management and operation of tailings facilities

- Water License No: 2AM-DOH1335, Amendment No.2, Doris North Project, Nunavut (2018) – License to operate. Expires March 30, 2035. License updated December 7, 2018 with approval of amendment

3.6 Facility Components

North Dam

The North Dam impounds Reclaim Pond and was designed as a water retaining structure with the following parameters:

- central frozen core with secondary upstream GCL
- construction from local quarry rock consisting of processed fines for core, 150 mm nominal sized transition material, and run of quarry (ROQ) outer shell
- key trench equipped with 12 horizontal thermosyphon evaporators to ensure frozen foundation conditions (SRK 2007, 2012, 2013, 2015a)

Note: The North Dam has been in place since 2012. Design parameters are provided in Section 3.10 and Figure 4.

South Dam

The South Dam is a frozen foundation dam consisting of

- a compacted rock fill with
- an upstream GCL keyed into the permafrost overburden foundation.

Note: As of 2018 the entire key trench of the South Dam (Phase 1 and 2) had been constructed, along with the minimum thermal protection over these sections. Above the original ground elevation, the minimal thermal protection over the key trench as well as the Phase 1 GCL and bulk rockfill are in place.

Construction Material

Construction materials are sourced from local rock quarries and include

- ROQ material and
- different grades of processed material attained through crushing and screening (SRK 2015a, SRK 2019b).

Tailings Deposition

Tailings are deposited as a beach from the face of the South Dam. At all times a minimum 100m long beach is planned to be maintained. In Phase 2, to accommodate the increased tailings quantities, the South Dam will be raised

- by 8 m in a downstream configuration
- to reach a crest elevation of 46.0 m.

Note: Design parameters in Section 3.10 and Figure 5.

West Dam

The West Dam is a frozen foundation dam with a

	• key trench and • GCL liner keyed into permafrost. **Note:** As of 2021 the West Dam was not required for tailings containment and has therefore has not been constructed. **Construction Material** Construction material consists of: • bedding, transition, and ROQ material and • granular fill produced on site from approved local quarries **Note:** Complete geological, mineralogical and geochemical details of these quarry sites are documented in SRK (2007, 2008). **Tailings Deposition** West Dam is planned to be constructed in a single raise and is • about 470 m long • with a maximum height of 5 m (crest elevation 46.0 m). **Note:** Design parameters in Section 3.10 and Figure 6.
Interim Dike	The interim Dike was planned to • be a homogeneous ROQ rock-fill dike with an upstream filter zone; • be constructed within the confines of the TIA directly on the existing lakebed sediment without dewatering the TIA; • help retain tailings solids while allowing for tailings supernatant water to pass through the interim dike (this water then being stored towards the upstream face of the North Dam); and • be placed 2.5 years following the start of tailings production (SRK 2016). **Note:** The Interim Dike is not required as part of the Phase 2 tailings deposition plan and therefore has not been presented in this manual.
Spillway	An operational spillway was originally designed for the TIA at the North Dam but is no longer required due to the freeboard of the North Dam being adjusted to inflow design flood (IDF) of probable maximum flood.
Tailings Deposition System	Tailings with an initial solids content of about 38% should be pumped to the TIA via a heat-traced and insulated pipeline. Daily production rates are variable expected between 1,200 TPD (first year) to an allowance of up to 4,000 TPD (dependent on the mine life). **Deposition** Deposition is • subaerial using single point spigots, • start from the crest of the South and West dams to create beaches that push the supernatant water away from these structures, and

Once these beaches are created,

- the spigot points will be moved to the east flank of the TIA, where
- deposition should begin from elevation 49.5 m.

Note: Deposition is carried out to create a long and even tailings surface sloping toward the North Dam, ensuring the water in the original Tail Lake is displaced towards the north.

Note: If saline water (such as from the underground) is deposited into the TIA then this should be preferential deposited towards the center of the facility (i.e. away from the South Dam crest and upstream of the primary North Dam pond).

Reclaim Water System

Source and Method

Reclaim water (for re-use in the Process Plant) is drawn

- from the TIA Reclaim Pond through
- submerged suction lines feeding a low-suction head pump installed in an on-shore enclosure located or on a floating barge location at the Reclaim Pond.

The pipeline is

- heat traced and insulated, and
- follow the Secondary Road from the Reclaim Pond to the Doris mill.

Reclaim Pond Capacity

The Reclaim Pond will reduce in size over the life of the Project. The Reclaim Pond will have enough capacity to allow year-round reclaim water to be drawn from the TIA, including under ice conditions in the winter. Near the end of the Project’s life, the pond will be reduced in size such that

- increased volumes of fresh make-up water and more TIA discharge will be required, and
- the full supply level (FSL) may have to be lowered to accommodate the IDF.

Discharge Setting

Water in the Reclaim Pond will continue to be managed via active pumping to the TIA / Roberts Bay Discharge System until the environmental discharge criteria can be met at which time,

- the water in the Reclaim Pond will be pumped down to its pre-mining elevation of 28.3 m and
- the North Dam will be breached.

TIA Discharge System

Source and Method

TIA water is discharged year-round to Roberts Bay via a discharge pump that is

- located adjacent to the reclaim pump and
- pumps water along a pipeline following the same route as the reclaim water pipeline.

The TIA discharge water

- may be co-disposed with Doris Mine underground flows and
- is pumped along an overland pipeline to the Robert Bay Outfall Structure and
- continues along the submarine pipeline to the Roberts Bay diffuser.

Additional Pipelines

In addition to the primary discharge pump and line from the site, a pipeline will be

- installed from Madrid North to the Doris North TIA and

3.7 Construction Timing

North Dam

Construction of the North Dam was carried out

- during the winter months of 2010/2011 and 2011/2012
- by an experienced earthworks contractor with rigorous quality control.

Quality assurance was carried out by SRK (SRK 2012).

South Dam

Construction started on the South Dam (Phase 1) in 2018. Excavation and backfill of the key trench for both Phase 1 and Phase 2 was completed during winter of 2018. This was done

- to thwart issues caused by thawing of the soft overburden soils and
- to ensure that a thermal blanket is completed to protect the permafrost in the foundation.

Bulk fill of the Phase 1 portion of the South Dam was done during the late winter to spring of 2018. The Phase 2 bulk fill can now be completed during any season.

West Dam

Excavation of the West Dam key trench must be completed in the winter.

Bulk fill can be completed during any season.

The West Dam has yet to be built (as of 2021).

3.8 Tailings Properties

Tailings properties consist of geotechnical characteristics and geochemistry described below.

Tailings Geotechnical Characteristics

Several campaigns of tailings geotechnical testing have been carried out since 2003. Definitive geotechnical design data for the Project with respect to tailings properties are provided below.

Parameter	Value
Specific gravity	2.85
% Fines (<0.075 mm)	65%
% Silt	52%
% Clay	13%
Void ratio (e) – slurried tailings	1.2
Void ratio (e) – drystack tailings	0.6
Deposited dry density (tonnes/m^3) – slurried tailings	1.30

Tailings Geochemistry

Phase 1 of the Project includes deposition of flotation tailings from the Doris deposit whereas Phase 2 includes the Doris, Madrid and Boston deposits. Based on the mine schedule, tailings from the Madrid South deposit is scheduled to be on the surface of the TIA at closure. The geochemical characterization programs for tailings and process water from Doris, Madrid North, Madrid South and Boston are documented in SRK 2015b and SRK 2017e.

Flotation tailings from all deposits are classified as non-Potential Acid Generating (PAG) with sulphur content highest for Madrid North, which was higher than Boston and Doris (which are roughly equivalent), which were typically higher than Madrid South. Pyrite was the primary sulphide mineral in all tailings types from all deposit areas.

The pH of all humidity cell tests of flotation tailing remained neutral to alkaline for the duration of the tests. Arsenic leaching is the primary metal leaching concern for both Madrid North and Boston and was highest for Madrid North flotation tailings. Arsenic leaching was not related to tailings type, sulphide content or arsenic content.

Process water from the mill is a mixture of flotation and detoxified tailings process water and is discharged to the TIA. A comparison of the mixed tailings process waters for Doris, Madrid North, Madrid South[1] and Boston metallurgical samples were roughly equivalent with the following exceptions:

- Arsenic levels for Madrid North and Boston were approximately two orders of magnitude higher than Doris, with concentrations from Madrid North slightly higher than Boston.
- Madrid North and Boston were higher than Doris for the following parameters: sulphate, antimony (Boston only), chromium, selenium (Madrid North only), and vanadium (Boston only).
- Doris had the highest levels of manganese.
- Cyanide is a reagent additive that is part of the milling process thus explaining the presence of total and WAD cyanide in the detoxified tailings process water only. Decreases in total and weak acid dissociable (WAD) cyanide were observed over the duration of both the oxic and anoxic tests indicating degradation of residual cyanide in the samples. Ammonia is a degradation product of cyanide thus explaining the elevated ammonia levels.

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[1] Where Boston is an analog for Madrid South.

3.9 Dam Hazard Classification

The dams associated with the TIA area consist of

- **North Dam** - Frozen core rock fill dam with GCL
- **South Dam** – Frozen foundation dam with GCL. Constructed in two phases with downstream raises of GCL and rock fill.
- **West Dam** – Frozen foundation rock fill dam with geomembrane

The North, South, and West Dams were assigned a dam hazard classification in accordance with the CDA (2013) dam safety guidelines.

Dam Class	**North Dam**	**South Dam**	**West Dam**
Population at Risk	significant	significant	significant
Loss of Life	significant	significant	significant
Environmental and Cultural Values	high	high	high

Infrastructure and Economics	low	low	low
Overall Hazard Classification	high	high	high

3.10 Overall TIA Design Criteria and Parameters

The basis of design, design criteria, and design parameters for the TIA outlined below (SRK 2017f).

Description	North Dam	South Dam	West Dam
Secondary Seepage Barrier	GCL	GCL	GCL
GCL Deployment Slope	2.5H:1V	3H:1V (4H:1V for the raise)	3H:1V
Crest Centerline Length	220 m	515 m	470 m
Maximum Height	11.0 m	14.0 m	5.0 m
Final Crest Elevation	37.5 m	46.0 masl	46.0 masl
Initial Crest Elevation	n/a	n/a	n/a
Core/GCL Elevation	35.0 m	45.0 m	45.0 m
Full Supply Level	33.5 masl	44.5 masl	44.5 masl
Normal Operating Water Level	Typically 32m masl, or lower, against the North Dam. Targets set annually and documented in the TIA Annual Geotechnical Inspection reports.		
Total Freeboard	3.3 m	1.5 m	1.5 m
Hydraulic Freeboard	1.8 m	0.5 m	0.5 m
Thermal Protection above Frozen Core	2.5 m	n/a	n/a
Settlement and Allowance Foundation thaw of 1 m (partial thaw) Foundation thaw of 7 m (full thaw)	1 m	 0.47-0.67 m 2.45-3.85 m	 0.40-0.60 m 2.03-3.43 m
Deformation Allowance (Total Strain due to Creep)	<2%	n/a	n/a
Crest Width	13 m	10 m	10 m
Upstream Structure Slope	6H:1V	4H:1V	4H:1V
Downstream Structure Slope	4H:1V	2H:1V	2H:1V
Key Trench Depth	Varies	4.0 m	4.0 m
Key Trench Upstream Slope	0.5H:1V	2H:1V	2H:1V
Key Trench Downstream Slope	0.5H:1V	1H:1V	1H:1V
Dam Hazard Classification	HIGH	HIGH	HIGH
Design Life:			

Description	North Dam	South Dam	West Dam
Active use period as water retaining structure Design basis as active water retaining structure Active use period as solids retaining structure Design basis as solids retaining structure Total life until breach	17 years 22 years 22 years	 17 years 25 years	 17 years 25 years
Tailings Production Rate	1,200 tpd for first year; 2,400 tpd for next 2 years; 3,600 tpd for remaining mine life except last year of mining when production rate drops to 2,400 tpd		
Production Life	17 years		
Tailings Solids Content	35% solids (by weight) initially, increasing to 65%	37.5% solids (by weight)	37.5% solids (by weight)
Tailings Specific Gravity	2.85		
Deposited Tailings Dry Density	1.3 t/m^3 (1)		
Ice Entrainment Allowance: Percentage of tailings capacity By volume	 20% 2.4 Mm^3		
Tailings Beach Slope: Subaerial tailings Sub-aqueous tailings	 1.0% 1.0%		
Annual Exceedance Probability (AEP) for Risk Based IDF	1/2475 (0.0004)		
AEP for Standards Based IDF	1/3 between 1/1000 and the Probable Maximum Flood (PMF)(1)		
Static Stability Factor of Safety Long-term (Drained Conditions)	1.3 during construction 1.5 during operation and closure 1.2 to 1.3 partial or rapid drawdown		
Stability Factors of Safety (Pseudo-Static)	1.0 during earthquake		
AEP for Earthquake Design Ground Motion	1.2 post earthquake		
Peak Ground Acceleration (PGA)	0.060g(2)	0.036g	0.043g
Mean Annual Air Temperature Climate Change	+6.8°C up to year 2100		
Thermal Design Freezing Point Depression Tailings Overburden Frozen core	 n/a -8°C -2°C	 0 to -1°C -2°C n/a	 0 to -1°C -2°C n/a
Seepage Allowance	78 m^3/day	50 m^3/day	<1 m^3/day

Notes:
(1) Value based on experiential engineered judgement.
(2) A peak ground acceleration for a 1/2475 return period was not available at the time of design of the North Dam, and therefore the PGA of 0.06 g was selected based on published data for Kugluktuk. This is further described in SRK (2007).

3.11 Dam Break Analysis

In determining the dam hazard classification, consideration was given to tailings supernatant water and tailings solids reaching the receiving environment. The breach scenarios described below are intuitive, although likely extremely conservative. Nonetheless, these scenarios were adopted in assigning the dam hazard classification for the structures (Section 3.9). In 2019, a dam breach analysis was completed for the North and South Dam as part of the 2019 Emergency Response Plan update(App F). These dam break checks were used to confirm the conclusions below.

North Dam

Breaching of the North Dam would reach

- Tail Lake outflow,
- Doris Lake, Doris Creek,
- and Little Roberts Lake further downstream.

Supernatant Water

Supernatant water could conceivably reach the entire north downstream catchment all the way to Roberts Bay.

Note: under a conservative case where the largest possible volume of supernatant water (over 12 Mm^3) is discharged rapidly over a period of less than 8hrs, then the Doris Creek Bridge would also be damaged.

Tailings Solids

Based on the current deposition plans (off the South and West dams on the south end of the TIA) there is no conceivable chance of tailings solids being released as a result of a breach of the North Dam.

South Dam

Breaching of the South Dam would reach

- Ogama Lake,
- Ogama Lake outflow, and
- Subsequently, Doris Lake.

Supernatant Water

Supernatant water would eventually progress all the way along the drainage network to Roberts Bay.

Tailings Solids

A breach of the South Dam could result in tailings solids releasing

- into Ogama Lake and
- though a remote chance, into the Ogama Lake outflow and ultimately Doris Lake.

Tailings solids would not be expected to be transported any further than Doris Lake, with most tailings between the South Dam and down to and into Ogama Lake.

West Dam

Tailings breaching the West Dam would reach Doris Lake.

Supernatant Water

Supernatant water could progress all the way along the drainage network to Roberts Bay.

	Tailings Solids Tailings solids could reach Doris Lake, but at a location about 3.5 km away from the Doris Lake outflow. It is not expected the solids would migrate any further.

3.12 Water Management

Contact Water	All site contact water is pumped or trucked to the TIA.
Underground Water	Saline underground water (i.e., mine water) may be pumped to the TIA or Roberts Bay at an expected maximum rate of 3,000 m^3/day (SRK 2015c). Saline water pumping to the TIA should be limited as much as practical / when possible to assist with maintaining lower operating levels in the TIA. **Note:** Standby pump capacity should be available on site in the event of mine water inflows greater than 3,000 m^3/day, wherein excess mine water may be pumped to the TIA (TMAC 2017b).
Mill Water	Mill make-up water is drawn from the Reclaim Pond to the extent possible.
Excess Water	Year round (any season) as long as the site water quality requirements (Mining and Diamond Mining Effluent Regulations - MMDER) are met. Any excess water in the TIA during operations should be discharged to Roberts Bay for ocean discharge at a rate of 6,750 m^3/day. Prior to discharge to Roberts Bay, all water must meet MDMER limits (SRK 2017a and TMAC 2017a).
Non-Contact Water	There are no non-contact surface water diversions upstream of the TIA. The TIA is in an isolated catchment, and the benefits of any diversions are outweighed by the relative cost and complexity of constructing them.
General Guidance	A site wide water and load balance, including the TIA, has been developed for the Project and forms the basis for the water management plan (SRK 2017a and TMAC 2017a).

3.13 Tailings Facility Performance

All data collected as part of the dam monitoring SOPs, currently the North Dam (SRK 2013) and South Dam (SRK 2019c), are uploaded monthly onto the site TIA web portal / viewer.

The Environmental and Geotechnical Data Management and GIS Map Viewer System is found online at: https://maps.srk.com/HopeBay/

When initially accessing the site, personnel will need to register as a new user. This can be requested through the web link show above. Once access is set up, currently managed through SRK, a confirmation email is sent to the user.

Note: if a user does not receive their confirmation access email then they should check their junk mailbox. If it does not appear in this location, then they should email the EOR and re-request access to the online portal and GIS viewer.

As of the end of 2019 the following information was available, and updated monthly, on the web portal:

North Dam	• Ground temperature cables • Inclinometer data • Datalogger battery levels and temperatures
South Dam	• Ground temperature cables • Aerial satellite photos of tailings deposition (Sentinel-2 data)
TIA Reservoir	• TL-1 water level • TL-1 water quality • TL-5 water quality

Relevant documents related to the TIA as listed in section 1.2, such as this OMS, the design reports, as-built reports, annual inspections, and SOPs are also available on the web portal for reference.

In addition, ongoing data reviews are completed by the Design Engineer (and supporting team) on a monthly basis. A detailed annual review of all performance data is completed as part of the annual inspections.

4 Operations

Definition	Operations is a job, task, or group of tasks performed at the project site (Hope Bay). Operations are the process of managing many intermediate and long-term activities in and around the mine site to facilitate the production of a mineral product (ref: mndm.gov.on.ca). In the case of this manual operations are the activities around the TIA that are done to ensure TIA performance is upheld while facilitating the TIA use for waste and water management. Related documents and SOPs are reference in section 1.2 of this manual
Objectives	The operational objectives for the Doris TIA are to • implement controls that enable the facility to operate within its intended design and • meet performance targets during operations, closure, and post-closure.
Components	Operation of the TIA involves the following periods.

Periods	Description
Operation	Tailings slurry will be subaerially deposited into the TIA and water from the Reclaim Pond will be simultaneously recovered.
At Closure	Water in the Reclaim Pond will continue to be discharged directly to Roberts Bay until water quality in the TIA meets Doris Creek water quality discharge criteria as listed in the water licence (SRK 2017a). Once criteria are met, the North Dam will be breached and • exposed tailings surface will be covered with a run-of-quarry rock cover, and • the Interim Dike (if constructed) will be lowered to match the cover elevation (SRK 2015a).
Operation and Active Closure	During operation and active closure, the following will be maintained and surveyed to ensure their performance within stipulated design and operating limits: • North, South, and West Dams • Interim Dike (if constructed) • tailings feed pipelines • reclaim water pipelines • discharge pipeline
Post-Closure	After a period of post-closure confirmatory monitoring, site presence will cease. **Note:** Triggers for determining cessation of post-closure monitoring will be determined by AEM as part of future closure plan updates and will be submitted to the NWB for approval.

Components Operating Outside Parameters

TIA components operating outside of design or performance parameters will be investigated and remedied by one or more of the following actions:

- conducting appropriate maintenance
- modifying surveillance methods
- revising operational procedures
- implementing remedial measures revisiting the design

4.1 Operating Criteria and Constraints

The following summarizes the operating criteria and constraints for the infrastructure. A detailed table containing Trigger Action Response Plan (TARP) levels and associated response is in Appendix G

Deformation, Cracks and Seepages – North Dam

Trigger

Excessive thaw of foundation

Operational and Preventative Maintenance

- Maintain lowest possible water level in TIA.
- Ensure thermosiphons are operational.
- Maintain core at −2°C and foundation at −8°C.
- Implement seepage pump-back system.
- Ongoing review of thermistor, inclinometer and survey information

Mitigation Strategies

- Clear snow at downstream toe during winter.
- Construct coarse rock convection berm at downstream toe.
- Convert thermosiphons to active thermosiphons.
- Retrofit dam with vertical thermosiphons.

Deformation, Cracks and Seepages – South and West Dams

Trigger

Excessive thaw of foundation

Operational and Preventative Maintenance

- Maximize beach development from dam.
- Maintain lowest possible water level in TIA.
- Maintain foundation at −2°C.
- Implement seepage pump-back system.
- Ongoing review of thermistor, and survey information

Mitigation Strategies

- Flatten downstream dam slope.
- Clear snow at downstream toe during winter.
- Construct coarse rock convection berm at downstream toe.
- Retrofit dam with vertical thermosiphons.

-

Water Balance

Trigger

Reclaim water shortage

Operational and Preventative Maintenance

- Manage annual discharge to maintain minimum required operating water level.

Mitigation Strategies

- Increase make-up water demand from Doris Lake.

	Trigger Excessive inventory **Operational and Preventative Maintenance** • Manage discharge to not exceed maximum required operating water level. **Mitigation Strategies** • Increase discharge capacity. • Increase water treatment (if / as required)
Load Balance	**Trigger** Reclaim water shortage **Operational and Preventative Maintenance** • Manage annual discharge to maintain minimum required operating water level. **Mitigation Strategies** • Increase make-up water demand from Doris Lake
	Trigger Excessive inventory or poor water quality **Operational and Preventative Maintenance** • Manage discharge to not exceed maximum required operating water level. **Mitigation Strategies** • Increase discharge capacity (if possible) • Increase water treatment (if / as required) • Increase residence / storage time in TIA (may vary seasonally)
Tailings Deposition	**Trigger** Improper beach development **Operational and Preventative Maintenance** • Survey existing beaches and used data to recalibrate deposition modeling to develop new deposition plan. • Track tailings beach development with satellite surveys (e.g. Sentinel-2) **Mitigation Strategies** • Add additional spigot points as required by the revised deposition plan. • Relocation tailings preferentially to upstream face of South and West dam

Pipeline Freezing – Tailings, Reclaim, and Discharge	**Trigger** Winter period pump stoppage **Operational and Preventative Maintenance** • Maintain minimum flow velocities of 1 m/sec. • Heat tracing and insulation of pipelines. • Mobile backup pumps **Mitigation Strategies** • Installation of secondary pipeline(s). • Complete repairs of any damaged insulation in summer (pre-winter)
Pipeline Breakage or Leakage – Tailings, Reclaim, and Discharge	**Trigger** Fatigue, corrosion, or accident **Operational and Preventative Maintenance** • Implement visual inspection procedure. • Establish barricades where appropriate. • Provide secondary containment in high risk areas. **Mitigation Strategies** • Stop pumping and implement site spill response plan.
Pipeline Sanding Up – Tailings	**Trigger** Pump stoppage for extended periods **Operational and Preventative Maintenance** • Mobile backup pumps. • Flush pipeline immediately following pump stoppage. **Mitigation Strategies** • Installation of secondary pipeline. • Dismantling affected section of pipeline and flushing or replace.
Tailings Dust	**Trigger** Wind and equipment traffic **Operational and Preventative Maintenance** • Minimize use of equipment on tailings beaches. • Apply water **Mitigation Strategies** • Apply chemical dust suppressants as appropriate. • Modify deposition strategy (assuming minimum 100+m beach length is being maintained off upstream slope of South and West dams).
Animal Access	**Trigger**

	Terrestrial mammals entering TIA area **Operational and Preventative Maintenance** • Implement Wildlife Monitoring and Mitigation Plan (WMMP). **Mitigation Strategies** • Refer to WMMP.
People Safety	**Trigger** Uninformed people accessing TIA area **Operational and Preventative Maintenance** • Conduct site specific orientation and training. **Mitigation Strategies** • Implement access controls through signs and road barricades. • Promote awareness, through training and information sessions and site inductions on site. • Require all vehicles do radio 'call-ins' / checks when entering the Tailings Lake Road from camp.

4.2 Tailings Transport and Deposition

Deposition

Deposition should be subaerial using single point spigots and placed as follows.

Step	Placement
1	Place tailings starting from the crest of the South and West Dams. **Note:** The placement should create beaches that push the supernatant water away from the dams. Tailings deposition is expected to result off the dam crests during the non-ice-covered months (e.g. summer to fall)
2	After the beaches are created, move the spigot points to the east and west flank of the TIA. **Note:** This should create a long, even tailings surface that slopes toward the North Dam and ensures the water in the original Tail Lake is displaced towards the north. Deposition at locations upstream of the South and West Dam crest is expected to be done during the colder months when ice is apparent on the TIA reservoir (e.g. winter and spring). This is done to allow for the tailings beach to cool over the

	winter to better protect the frozen foundations, and to avoid excessive spigot movement in the winter that may lead to increased ice entrainment.

Double-Walled Pipeline Placement

As an added environmental protection measure against spill containment, the pipeline should double-walled at the following locations (SRK 2015a):

- where the pipeline crosses Doris Creek at the Doris Creek bridge and
- at the three locations along the Doris to Windy all-weather road between Madrid North and the Doris North TIA (SRK 2017d).

Staged Tailings Deposition

A series of plans showing the staged tailings deposition for from the projected end of 2020 and then for the end of the active tailings deposition (end of Phase 2) is presented in SRK (2020). This is based on latest bathymetry data and updated tailings deposition plans. Updated tailings stage storage curves are to be generated annually and incorporated into the operational water and load balance tool to track tailings storage capacity, and plan for annual spigot deposition point moves as directed by the design engineer.

The stage storage data for the Doris TIA as of the start of 2020 is approximately as follows:

Lower Elevation (m)	Upper Elevation (m)	Volume (m^3)	Cumulative Volume (m^3)	Plan Area (m^2)
19.5	22	0	0	0
22	23	27,000	27,000	53,000
23	24	178,000	178,000	203,000
24	25	440,000	440,000	310,000
25	26	816,000	816,000	429,000
26	27	1,295,000	1,295,000	524,000
27	28	1,860,000	1,860,000	605,000
28	29	2,509,000	2,509,000	690,000

29	30	3,243,000	3,243,000	770,000
30	31	4,061,000	4,061,000	874,000
31	32	5,042,000	5,042,000	1,057,000
32	33	6,169,000	6,169,000	1,185,000
33	34	7,417,000	7,417,000	1,307,000
34	35	8,785,000	8,785,000	1,418,000
35	36	10,257,000	10,257,000	1,528,000
36	36.75	11,434,000	11,434,000	1,609,000

Deposition Planning Compliance

At the end of each month the compliance to the deposition performed must be validated against the performance indicator in the table below to verify if the deposition is on track. This compliance analysis is documented monthly in the SRK monthly dashboards.

4.3 Ongoing Construction

An OMS manual identifies requirements and plans for staged tailings facility construction during the operations and ongoing construction phase of the life cycle to maintain adequate solids storage capacity and water management, including:

- method(s) of stacking, hydraulic placement, and/or dam construction;
- schedule of facility expansions;
- material and equipment required;
- construction management procedures; and
- quality assurance and quality control measures and activities (e.g., documentation, as-built survey records).

An OMS manual describes performance objectives and indicators that the tailings facility construction plan and schedule are based on acceptable performance ranges for those indicators.

4.4 Dust Management

Control Measures

The tailings deposition plan was developed, as far as practical, to minimize the area of exposed inactive tailings surface that may be prone to dusting. Nevertheless, when needed, application of environmentally suitable chemical dust suppressants should be

- applied annually in general,
- applied more frequently if needed as discharge locations change, and
- reviewed on an ongoing basis to ensure at-risk areas are adequately covered.

Note: Appendix B provides a comprehensive assessment of possible dust management practices for the tailings surface.

Control Products

While the effectiveness of dust suppression fluctuates depending on how deposition points vary during the winter season, dust should be controlled using

- packed snow when available and practical,
- chemical suppressants, and
- water cannons to wet areas of concerns when other methods prove temporarily ineffective.

Note: Attachment C contains details on the product that has been outlined as preferred by AEM. Use dust suppression products is permitted upon receipt of approval from the Nunavut Water Board.

4.5 Water Management

Contact Water

In addition to tailings slurry, the following sources of mine contact water may be pumped to the TIA during operations:

- underground mine water
- pollution control pond water
- sedimentation pond water
- landfill sump water
- bulk fuel storage sump water
- treated sewage effluent
- other industrial water collected from various locations (Figure 8)

Supernatant Water

Drains into the TIA Reclaim Pond and reclaimed for use in mill operations

Excess Water

If in…	then excess water discharges to Roberts Bay…
operations	year round

care and maintenance	via the Marine Outfall Mixing Box annually during the open water season.

Note: Site specific water quality requirements (MMDER) must be met before any discharge.

General Guidance

Complete water management procedures are provided in the Water Management Plan (SRK 2017a, AEM 2022a).

4.6 Site Access and Security

Access

The Doris project is accessed by

- air via an all-weather air strip and
- water via a barge sealift resupply in Roberts Bay annually during the open water season.

Security

Access to the TIA is restricted to authorized

- employees,
- contractors, and
- consultants.

Note: All workers accessing the facility are trained and knowledgeable about hazards at and near the TIA.

4.7 Environmental Protection

Aquatic Environment

Protection of the aquatic environment was incorporated into the design of the facility through

- selection of a dam classification criterion,
- dust management system,
- water management planning,
- the incorporation of an impermeable liner within the North, South and West Dams, and
- secondary pipeline containment along the extent of the Doris Creek crossing and along the creek crossing form Madrid North to the Doris TIA along the all-weather access road.

References: SRK 2015a, 2015d, 2017d and TMAC 2016.

4.8 Freeboard Requirements and Operating Levels

Freeboard requirements should be reassessed annually as part of the annual geotechnical inspections.

Structure	**Freeboard to crest (m)**		**Maximum tailings elevation (m)**	**Operation Water level (m)**		**Corrective Action Condition**	**Critical Condition Level (m)**
	Tailings	**Water**		**Normal**	**Early Warning level (m)**	**Max = Full Supply Level (m)**	
North Dam	N/A	2.0	N/A	<31.5	31.5-32.5	32.5-33.5	>33.5
South Dam	1.5	N/A	33.5	N/A	N/A	N/A	N/A
West Dam	1.5	N/A	33.5	N/A	N/A	N/A	N/A
TARP Level	N/A			Green	Yellow	Orange	Red
Response	N/A			Standard operations	Inform stakeholders (Section 4.9) Refer to Appendix D for specific action	Immediately take action to stop increase. Inform stakeholders (Section 4.9) Refer to Appendix D for specific action	Trigger ERP (Section 4.9)

North Dam

The North Dam is operated as a water retaining dam with the parameters indicated below.

Component	Elevation (m)
crest elevation	37.5
top of frozen core and geosynthetic clay layer	35.3
full supply level (TARP Level 3)	33.5
total freeboard	4.2
normal freeboard	2

Note: These freeboard numbers include a 1 m allowance for dam deformation (SRK 2015a). Total freeboard also includes required area to store a storm volume at least 1/3 between 1/1000 and the PMF (see Section 3.10).

South and West Dams

The South and West Dams are not water retaining structures with the parameters indicated below.

Component	Elevation (m)
crest elevation – Phase 1 crest elevation – Phase 2	38.0 44.5
top of geosynthetic clay liner – Phase 1 top of geosynthetic clay liner – Phase 2	36.5 45.0
full supply level	33.5
freeboard	1.5

Note: Tailings beaches along the upstream slope of these dams creates a final topography that free-drains towards the Reclaim Pond ensuring no water will pond adjacent to these structures. Tailings deposition discharges from points located near the dam crest. The tailings level at the South and West dam is designed to be above the full supply level (which is governed by the elevation of the North Dam).

4.9 Communication and Decision Making

Figure 4-1 indicates the communication and decision processes when the threshold criteria are met and when pre-defined action need to be implemented. Table 4-1 indicates the communication procedure to follow when changing the TARP level.

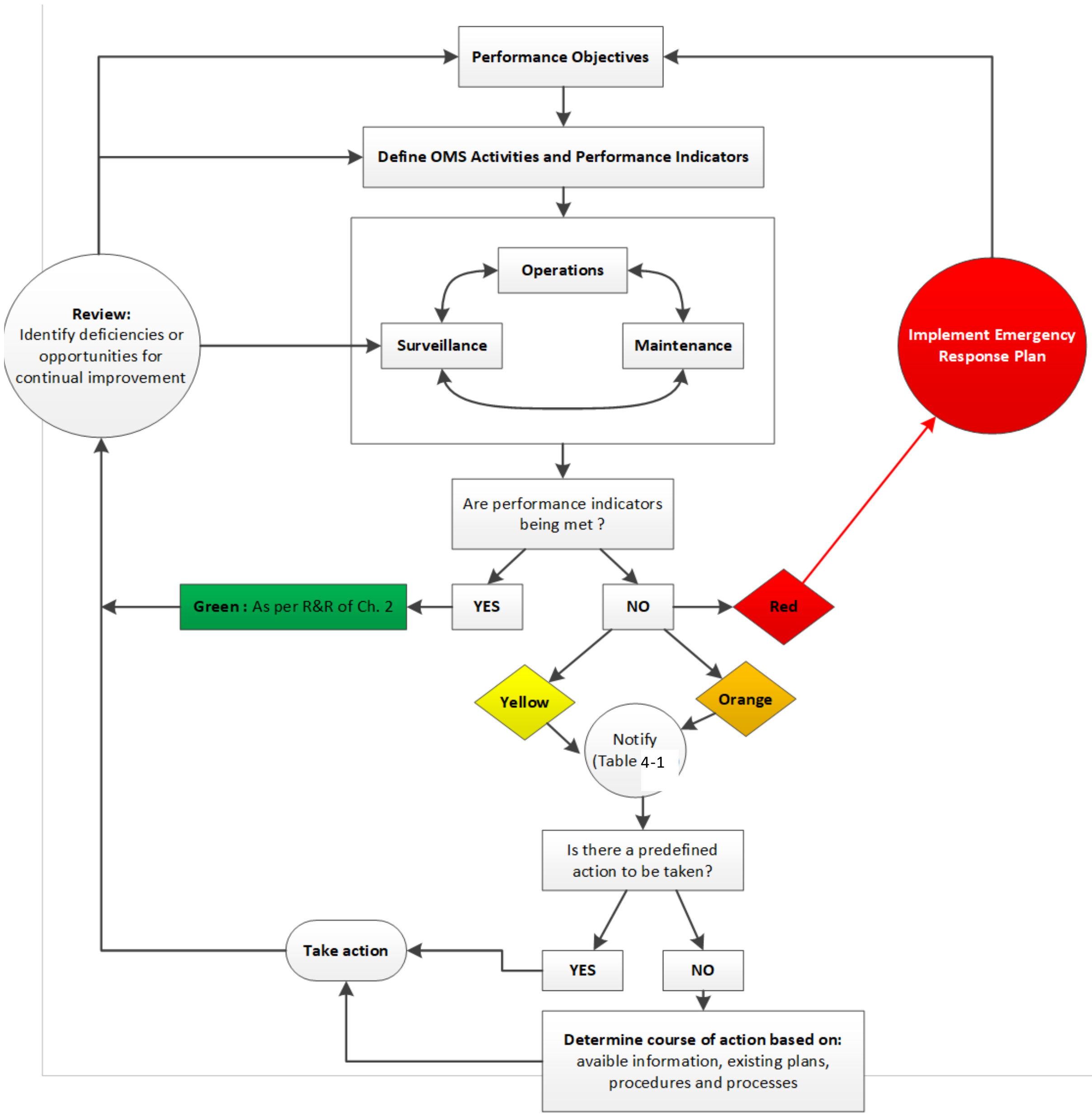

Figure 4-1: Communication and Decision Process for Water Management Infrastructure TARP

Table 4-1 : Communication Procedure to Change TARP Level

<table>
<tr><th>Category</th><th>Notify</th><th>Timeline</th><th>Method of Communication</th></tr>
<tr><td>Green</td><td>On-Site team → Responsible person →
• Independent Review Board
• Designer
• General Manager
• EOR
• AEO</td><td>The trigger are back to green for more than 2 weeks</td><td>Phone Call and E-mail to inform on status change. RP and EOR must agree to change status

Brief memo sent by e-mail to officialise TARP change</td></tr>
<tr><td rowspan="3">Yellow</td><td>On-Site team → Responsible person →
• EOR</td><td>Within 24 hours of the TARP level condition being met</td><td>Phone Call and E-mail to inform on status change. RP and EOR must agree to change status. If RP can't be joined the on-site team will try to contact these people in this order : Water & Tailings GS, EOR, AEO</td></tr>
<tr><td>Responsible person →
• Independent Review Board
• Designer
• General Manager
• EOR
• Process Plant Superintendent</td><td>Within 72 hours of the TARP level change</td><td>Brief memo sent by e-mail to officialise TARP change

Meeting to be set to explain situation if required</td></tr>
<tr><td>EOR →
• AEO</td><td>Within 1 week of TARP level change</td><td>Left to the EOR discretion</td></tr>
<tr><td rowspan="2">Orange</td><td>On-Site team → Responsible person →
• EOR</td><td>Immediately upon discovering TARP level triggers change</td><td>Phone Call, E-mail and meeting to inform on status change. If RP can't be joined the on-site team will try to contact these people in this order : Water & Tailings GS, EOR, AEO</td></tr>
<tr><td>Responsible person →
• Independent Review Board
• Designer
• General Manager
• EOR
• AEO
• Health & Safety Superintendent
• Process Plant Superintendent</td><td>Within 24 hours of the TARP level change</td><td>Brief memo sent by e-mail to officialise TARP change

Meeting to be set to explain situation</td></tr>
<tr><td rowspan="2">RED</td><td rowspan="2">On-Site team → Emergencies Response Team

Once an emergency is declared refer to the ERP. Emergency response is out of scope of this document</td><td>Immediately when the emergency is discovered.
If there is currently a risk to Env or Health and Safety</td><td>Emergency – Emergency Emergency and road channel
Or at
Emergencies 911</td></tr>
<tr><td>Immediately when the emergency is discovered.
If there is imminent risk to Env or Health and Safety</td><td>Phone call to ERT coordinator (103) & Health and Safety Superintendent</td></tr>
</table>

4.10 Closure Overview

The overall objectives of the conceptual closure and reclamation plan are to leave the site in a manner safe for humans, wildlife, and the environment that meets future land use goals. This will be done by establishing stable chemical and physical conditions and ensuring the future use and aesthetics of the site following reclamation meet the requirements of Aboriginal, Federal and Territorial governments, landowners, local communities and regulatory authorities.

The tailings surface will be covered with a nominal waste rock cover of 0.3 m thickness. The function of the cover is to prevent dust and to minimize direct contact by terrestrial wildlife. Once the water quality in the Reclaim Pond has reached the required discharge criteria, the North Dam will be breached as originally intended for Phase 1. The TIA once breached will discharge into Doris Lake which in turn discharges into Doris Creek.

The TIA will only contain flotation tailings which are non-PAG with abundant neutralization potential and thus buffering capacity. Although several metals in the tailings solids occur at concentrations more than crustal abundances, many of these metals are associated with sulphides and as such will primarily partition into the detoxified tailings which means they will not be of concern in the TIA.

Long-term humidity cell tests indicate that after the initial flushing of the samples, an increased tendency for neutral pH metal leaching may develop, with arsenic being of concern. The TIA water and load balance (SRK 2017a) suggests that possible neutral metal leaching does not pose a limitation in ensuring that the water quality in the TIA meet site specific closure water quality criteria, and therefore no infiltration reduction cover is required on the exposed tailings surface. The tailings surface will, however, be susceptible to wind erosion with the resultant effect of dust exposure. Similarly, although the tailings surface is landscaped to allow free drainage, the tailings are susceptible to hydraulic erosion, which will mobilize tailings towards the Reclaim Pond with a resultant increase in total suspended solids.

The tailings cover that functions to prevent wind and water erosion will be constructed over the entire tailings surface. The minimum thickness of cover that can practically be placed over the tailings surface would be about 0.3 m thick, and therefore the cover design has been set at 0.3 m thick ROQ material.

5 Maintenance

Definition	Maintenance is an ongoing process of activities to maintain (uphold) the proper function of the dam, thereby ensuring compliance with safety regulations. Ongoing maintenance can consist of items such as housekeeping, small repairs and regular inspection of the dam structures and proper operation of all components linked to the TIA. Good maintenance habits can lead to early detection of deficient, help reduce the risk of failures, and extend the useful life of the dams and TIA system as a whole.
Objective	The objective of the maintenance program is to ensure all TIA components operation according to their performance criteria by carrying out • routine and preventative maintenance (such as to address minor settlement) and • event-driven maintenance (such as after a large storm event)
Components	The Doris TIA components that require maintenance include the • pipeline systems, including the ocean discharge system and • North Dam, South Dam, and West Dam (not yet constructed).

5.1 Pipeline Systems Maintenance

Scope	Routine and preventative maintenance should be carried out on pumps, pipelines, drain outlet pipes, valves, and flow and hour meters.
Person(s) Responsible	Operations staff (member of the mill)
Frequency	Varies by component (see below)
Documentation	Maintenance records for each component are communicated to the Process Operations Superintendent , kept by maintenance and include the following: • up-to-date logs of in-service equipment and facilities • maintenance schedules • maintenance history • inspection logs • repair records • frequency and cause of problems, and planned mitigation • component reliability records • photographic evidence of repairs • inventory of spares, material, tools, and equipment • critical spares list

Reporting	Hard copies of all documents produced in the reporting and tracking process should be stored at the project safe-keeping location. All hard copy documents should be scanned and turned into electronic records at least annually. All electronic documents should be saved on a safe computer or network drive.
Pumps	Maintain pumps (including seals, controls, instrumentation, and electrics) per the manufacturer's specifications.
Pipelines	Flush pipelines completely with fresh water every six months (or as needed). Pressure test pipelines to check for leaks annually.
Drain Outlet Pipes	Monitor drain outlet pipes during drainage. **Important!** If a flow rate drop-off is detected, flush the pipe using hydraulic cleaning equipment.
Valves	Maintain isolating and check valves per the manufacturer's specifications.
Flow and Hour Meters	Service flow and hour meters annually, recalibrating them to the manufacturer's specifications.

5.2 Dam Maintenance

Scope	Dam maintenance needs should be determined after completion of the dam safety inspection (Section 6.5). However, ongoing maintenance of instrumentation, the foundations, downstream toe, and thermosyphons will be likely / should be expected to be required each year during operation.
Person(s) Responsible	Responsible Person
Frequency	Annually
Documentation	As-built survey pick-up and a written and document event log (outlining the approach taken for any maintenance as well as the element and location) will be required. If fill materials are placed, then volume estimated (truck counts and as-built surveys before and after) should be completed.
Reporting	A record of all maintenance activities should be kept on site and reviewed at least monthly by the Responsible Person. For any notable earthworks, or areas where maintenance is done over a larger special extent, (e.g. to clean up a tailings spill, fill placement for buttressing or crack repair etc…) the EOR or record should be notified and as-built survey pick-ups must be completed.

General Guidance	The annual geotechnical inspection reports (as performed by the EOR) should be consulted for examples of past maintenance and for general guidance.
Instrumentation	Repair or replace worn or damaged instrumentation as needed and recalibrate (SRK 2013, SRK 2019c).
Foundations	**Background** Thermal modeling for the dams has shown that although the dam core and its foundation will remain frozen, the upstream and downstream foundations will gradually thaw and lead to settlement of those sections of the dam. **Maintenance** Based on the findings of the DSI, areas that have undergone settlement may have to be repaired by adding more fill (SRK 2007, 2013, 2015a).
Downstream Toe	**Background** Snow drifts on the downstream toe of the dams will result in an insulating effect on the downstream toe, which may lead to more rapid thaw of the downstream foundation. **Maintenance** To maximize dam performance beyond what the thermal modelling may suggest, clear snow regularly from this area.
Thermosyphons	Inspect thermosyphons visually for performance deficiencies. If needed, • recharge with CO_2 if needed and • repair or replace any damaged radiator fins (SRK 2013).

5.3 Event-Driven Maintenance

Scope	The TIA should be inspected after unusual or extreme events such as • heavy rainfall, • flooding or exceedance of the maximum water level, • severe icing, • rapid snowmelt, or • earthquakes.
Person(s) Responsible	Responsible Person
Frequency and Timing	After unusual or extreme events

Documentation	Records for all event driven maintenance should be summarized in a deliverable format similar to what is required for the visual site inspections (Section 6.1).
Reporting	For event-driven maintenance, the EOR should be notified to ensure maintenance activities and plans are appropriate to uphold the design integrity of the TIA components. As-built surveys will be required to be gathered before and after any even-driven maintenance. All digital files along with notes and photos of the maintenance work performed should be submitted to the EOR for review.
General Guidance	Review the design criteria (Section 3.10) to better understand what triggers the need for event-driven maintenance. **Important!** To a large extent, the judgement of persons responsible on site governs specific event-driven maintenance. When in doubt contact the Mill (Process) Manager, the Environmental Site Superintendent and/ or the EOR for additional guidance or clarification.

6 Surveillance

Definition

Surveillance is the process of gathering information through visual inspections, monitoring performance, safety audits, and data collection.

Objectives

The objectives of the Doris TIA surveillance program are to

- regularly monitor the operational performance of the TIA and its components,
- consistently report observations,
- regularly review and interpret surveillance data, and
- inform preventative maintenance by generating qualitative and quantitative surveillance information.

Components

The surveillance elements for the Doris TIA includes

- visual site inspections,
- instrumentation monitoring (thermal, deformation, and water balance),
- tailings geochemistry monitoring,
- water quality monitoring,
- dam safety inspections, and
- dam safety reviews.

Data Management

Staff should complete the following actions to manage monitoring data.

Step	Action
1	Back up all monitoring data electronically.
2	Scan manual notes and save together with raw and transposed data.
3	Immediately following collection, qualified staff should review data to • confirm integrity of the instrumentation and • ensure the TIA is performing to expectations and monitoring guidelines specified in the dam surveillance SOPs (SRK 2013, SRK 2019c).

The RP is responsible for ensuring that the ongoing monitoring as documented in the dam surveillance SOP is carried out (SRK 2013, 2019c). If determined necessary, the Process Operations Superintendent may consult with the EOR to complete a safety inspection outside of the routine annual DSI.

6.1 Visual Site Inspections

Scope	Visual inspections are carried out on the TIA structures including dams, pump stations, pipelines, and spigots.
Person(s) Responsible	Operations staff
Frequency	Daily
Documentation	All inspections and observations are recorded in the appropriate site logbooks.
Reporting	As directed by the Process Operations Superintendent personnel with be trained and assigned to complete ongoing daily visual inspection. These personnel will report back to the Process Operations Superintendent. **Reporting Notable Changes** Notify the engineer-of-record immediately after any inspection where notable changes to any of the TIA facilities outside of normal operating constraints are observed. The EOR should, in consultation with operations staff, assess the situation and develop any actions plans deemed appropriate. **Daily Visual Inspection Report** Under supervision of the Process Operations Superintendent, prepare the daily visual inspection report and kept in-house. **Note:** A template for this report can be found in the SOP (SRK 2013, 2019c). **Annual Reporting** In accordance with the relevant water licences, visual site inspection information (along with instrumentation monitoring information) should be • included in the annual geotechnical inspection report and • submitted no later than March 31 each year (submitted as part of the annual water license requirements).
General Guidance	A monitoring checklist is presented in the dam surveillance SOP (SRK 2013, 2019c).
All Structures	Visually inspect all TIA structures, taking note of • any signs of settlement, • unaccounted for drops in water levels, • signs of seepage, and • any signs of damage or vandalism to instrument clusters.
Dams	Monitor creep deformation within the South Dam and West dam, as these structures may be susceptible to creep deformation and or thermal

degradation of the foundations (all dams) or core (specifically for the North Dam) in the long term.

Pump Stations

Staff are to complete the following actions when visually inspecting pump stations.

Step	Action
1	For each pump, verify • whether it is operating properly, • hours operated, and • discharge and suction pressures.
2	Check for leaks and spillages.
3	Confirm oil levels for all pumps.
4	Inspect water pump seals on tailings pumps.
5	Note alarms and messages.

Pipelines

Staff are to complete the following actions when visually inspecting pipelines.

Step	Action
1	For each pipeline, verify • whether it is operating properly, • hours operated, • flowmeter data, and • operating pressures along each pipeline.
2	Check for leaks and spillages.
3	Note hazards along pipeline route.
4	Verify where tailings deposition has taken place (i.e. within the past 24 hours).
5	Note alarms and messages. **Example:** Malfunction of electric heat tracing cable inside the pipeline during freezing temperatures.

Spigots

Stringent monitoring of the two spigots situated on the east flank of the TIA is required since both spigots are above the crest elevation of the South Dam.

Important! Spigot elevations are typically lower than the crest elevation of containment structures.

6.2 Instrumentation Monitoring

Scope	Instrumentation monitoring is carried out on the North, South dams (both constructed), and West Dam (when constructed) and include • thermal, settlement, and other general deformation monitoring such as inclinometers, deep survey monitoring points, and surficial survey monitoring points, and • thermal monitoring of the tailings profile to confirm tailings freeze-back assumptions.
Person(s) Responsible	Qualified person under the direction of the RP
Frequency and Timing	Weekly to Monthly
Documentation	Consult latest North Dam and South Dam monitoring Standard Operating Procedures (SOP) documents for additional details and inspections forms.
Reporting	**Monthly Instrumentation Report** Under supervision of the RP, prepare the monthly instrumentation report and submit it to the engineer-of-record. **Annual Reporting** In accordance with the relevant water licences, instrumentation monitoring information (along with visual site inspection information) should be • included in the annual geotechnical inspection report and • submitted as part of the annual geotechnical inspection process to the inspector.
General Guidance	Additional guidance on the required instrument monitoring (how to perform and frequency) is presented in the dam surveillance SOP (SRK 2013, 2019c).
North Dam	The locations of North Dam monitoring instruments are shown in Figures 9 to 12.
South Dam	The locations of South Dam monitoring instruments are shown in Figures 13.
West Dam	As the West Dam is not currently built (will be built as part of Phase 2 operations) there is no required monitoring.

6.3 Tailings Geochemistry Monitoring

Background	Flotation tailings geochemical characterization testing has confirmed that due to the high neutralization potential and low sulfur content, acid rock drainage potential is considered low; however, there is potential for neutral pH metal leaching, particularly for arsenic (SRK 2015b and SRK 2017e).
Scope	Sample collection for the preparation of a monthly composite sample that will be analysed for • total metals by aqua regia digestion followed by ICP finish, • total sulphur by Leco furnace, and • direct measurement of total inorganic carbon.
Person(s) Responsible	Coordination through AEM site environmental supervisor
Frequency	Weekly
Documentation	Sampling and testing results and analysis presented in annual waste rock, quarry and tailings monitoring reports.
Reporting	In accordance with the relevant water licences, an annual geochemical monitoring report should be submitted no later than March 31 each year.
General Guidance	Recent annual waste rock, quarry and tailings monitoring reports (SRK 2020d)

6.4 Water Quality Monitoring

Scope	TIA Water quality is monitored at compliance station TL-1 at the Reclaim Water pump station. Ongoing review of water quality trends and a comparison to MDMER limits are completed each year. In additional to the above, weekly sampling and geochemical analysis of any North Dam or South Dam toe seepage is to be completed when present.
Person(s) Responsible	Coordination through AEM site environmental supervisor
Frequency	Monthly (minimum) Seepage typically sampled during ice free / summer months (around June to October) if present.
Documentation	Monthly water quality reports prepared by AEM

Reporting	In accordance with the relevant water licences, data should be presented as part of annual reporting.
General Guidance	Water quality monitoring for the TIA is described in the Doris and Madrid Water Management Plan (TMAC 2017a). For seepage sampling see North and South Dam SOPs (SRK 2020a, 2020b)

6.5 Dam Safety Inspection

Scope	The dam safety inspection is a physical surveillance of the North, South, and West dams.
Person(s) Responsible	The engineer of record—or another qualified professional engineer authorized by the engineer of record—must complete the inspection.
Frequency and Timing	The dam safety inspection should be carried out • annually • within the summer (ice free) months.
Documentation	Records of annual inspections and detailed review of monitoring data by the engineer of record —or another qualified professional engineer authorized by the engineer of record— presented in a TIA Annual Geotechnical Inspection report (AGI). These are submitted annual and are a permit requirement for the project.
Reporting	The engineer of record should prepare a detailed dam safety inspection report that includes her findings and recommendations on the performance of the dams and accounts for • review and analysis of collected monitoring data • inspection observations, and • interviews with TIA staff. **Note:** The report should be delivered within 90 days of inspection to Agnico (Responsible Person) so any maintenance and mitigation can be carried as early as possible and to meet submission requirement to NWB.
General Guidance	See recent annual geotechnical inspections for additional details (SRK 2020c).
Significant Concerns	Any areas of significant concern should be immediately communicated to AEM at the time of the dam safety inspection.

6.6 Dam Safety Review

Scope

The dam safety review is a physical surveillance of the Doris TIA with a focus on the North, South, and West Dams. This systematic assessment should consider all aspects of the Doris TIA's design, construction, maintenance, operation, processes, and systems affecting its safety.

Note: This review should use state-of-practice principles as opposed to when those used when the facilities were designed.

Person(s) Responsible

An independent third party must complete the inspection.

Frequency

The dam safety review should be carried out every seven years in addition to the annual dam safety inspection.

Key Date: The next dam safety review should be completed in 2028.

Documentation

Records of the dam safety review to be documented in a stand along dam safety review report.

Reporting

An independent third party professional engineering should prepare a detailed report that documents a complete systematic review and evaluation, of all aspects of design, construction, operation, maintenance, and surveillance, and other relevant processes and systems affecting a dam, to evaluate the design criteria with current standards, operational compliance with design intent, stability and functionality of the dam, and to identify appropriate remedial measures (if / as applicable).

General Guidance

See Mining Association of Canada (MAC) 'A Guide to the Management of Tailings Facilities' (2017) and the Canadian Dam Association (CDA) 'Dam Safety Review Technical Bulletin' (2016)

Significant Concerns

Any areas of significant concern should be immediately communicated to engineer of record and AEM at the time of the dam safety review.

6.7 Independent Review Board Meeting

Scope

The Independent Review Board (IRB) shall meet to discuss the following topics

- Site visit (during period of flow) of all infrastructure covered by the scope of the IRB
- Review of mine waste management strategy (including tailings and waste rock storage facilities);
- Review tailings management infrastructure designs and performance (including water retaining infrastructures);

	• Review of on-going construction works and monitoring data; • Comment on implementation progress of proposed mine waste management improvement measures; • Provide opinions and guidance to the operation on the physical integrity, safety, behavior, and performance of the confinement systems for mine waste and water retaining infrastructures; and • Comment on management systems, emergency preparedness and overall management approach of the different mine waste management facilities and water retaining infrastructures.
Person(s) Responsible	The RP will organize the meeting
Frequency	A meeting will be held annually, typically following the site visit
Documentation	Meeting minutes
Reporting	The IRB will submit a report following their observation and recommendation following each meeting. The Environmental Superintendent will ensure that an action plan is developed to address the recommendation and will transmit the report and the action plan to the EOR.
General Guidance	See Agnico's Governance for Critical Infrastructure – Terms of Reference for IRB
Significant Concerns	Any areas of significant concern should be immediately communicated to engineer of record and AEM at the time of the IRB annual visit.

7 Emergency Management

Objectives

The emergency management procedures below have two key objectives:

- avoid injury or death of persons working on pipeline systems, and
- prevent or minimize environmental damage.

Emergency Response Plan

This section outlines linkages with the site Emergency Response Plan (AEM 2022) and the Dam Emergency Plan (DEP) (AEM 2022). The ERP and the DEP area stand-alone plans and is complimentary to this OMS document, both are located in Appendix E & F respectively.

The emergency response plan (ERP) and procedures are provided in Appendix E and F and include information on the following:

- site access,
- communication and procedures;
- key contacts;
- Emergency Remedial Action for level 2 conditions; and
- Inundation Maps.

Training should be provided to site staff and a designated AEM 'incident command group' created to ensure that a key group of site personnel are thoroughly familiar with all elements of the emergency preparedness and response plan (TMAC 2016, CDA 2014). The Mine Manager, Process Operations Superintendent, Site Health and Safety Superintended and Environmental Site Superintendent should be trained in problem detection, problem evaluation and appropriate remedial (emergency and non-emergency) measures. This training is essential for proper evaluation of developing situations at all levels of responsibility (initial evaluation is usually based on on-site observations).

Testing is an integral part of emergency preparedness, to ensure that both the documents and the training of involved parties are adequate. Tests can range from a limited pen and paper exercise to a full-scale simulation of an emergency and can include multiple failure scenarios.

The Mine Manager and Site Health and Safety Superintendent should coordinate and participate in joint periodic testing of the emergency procedures with site staff. It is incumbent upon each responding agency to have adequate plans and trained staff in place to deal with any emergency within their jurisdiction (in the case of Hope Bay in the north central region of Nunavut).

The AEM Mine Manager and Site Health and Safety Superintended is responsible for updating the ERP as deemed practical; this includes small tasks such as updating the contact lists as necessary. Revisions should be issued to all affected agencies identified as document holders (as a minimum everyone outlined in Section 2.1).

It is the responsibility of all personnel visiting the site to ensure personal and worker safety. In cases of injuries, medical help must be called. If safe to do so, personnel on site may attend to injured person and, if qualified, administer first aid.

Alert Level
The alert level is the first or lowest level of action for a given incident (see SRK 2020a and 2020b for monitoring requirements to help indicate alerts). This level of action is assigned to typical operations and maintenance conditions and is dealt with in previous sections of this OMS Manual. No external (off mine-site) notification is required. Response to incidents is done internally under the general protocols provided Section 4.1. Typical incidents at the alert level may include the following: • Smaller deformation, cracks or seepages • Improper beach development • Anomalous water levels or water quality readings • Minor erosion gullies due to runoff If ignored, some of these incidents may develop into emergency situations that must then be dealt with outside of the normal scope of OMS activities.
Emergency Level
The emergency level is the first level of potential danger to human health or the safety of the environment. These plans are for emergency situations that require actions outside the normal scope of OMS activities. External communication, according to the notification procedure outlined in the Emergency Response Plan (TMAC 2021). In this scenario it is required to mobilize the resources and response required to eliminate the threat to the structures. The incident level may be downgraded from emergency to alert level or upgraded to failure level, depending on the change in conditions at the structure or as new information or analysis becomes available.
Failure Level

At failure level, an incident has progressed to the point where failure of the structure is imminent. A failure level incident would require immediate notification of any downstream area by means of the general and local warning system. The failure level response should be implemented immediately upon verification of the conditions that tailings impoundment is failing or about to fail. Such a response is used as a precautionary measure when there is uncertainty whether the impoundment may fail, but there is a significant probability that it will. Notify the Mine General Manager, Process Operations Superintendent, Environmental Site Superintendent, and the Engineer of Record and appropriate regulatory bodies. Any emergency repair measure that has some potential to avert, delay or retard the rate of failure should be initiated. In addition, measures for post-failure monitoring and assessment should be initiated.

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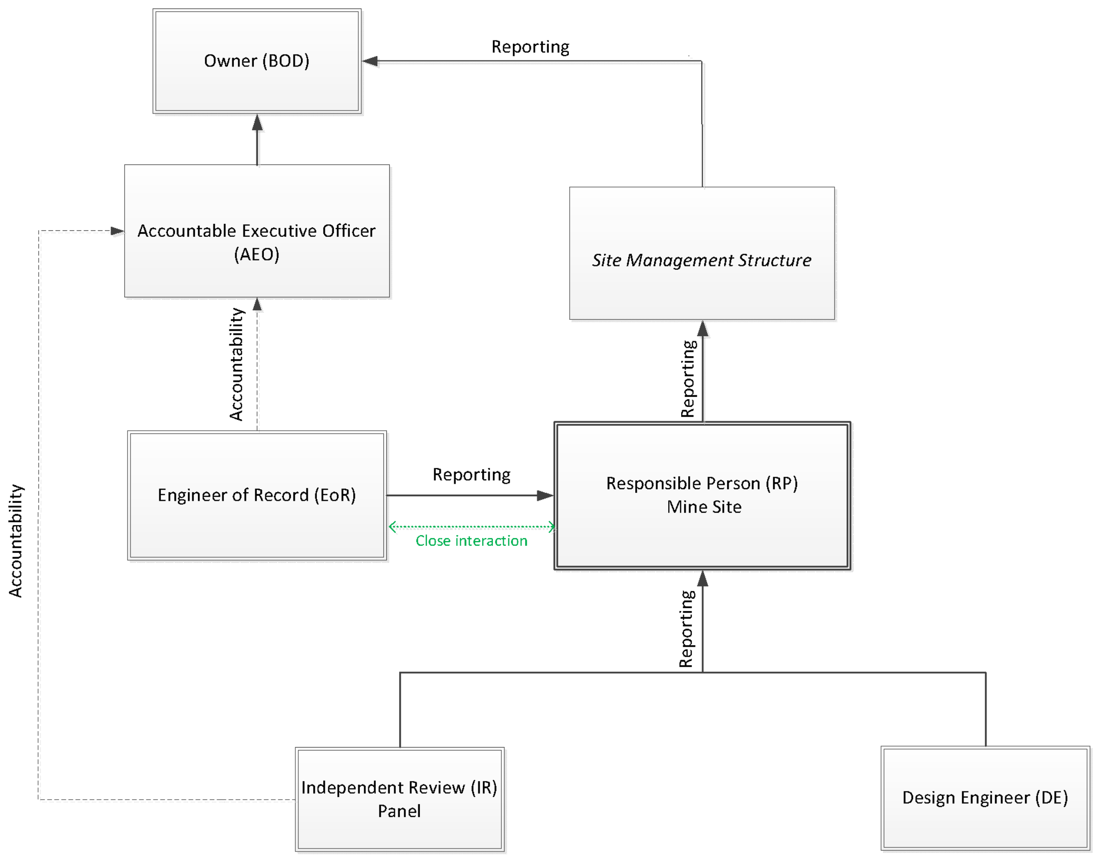
OPERATIONS, MAINTENANCE AND SURVEILLANCE MANUAL: HOPE BAY DORIS TAILINGS IMPOUNDMENT AREA

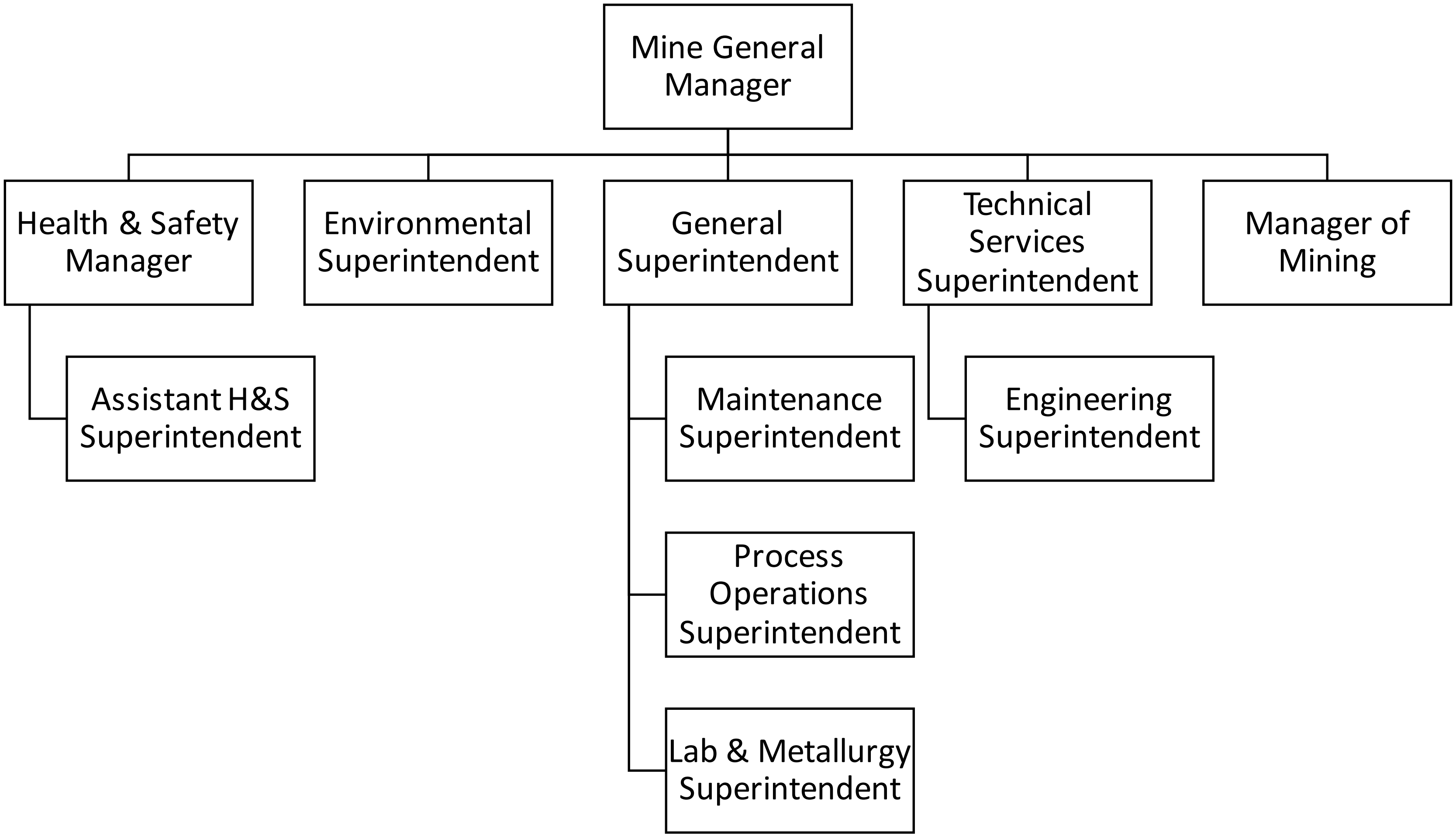
HOPE BAY, NUNAVUT

Appendix A: Site Management & AEM Governance Structure

AEM Governance Structure



Hope Bay Site Management Structure



AGNICO EAGLE

OPERATIONS, MAINTENANCE AND SURVEILLANCE MANUAL: HOPE BAY DORIS TAILINGS IMPOUNDMENT AREA

HOPE BAY, NUNAVUT

Appendix B: Tailings Area Dust Control Strategy for Doris TIA

SRK Consulting (Canada) Inc.
2200–1066 West Hastings Street
Vancouver, BC V6E 3X2

T: +1.604.681.4196
F: +1.604.687.5532

vancouver@srk.com
www.srk.com

Memo

To:	Project File	**Client:**	TMAC Resources Inc.
From:	Iozsef Miskolczi, PEng	**Project No:**	1CT022.004
Reviewed By:	Maritz Rykaart, PhD, PEng	**Date:**	December 13, 2016
Subject:	Hope Bay Project: Tailings Area Dust Control Strategy for Doris TIA		

1 Introduction

The Hope Bay Project (the Project) is a gold mining and milling undertaking of TMAC Resources Inc. The Project is located 705 km northeast of Yellowknife and 153 km southwest of Cambridge Bay in Nunavut Territory, and is situated east of Bathurst Inlet. The Project comprises of three distinct areas of known mineralization plus extensive exploration potential and targets. The three areas that host mineral resources are Doris, Madrid, and Boston.

The Project consists of two phases; Phase 1 (Doris project), which is currently being carried out under an existing Water Licence, and Phase 2 which is in the environmental assessment stage. Phase 1 includes mining and infrastructure at Doris, while Phase 2 includes mining and infrastructure at Madrid and Boston located approximately 10 and 60 km due south from Doris, respectively.

Two tailings storage areas are planned for Phase 2. The existing Doris tailings impoundment area (TIA) will be expanded, and a new Boston tailings management area (TMA) will be developed. The Doris TIA tailings deposition will consist of subaerial tailings deposition, while the Boston TMA will be comprised of filtered tailings developed as a dry-stack. This memo is addressing dust management strategies for the Doris TIA.

Two tailings streams will be produced; flotation tailings, comprising approximately 92-94% of the overall volume, and detoxified leach tailings (following cyanidation, and subsequent cyanide destruction), comprising about 6-8% of the overall volume. Only flotation tailings will be deposited in the Doris TIA. The detoxified leach tailings will be filtered, mixed with mine waste rock and used for underground mine backfill.

Upon closure, the tailings surface of the Doris TIA will be covered with a nominal waste rock cover of about 0.3 m thick. The function of the cover is to prevent dust and to minimize direct contact by terrestrial animals. Once the water quality in the Reclaim Pond has reached the required discharge criteria, the North Dam will be breached allowing the TIA to return to its pre-mining elevation of 28.3 m.

Throughout the operational phase, portions of the tailings surface will be exposed, and sufficiently inactive such that they would dry out and pose a dusting risk. This memo describes alternative dust management strategies that have been considered and presents the rationale for selection of the preferred strategy.

2 Definition of Dust

2.1 Fugitive Dust

Fugitive dust is particulate matter suspended in air by wind action and human activities. Within the Doris TIA, tailings will be deposited by hydraulic placement of a tailings slurry which does not generate any fugitive dust. Fugitive tailings dust will however be generated during the period when the tailings closure cover is being constructed.

2.2 Aeolian Dust

Aeolian dust is defined as particles that are transported as suspended load due to wind action on a surface. Although tailings are discharged wet, the surface eventually dries out as a result of evaporation or freezing of the tailings surface. As a result, at any given time, large areas of the tailings surface would expose dry tailings. Aeolian tailings dust is expected because the Project site is prone to high winds and the moderate surrounding topography does not offer effective protection from wind.

3 Typical Dust Control Methods

3.1 State of Practice

Dust control from operating and closed tailings impoundments is a significant concern in the mining industry, and as a result, the state of practice is quite advanced. There are three primary dust control strategies for fugitive and aeolian dust from exposed tailings areas: natural dust control, physical dust control and chemical dust control. Natural dust control specifically relies on maximizing the benefits offered by nature in the form of precipitation (rain and snow). While highly effective, these benefits are opportunistic and may not always be available at the times when it may be needed.

Physical dust control is by far the most effective strategy, as it relies on creating a physical barrier, such as a cover, that would preclude dusting. This may however not be a cost efficient strategy for an operating tailings impoundment, since any interim cover would occupy space within a tailings impoundment that would otherwise be required for tailings.

Chemical dust control relies on modification of the tailings surface that generates the dust. The effectiveness of this method is temporary, but its application is typically simple, making it a very good alternative for managing dust from an operating tailings impoundment.

The sections that follow provide a detailed description of all the dust control methods that are currently being used in the industry, with a specific focus towards their potential applicability for this Project.

3.2 Natural Methods

3.2.1 Snow Cover

If early in the fall season, wet snow falls directly on the exposed tailings surface and subsequently freezes, it will remain in place all winter protecting the tailing surface from dusting. Snow that falls later in the season is typically drier and more powdery and it tends to be subject to wind transport and redistribution (drifting). This means that portions of the tailings surface will become exposed and opportunity for dust release increases. This is exacerbated by the fact that during the winter the tailings surface gets extremely dry as a result of freezing, making it highly susceptible to dusting.

To maximize the potential benefits offered by snow as a natural dust control method, any snow that does fall on the tailings surface can be track compacted in areas where the tailings surface is trafficable. By mechanically compacting the snow, it will stay in place longer and will melt at a much slower rate in the spring, extending the useful life of the snow as a dust control method.

It is however important to minimize the amount of tailings that gets deposited over the compacted snow. If the compacted snow does not melt during the subsequent summer season due to the insulating blanket of the overlying tailings, ice lenses within the tailings impoundment are created which result in a loss of tailings storage space and possible instability.

There is sufficient snowfall at the Project site that this dust control method could be effectively used. In addition, there is a requirement at the Project site for snow removal in specific areas. Snow that is removed could be hauled to the TIA and used specifically for the purpose of creating a compacted snow cover over any temporarily inactive tailings surface areas. Due to the temporary nature of this dust control method, it will not be a complete solution, but would be a practical and complementary method.

3.2.2 Ice Cover

Similar to compacted snow, an ice cover will remain in place for the duration of the winter and thus temporarily mitigate dust migration. Ice cover on exposed tailing surfaces can be achieved by various methods, including ponding water during freezing weather and mechanical placement of ice blocks imported from a different source (contact water ponds).

Water can be held back in specified locations and retained there during the shoulder seasons when freezing weather will create an ice cap. Once the ice cap is achieved the open water beneath the ice can be drained off, leaving an ice cap.

The ice cap can also be created mechanically by loading ice from contact water ponds (or fresh water streams) into haul trucks and dumping the ice on the tailings surface.

Similar to compacted snow, care must be taken to ensure that the amount of tailings deposited over an ice cover is limited to avoid entraining long-term ice in the TIA.

There are several contact water ponds throughout the Project site all of which must be managed such that they are normally empty. Contact water ponds are; therefore, unable to provide a reliable source of water to use to create an ice cover. Fresh water cannot be readily hauled to the TIA to create an ice cover as the use of fresh water is governed by the Water License (2AM-DOH1323); therefore, creating an ice cover for dust control is not considered a viable practical alternative for application at the Project.

3.3 Physical Methods

3.3.1 Water – Surface Wetting

Water is by far the most common temporary dust control measure used in areas where water shortage is not of concern. The exposed surface is wetted up, preventing particles from becoming airborne. Since the water rapidly evaporates (in a matter of hours or days), it needs to be reapplied at a frequent interval to be effective. The surface wetting can be done using a conventional water truck, a water cannon fitted to a water truck, or a stationary sprinkler system. Naturally this dust control method is only applicable during non-freezing periods of the year.

For the Project, water could readily be obtained from the Reclaim Pond or can be hauled via water truck from other site contact water ponds. The tailings surface is however not expected to be trafficable in the short term and the only viable means of frequent tailings wetting would be via a water cannon, or a sprinkler system. While both of these methods are viable, the short useful life of every wetting cycle makes this a very labor intensive dust control method which is not preferred. This method will however be reserved as a last line of defence should any of the other dust control methods prove to be ineffective.

3.3.2 Water – Flooding

Flooding the tailings surface will naturally preclude any dust concerns. This is however not a viable strategy for the Project since the objective is to place tailings subaerially. At Doris, TIA portions of the tailings may be seasonally flooded as the water level in the Reclaim Pond rises; however, the water level will be managed such that a perpetual water cover will not be present.

3.3.3 Permanent Dry Cover

The most effective permanent dust control system is a permanent physical dust cover. Typically this is in the form of a layer of soil, or other suitable readily available cover material. This is however not practical until the tailings surface has reached its final elevation. In order to facilitate placement of a final dust cover as expediently as possible, any tailings deposition plan should be designed taking into consideration all opportunities for progressive reclamation.

In the context of the Doris TIA, the tailings deposition plan provides limited opportunity for progressive reclamation during the early Project life. This is predominantly driven by the surface topography and as a result there are no practical means to improve the design. The only viable permanent dust cover would be geochemically suitable waste rock, or quarry rock. Since all the Project waste rock is designated for use as structural underground backfill, only quarry rock can be considered a viable source for a permanent dust cover. While this will be the final closure dust control method, it is not considered a viable method during the operational phase of the Project.

3.3.4 Sacrificial Dry Cover

In extreme cases, nominal sacrificial covers such as a layer of sand or gravel are used to manage tailings dust when the final tailings surface has not yet been reached, but the period until tailings deposition might resume at any particular spot may be extensive. When tailings deposition eventually returns to the covered area, these materials are not removed and tailings deposition proceeds to overtop the sacrificial cover. This can be very cost intensive and will only be practical if the tailings surface is readily trafficable.

There are no suitable natural sacrificial cover materials readily available at the Project site. Gravel could be produced from quarry rock; however, at great cost. This is therefore not considered a viable dust control strategy for the Project TIA.

3.3.5 Biodegradable Cover

Biodegradable material such as hay, wood mulch or sewage treatment sludge can be applied over exposed tailings surfaces to mitigate dust for a limited period (i.e. requiring occasional reapplication). Naturally this option is only economically viable if the organic source is readily available. The tailings surface must also be sufficiently trafficable to allow equipment to spread these materials. As these materials biodegrade and dry out, they themselves become prone to being part of the dust hazard.

There is no viable source of biodegradable materials at the Project site, and therefore this is not considered a viable dust control strategy for the Project.

3.3.6 Wind Barriers

A wind barrier (aka windbreak or shelterbelt) is a physical structure used to reduce the wind speed, which will reduce tailings from being re-mobilized from the TIA. Typically, a wind barrier consists of one or more rows of trees or shrubs. Trees and shrubs don’t grow at the Project site (at least not to the size where they would be effective wind barriers), therefore, any wind barriers would have to be engineered structures. The efficiency of wind barriers is also a function of wind speed, and often, at very high wind speeds, wind barriers can fail since it is simply not cost effective to design and build these structures to withstand large wind velocities. As well, wind barriers only work effectively over a very narrow range of wind directions. Multiple wind barriers would need to be installed to cover all of the Project’s prevalent wind directions so as to provide a comprehensive dust management system for the TIA.

Given the very high wind speeds and the multiple wind directions, experienced at the Project’s TIA, engineered wind barriers are not be considered a viable dust control strategy for the Project’s TIA.

3.3.7 Vegetation

Revegetating an exposed tailings surface is a very effective way to mitigate dust. In an arctic setting such as at the Project site, this is not a practical option since the growth season is simply too short to allow for rapid onset of effective vegetation. In addition, the tailings material may not be amenable to supporting vegetation without the addition of supplemental nutrients, which might preclude establishment of natural successional vegetation species. This is therefore not a viable dust control method for the Project.

3.4 Chemical Methods

3.4.1 Salt (Calcium Chloride)

"Salted" sand will not freeze at temperatures above -10˚C, and can be spread in a thin layer over exposed frozen tailings surfaces during the shoulder seasons when frost penetration is enough to support the spreader truck (or other suitable spreader mechanism). The calcium chloride in the sand acts to melt the frost on the exposed tailing surface and stops the fine particulate dust particles from becoming airborne.

There are no sources of sand at the Project site, requiring that both sand and salt would have to be imported at great cost. As runoff occurs from the tailings surface, the salt will dissolve reducing the efficiency; however, since this mitigation method is best used during freezing conditions this risk is limited. However, during freshet the salt is washed off towards the Reclaim Pond which results in an increased salt load to the TIA, which may limit the use of TIA reclaim water to the mill. This is therefore not a viable dust control strategy for the Project TIA.

3.4.2 Chemical Suppressants

There are many environmentally safe commercial chemical dust suppressants on the market. Although originally developed for other forms of fugitive dust management, they are routinely used for dust control on tailings surfaces. These products work in different ways, but principally they all either chemically bind dust, or alternately facilitate towards development of a crust to prevent particles from separating and becoming airborne.

The chemical suppressants are normally supplied in concentrated liquid form in containers of various sizes. They are typically water based and are diluted before application at a ratio of about nine parts water to one part suppressant. The solution is applied by means of a spray cannon mounted on a modified water truck, but can also be done via hand held sprayers. The application rate is typically about four liters per square metre.

Chemical suppressants have a useful life which is dependent on the concentration applied and local weather conditions. Normally, products are applied at a concentration which would render a useful life of approximately one year.

Of all the dust control methods, chemical suppressants offer the greatest flexibility for application at the Project TIA. The concentrated liquid can be shipped to site on an annual basis and solution can be mixed an applied on site as required. The relatively long useful life limits the amount of effort that needs to be exerted and therefore makes the dust control method practical.

4 Dust Control Procedures for Tailings

The primary dust control measures of the Project site tailings facilities will be the use of environmentally suitable chemical dust suppressants. The application of these suppressants will be reviewed on an ongoing basis to ensure that any areas that may be at risk will be adequately covered. Generally, annual application of chemical suppressants will be applied; however it is recognized that more frequent applications may be required as discharge locations are changed throughout any year.

In addition to chemical dust suppressants, natural dust control in the form of packed snow when available will be used as far as practical. Again, the effectiveness will vary on a year by year basis depending on how deposition points vary for any given winter season.

Finally, if for any reason, any of the above dust control methods prove to be temporally ineffective, a suitable water cannon will be available to allow for dust suppression in the form of spraying of the areas of concern.

OPERATIONS, MAINTENANCE AND SURVEILLANCE MANUAL: HOPE BAY DORIS TAILINGS IMPOUNDMENT AREA

HOPE BAY, NUNAVUT

Appendix C: AEM Preferred Dust Control Product

Dust Stop Municipal Blend

CYPHER ENVIRONMENTAL

100% Environmentally Friendly
Non-Corrosive, Non–Toxic
Cost Competitive Dust Control

Dust Stop Municipal Blend (DSMB) is a formula consisting of natural organic ingredients specifically engineered for all types of unpaved roads. Applicable to any soil type, it is applied using standard equipment and techniques. DSMB was designed to provide an environmentally friendly, non-corrosive and cost-competitive replacement for calcium and magnesium chloride. DSMB is not adversely affected by heavy rains or long periods of dry weather and has no adverse effect on the environment or vehicles, due to its non-corrosive properties.

- **Significantly reduces long term maintenance costs**
  - » Reduced need to grade treated roads
  - » Reduction in watering requirements
- **Non-corrosive and environmentally friendly**
  - » Will not cause rust on vehicles or application equipment
  - » No adverse impact on roadside vegetation
- **Increased water resistance resulting in better performance in all weather conditions**
  - » Reduction in maintenance requirements as a result of wet weather
  - » Does not get slippery when wet
- **Long lasting results**
- **Cost Competitive with chlorides**
- **DSMB treated roads show improved engineering properties**

Driven By Innovation – Partners in Performance

1149 St. Matthews Ave | 204.489.1214 | CypherEnvironmental.com

Dust Stop Municipal Blend

100% Environmentally Friendly
Non-Corrosive, Non–Toxic
Cost Competitive Dust Control

CYPHER ENVIRONMENTAL

- Haul Roads
- Access/Secondary Roads
- Logging Roads
- Construction Sites
- Parking Lots
- Back Lanes and Trails
- Tarmacs, Runways & Helipads
- Erosion Control

Testimonial

"We have recently applied Cypher Environmental's new Dust Stop Municipal Blend (DSMB) product on La Verendrye Road within the municipality. DSMB was advertised to be competitive with chlorides in terms of cost and effectiveness and so far has performed well and exhibited excellent properties during and after rain. The product has stood up to the elements very well thus far, with several periods of rain and hot, dry and windy weather."

Grant Baker, Public Works Manager,
Rural Municipality of MacDonald, Manitoba

Driven By Innovation – Partners in Performance

1149 St. Matthews Ave | 204.489.1214 | CypherEnvironmental.com

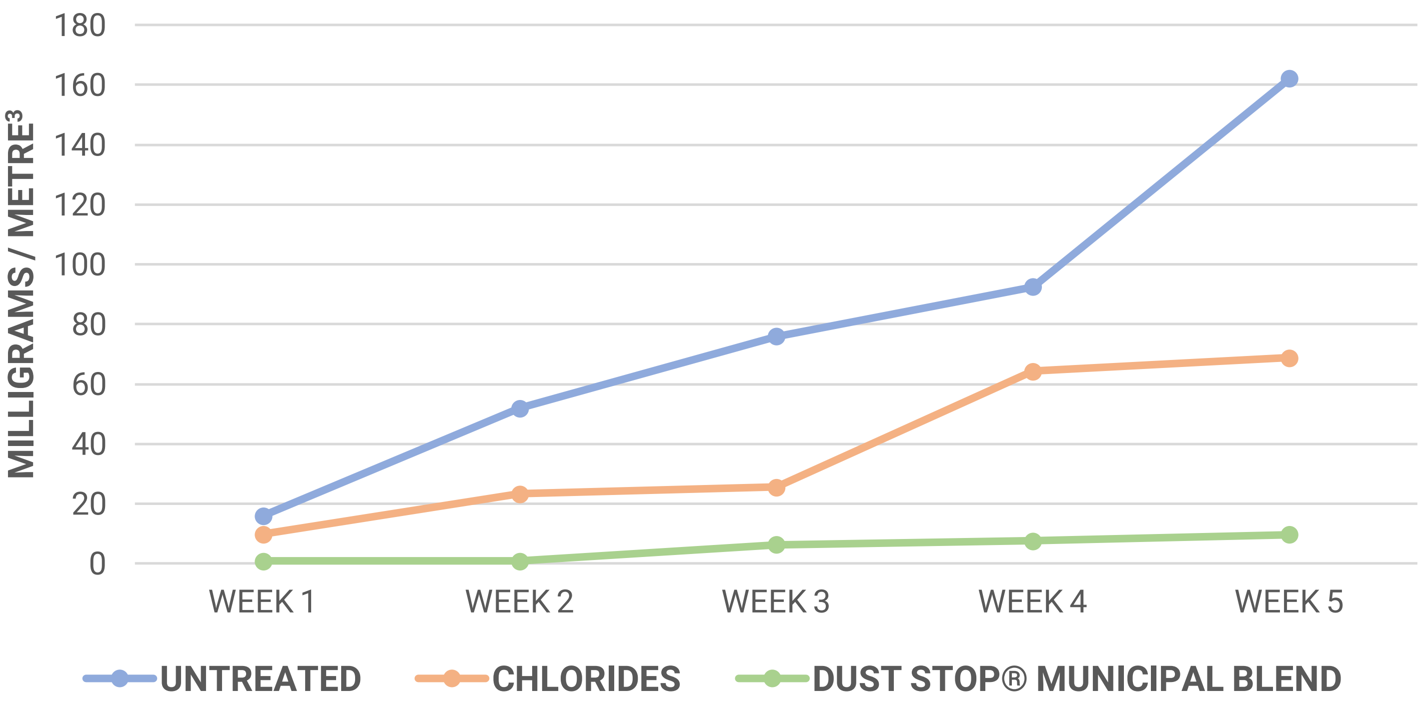
Superior dust control.

DUST STOP®
MUNICIPAL BLEND

REDUCE DUST POLLUTION BY UP TO 90% WITH DUST STOP® MUNICIPAL BLEND.

In order to measure the effectiveness of the dust control properties of Dust Stop® Municipal Blend, data was collected from a Turnkey® Dust Mate environmental dust detector during a series of controlled road tests over the period of several weeks. The Dust Mate Remote Vehicle Probe was installed on the wheel-well of our company vehicle, and dust concentration data was collected while controlling the speed of the vehicle and the elapsed time of each test. This data was collected on three road surface types on the same stretch of road (Untreated, Chlorides & Dust Stop® Municipal Blend) under the same conditions. These conditions included direction of travel, speed of travel, wind speed, wind direction, temperature, road conditions and traffic frequency.

AERIAL DUST CONCENTRATION



Dust Stop Municipal Blend – How It Works

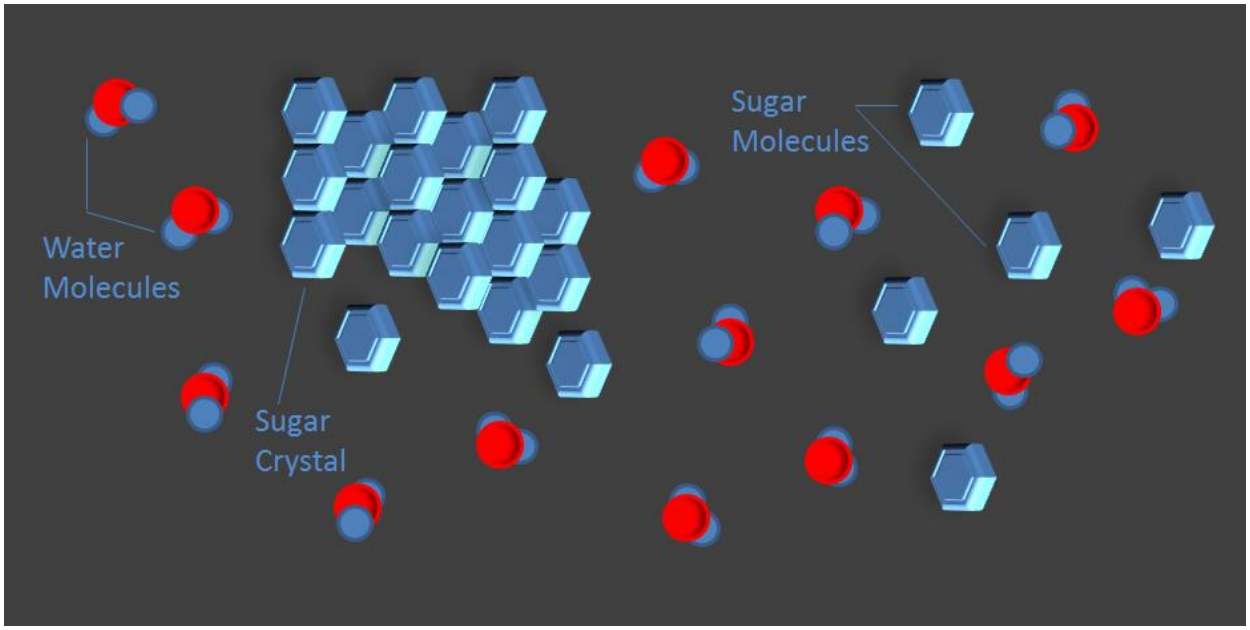
Introduction

Dust Stop Municipal blend contains three main constituents; sugars, starches, and minerals. These components are all commonly found in nature and play a big role in our everyday lives. Sugar is the universal term for sweet, short-chain, soluble carbohydrates that are primarily composed of the elements carbon, hydrogen, and oxygen. Sugars can be derived from multiple sources; simple sugars are called monosaccharides and include glucose (also known as dextrose), fructose, and galactose. Granulated sugar which is most customarily used in the food industry is sucrose, also known as a disaccharide.

The building blocks of Sugar- Greatest binding influence in DSMB

Hydrogen bonding is the greatest contributing factor to sugar's stickiness. When sugars are crystalline in structure they are unable to stick to other molecule but can be easily dispensed or poured. When a liquid such as water is added to crystalline sugar, the formerly strong oxygen-hydrogen bonds will begin to degrade and cause the newly available hydrogen atoms to seek out other materials to bind to.

Available hydrogen atoms have an opportunity to stick to the closest surfaces, some will be attracted to the hydrogen molecules in the liquid, and some will bind with another available hydrogen or oxygen atom present in the sugar. This bonding action results in the sticky nature of sugar. When the bonds in sugar are broken there is more opportunity for the molecules to grab onto whatever they're in contact with, including other sugar molecules and surrounding particles. The new bonds are more secure because there are so many of them. Therefore, it's harder to pull them apart.



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1149 St. Matthews Avenue
Winnipeg, MB R3G 0J8 Canada

(204) 489-1214
info@cypherenvironmental.com
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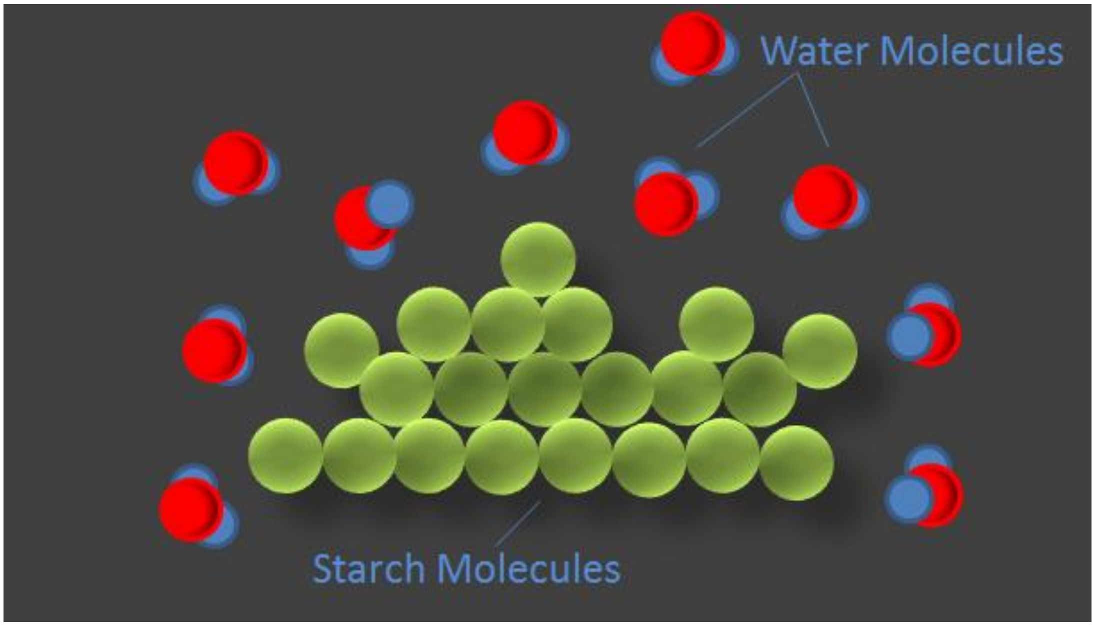
Starches and Minerals

Starch is a term with the following meanings “strong, stiff, strengthens, stiffen". Starches are comprised of polymeric carbohydrates consisting of a large number of glucose units joined by glycosidic bonds. They are insoluble in cold water and alcohol due to two types of molecules: the linear and helical amylose and the branched amylopectin. The minerals incorporated in DSMB are not unlike starches, due to their strong chemical makeup they are insoluble in water and have the opportunity to form bonds with other available molecules providing further strength and durability when applied. The bonds fashioned between the minerals, starches and sugars are, in most cases, stronger than the bond that would be formed between these components and water. Consequently, they are less likely to be dissolved or run of with the application of water.



How DSMB works

The unique blend of materials utilizes the functional properties of sugars, starches, and minerals allowing DSMB to bind and harden any loose particulate matter, decreasing dust on surfaces. DSMB is applied in a diluted form; water evaporates from the product as it dries. Dust control is achieved during this process as the high-viscosity, naturally adhesive material traps loose particulate.

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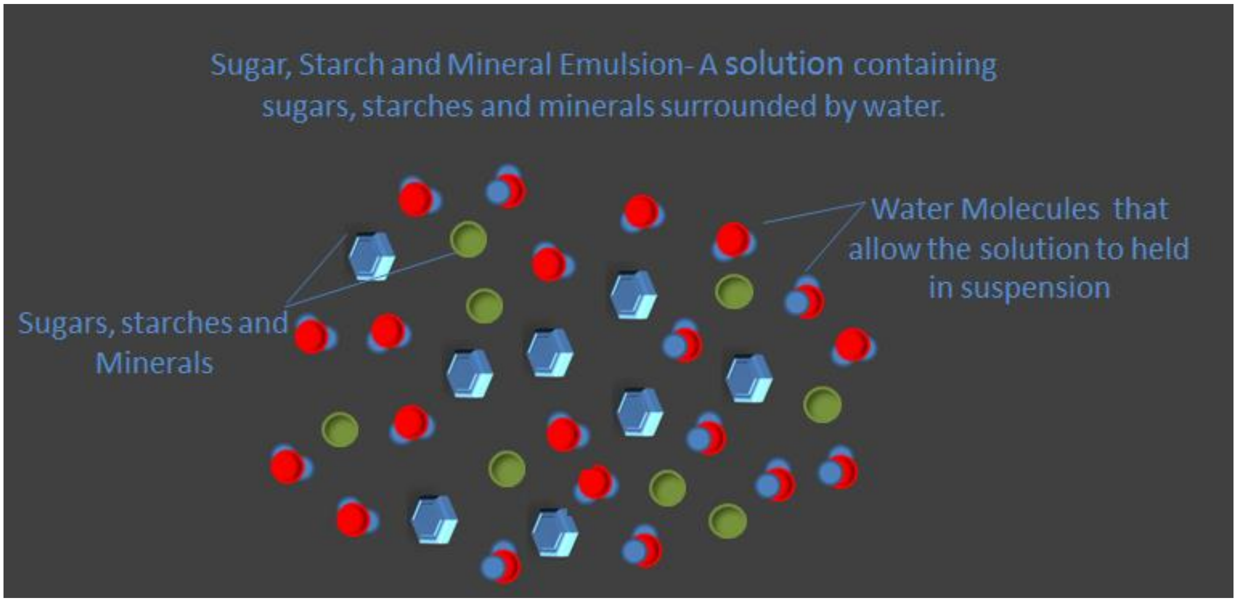
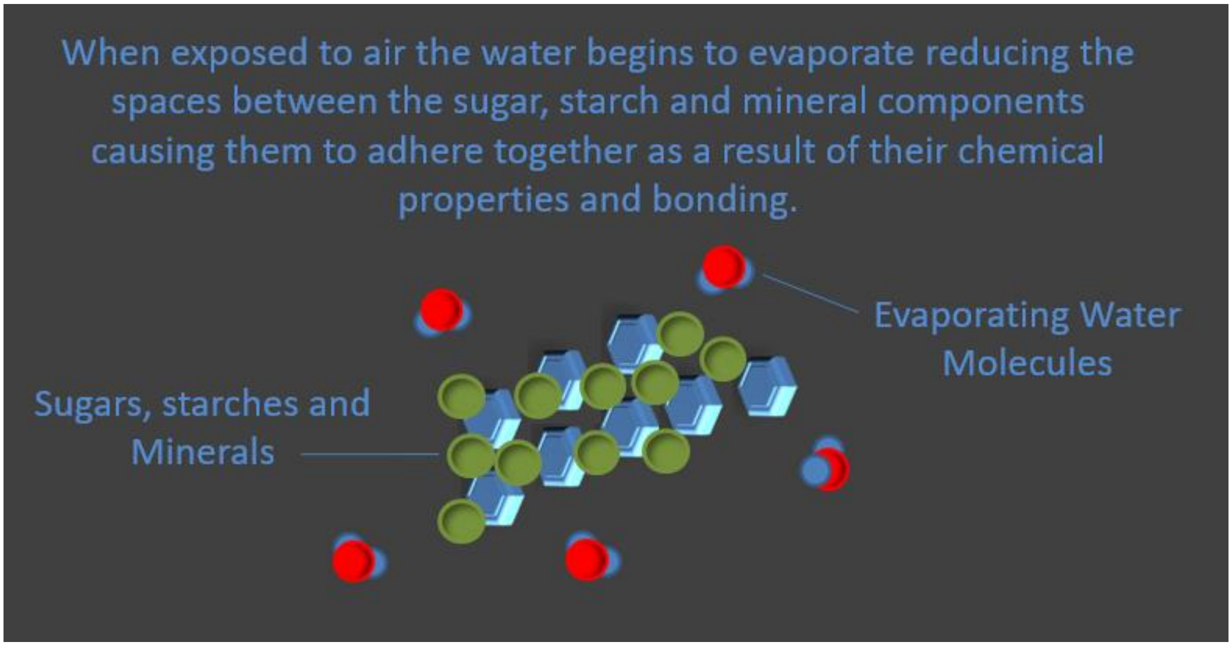
1) Water is added to the highly concentrated product allowing for suspension of the active inputs; sugars, starches, and minerals.



2) As water evaporates, the molecules bind together to form a cohesive matrix.



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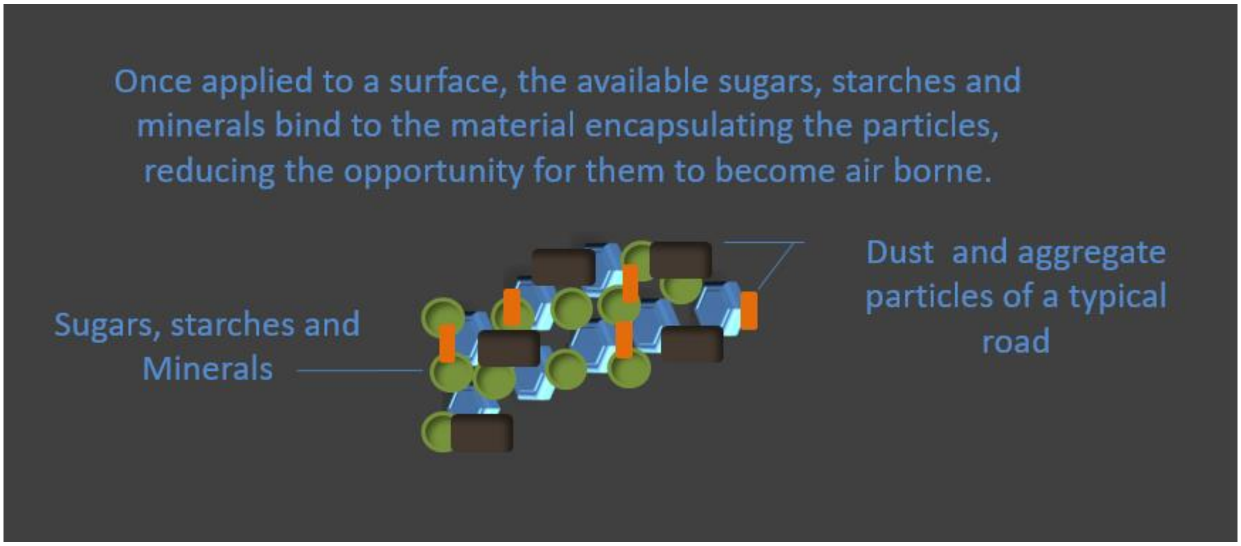
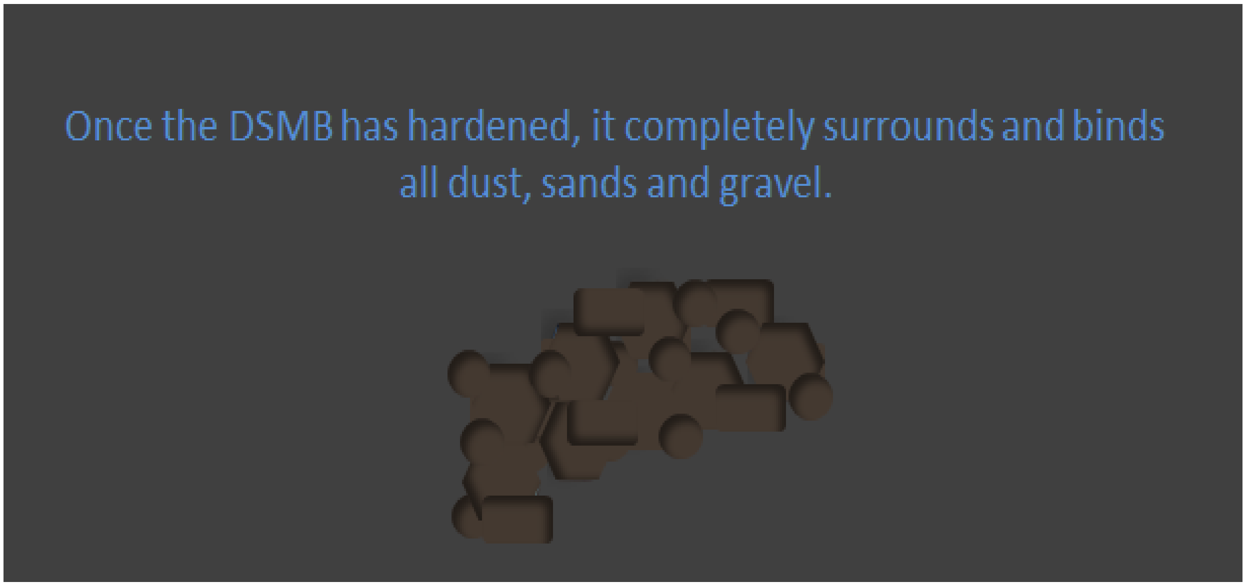
3) The newly formed matrix will now function to attract and bind the loose soil, dust or other particulates that may otherwise become air born and create dust.



4) Over time; as more water evaporates, the solution becomes firm and durable preventing any of the encapsulated dust generating material from becoming air born.



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The product's unique blend of materials also functions to reduce road surface issues in the rain or in wet conditions. The incorporated sugars compete for water making it less available to bind with other soil molecules while providing some minimal structural support and added road stability. The insoluble mineral component forms a bond with the sugar molecules creating some means of insolubility and will have less of a chance to run off in wet conditions. Once wet, the product will re-set once road surfaces dry, re-binding any loose materials. For these reasons, DSMB is not adversely affected by heavy rain, yet very effective and long lasting in dry weather, with no adverse effects on the environment or vehicles using the road due to its non-corrosive properties.

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1149 St. Matthews Avenue
Winnipeg, MB R3G 0J8 Canada

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info@cypherenvironmental.com
www.cypherenvironmental.com

CYPHER ENVIRONMENTAL

DUST STOP MUNICIPAL BLEND (DSMB)

FREQUENTLY ASKED QUESTIONS

1) Why use Dust Stop Municipal Blend for dust suppression on your roads?

Dust Stop Municipal Blend should be used on your roads because it is a non-corrosive and environmentally friendly alternative to chlorides. Dust Stop Municipal Blend is not only environmentally friendly and non-corrosive, but also highly effective on a variety of road and material types, applied using standard techniques and equipment, and does not run-off or get sticky in the rain. Products such as various oil based emulsions and chloride based products (magnesium chloride / calcium chloride) have been used in the past for dust suppression at the expense of the environment (Canadian Environmental Protection Act 1999-link below), none of which is a concern for Dust Stop Municipal Blend. The product is based on organic sugar and starch ingredients, as well as a proprietary mineral compound, providing effective dust control with no adverse impact on the environment. http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/psl2- lsp2/road_salt_sels_voirie/index-eng.php#a02

2) What is the difference between Dust Stop Municipal Blend and other products on the market?

Dust Stop Municipal Blend is specifically designed as a non-corrosive and environmentally friendly alternative to other dust control products such as magnesium chloride, calcium chloride, offering superior road dust control results. Dust Stop Municipal Blend is very cost-competitive with road salts, while being able to very effectively eliminate unwanted fugitive dust from unpaved roads of any soil type. While road salts are minimally effective, they are hygroscopic by nature, meaning they require moisture, which they attract to the road, to be effective, and are therefore not effective during long periods of dry weather, and can also run-off in the rain. Dust Stop Municipal Blend is not hygroscopic, so it is not burdened with the same issues road salts have during prolonged dry periods, or wet weather. The concentrated liquid formulation is easily mixed with several parts water prior to its application, allowing it to be easily transported and applied with standard water trucks. Once the solution is sprayed on the road and allowed to dry, immediate dust control results will be achieved. In comparison to other dust control products mentioned above, Dust Stop Municipal Bend requires a reduced application frequency further reducing application and maintenance costs.

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3) What is Dust Stop Municipal Blend made of?

Dust Stop Municipal Blend's proprietary formula is composed of an environmentally friendly blend of sugars, starches and minerals. Dust Stop Municipal Blend utilizes these main inputs in a concentrated liquid form to produce a very effective dust control product that is applicable to almost any material type.

4) How does Dust Stop Municipal Blend work?

The unique blend of materials utilizes the functional properties of sugars and starches allowing DSMB to bind and harden any loose particulate matter, decreasing dust in road surfaces. The product's unique blend of materials also functions to reduce road surface issues both during and after rain. The incorporated sugars compete for water making it less available to bind with other soil molecules, while providing some minimal structural support and added road stability. The product will re-set once road surfaces dry, re-binding any loose materials. For these reasons, DSMB is not adversely affected by heavy rain, yet very effective and long lasting in dry weather, with no adverse effects on the environment or vehicles using the road due to its non-corrosive properties.

5) What are the benefits of Dust Stop Municipal Blend?

Dust Stop Municipal Blend has numerous benefits associated with its use as a dust control product. Dust Stop Municipal Blend is supplied in concentrated liquid form, allowing for easier transportation as well as application. The ingredients in the product provide stability to the road surface that decrease maintenance requirements and significant dust reduction. The unique blend of materials utilizes the functional properties of sugars and starches allow DSMB to bind and harden any loose particulate matter, decreasing dust on road surfaces. These materials function to reduce road surface issues in both dry and wet conditions. Once wet, the product has the ability to re-set once the road surface becomes dry, re-binding any loose materials. Due to the specific blend of sugars and starches, it will rejuvenate with moisture allowing it last longer than other products on the market, yet not run-off in the rain. For these reasons application and maintenance costs can be reduced. Dust Stop Municipal blend is non corrosive, will not cause corrosion to equipment or vehicles and does not have any harmful effects to roadside vegetation making it safe to use in sensitive environmental areas.

6) What kinds of roads is Dust Stop Municipal Blend applicable for?

Dust Stop Municipal Blend is an effective dust control product on any unpaved roads or surfaces requiring dust suppression and temporary soil stabilization. Dust Stop Municipal Blend is effective on municipal roads, secondary roads, county roads, mine haul roads, access roads, runways, helipads, parking lots, driveways and a wide range of other applications that require dust suppression or temporary stabilization such as tailings piles, stockpiles, erosion control and open haulage situations.

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7) How do you apply Dust Stop Municipal Blend?

Dust Stop Municipal Blend is applied with standard road construction equipment and can be applied topically or mixed into the top layer of the road material. The first step involved in the application of Dust Stop Municipal Blend is to determine the area of the road / surface that you will be treating. Once you determine this you can calculate the amount of water and Dust Stop Municipal Blend that is required (please communicate with your local representative who will help you figure out the best application rate for your requirements). The next step in the application of the product is to add the Dust Stop Municipal Blend with water prior to the application of the product. Always add the water to the water truck prior to the Dust Stop Municipal Blend. Once the pre-determined amount of water is added to the truck, add the pre-determined amount of Dust Stop Municipal Blend. Once the product is added to the water truck it can immediately be sprayed on the road surface. Once the product is applied you will notice dust control results immediately, however traffic should stay off of the road until the product has time to dry (drying time can vary depending on the climatic conditions on the day of application, in many cases is around 1 hour on a warm day).

If mixing the product into the road surface, the addition of a road grader and rubber wheeled compactor needs to be added to the project. Generally performed during routine maintenance, the DSMB can be mixed into the soil once the top layer has been loosened to repair potholes and wash boarding. The prescribed mixture of water and DSMB should be applied evenly and lightly mixed into the soil prior to shaping and compacting. Shaping of the road surface is still important to ensure that water is quickly evacuated away from the road surface. Additional details and specifics can be discussed with your Cypher representative.

8) What happens to Dust Stop Municipal Blend when it rains?

There are no long term effects on Dust Stop Municipal Blend if it is subjected to rain. Dust Stop Municipal Blend contains a blend of soluble sugars, starches, and an insoluble mineral component that once cured are able to hold their strength in the presence of water. For these reasons, DSMB is not adversely affected by heavy rain, yet very effective and long lasting in dry weather, with no adverse effects on the environment or vehicles using the road due to its non-corrosive properties.

9) Is Dust Stop Municipal Blend effective during long periods of dry weather?

Yes, Dust Stop Municipal Blend is an effective dust control product during long periods of dry weather. One reason Dust Stop Municipal Blend is so effective in dry weather is that, unlike chloride-based products, it is not hygroscopic so it does not rely 100% on the ambient moisture in the atmosphere to work. The product derives its main efficacy through the hardening and binding power of its ingredients, which forms a physical barrier over the surface of the road, binding the dust particles down and providing long term dust control results.

10) Is Dust Stop Municipal Blend effective on all material types?

Yes, Dust Stop Municipal Blend is an effective dust control product on almost any material type. Dust Stop Municipal Blend will bond to any solid material it is exposed to, it will incorporate any particles it touches into the film once it cures. Therefore, almost any soil type can be treated with Dust Stop Municipal Blend. However, the application rate of Dust Stop Municipal Blend that is recommended may vary slightly depending on the material being treated.

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11) How long will Dust Stop Municipal Blend last?

Dust Stop Municipal Blend is a seasonal dust control solution, designed to reduce the frequency of treatments compared to other dust control methods, such as chlorides. Some variables that will affect the longevity of an application would be the application rate used, type of material, wet/rainy conditions, type and amount of traffic and climatic conditions. The application rate will have an effect on the longevity of dust control results you see; the stronger you apply Dust Stop Municipal Blend the longer it will last. Some Dust Stop Municipal Blend users apply it at rates that are much less concentrated and on a more frequent basis, therefore in essence making these applications maintenance doses and allowing for a more cost-effective long-term use of the product.

12) Will Dust Stop Municipal Blend have any adverse effects on the vehicles used to apply it?

No, Dust Stop Municipal Blend will not have any adverse effects on either the vehicles used to apply the product or the vehicles using the road. Dust Stop Municipal Blend has a pH that is almost neutral which is why it will have no corrosive effect on any vehicles it comes into contact with, or any damaging effect to road side vegetation. In fact, Dust Stop Municipal Blend ‘s use as a dust control product will eliminate harmful dust from having an abrasive effect on the moving parts of the vehicles traveling on the Dust Stop Municipal Blend treated roads therefore reducing their associated maintenance requirements. It is unlike corrosive and toxic products such as chlorides, it will not cause irreversible long term damage to equipment and vehicles.

13) Why use a dust control product?

Dust control should be used to minimize the risks involved with the generation and movement of dust particles emanating from any trafficked unpaved surfaces. Dust also represents the fines that are the essential binders that maintain the strength and stability of an unpaved surface, and help to lock down the aggregate road. It is estimated that for every vehicle traveling one mile of unpaved roadway once a day, every day for a year, one ton of dust is deposited along a corridor extending 500 feet out on either side of the road. This dust poses a threat to human health through inhalation into the lungs, as well as a threat to the safety of the people using the road due to the reduced visibility caused by the thick clouds of dust. The creation of dust is also quite costly because it represents significant annual losses in fine soil material and can cause damage via abrasion to moving parts of the vehicles traveling on the road. Applying a dust suppressant / dust control product, such as Dust Stop Municipal Blend, will help to minimize these threats and provide a much safer, healthier road environment.

Additional information can be found at www.cypherenvironmental.com. For questions, contact your regional distributor or Cypher Environmental Ltd.’s head office at info@CypherEnvironmental.com.

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DUST STOP LIQUID CONCENTRATE (DSLC) QUESTIONNAIRE DEFINITIONS

Cypher environmental prides itself in providing a customized approach to every project; we know that no two projects are the same, understanding the variables such as size, project type, material type, traffic frequency and traffic type are paramount to providing the best solution.

A significant amount of time and effort is placed on providing the best solution for the issue of dust control based on the circumstances of a particular project. Areas such as dimensions of the project are easily determined while others such as traffic type and traffic frequency are somewhat subjective. In order to provide some framework for understanding these terms, Cypher provides the following reference information:

Road Type:

Mine Haul	– A crude road built to facilitate the movement of people, equipment, and/or materials along the route of a job. – A road built to carry heavily loaded trucks (60-450 ton) at a good speed; the grade is limited and usually kept to less than 17% of climb. – Truck haulage cost amounts to between 30 and 50 per cent of total surface mining costs and up to 60 per cent of total forestry operation costs. The savings from appropriate design, construction and maintenance of haulage roads and utilization of the most suitable materials is thus significant.
Access Road	– A road providing a means of entry into a region or approach to another road, site or project; usually exposed to heavy traffic (not as significant as a haul road). – A road that provides access to a specific destination, as to a main highway or to a property that lies within another property.
Secondary Road	– A road supplementing a main road, usually wide enough and suitable for two-way, all-weather traffic at moderate or slow speeds (lighter vehicles than an access road).
Parking Lot	– A cleared unpaved area that is intended for parking vehicles, these surfaces can be exposed to additional shear forces not found on other road types due to static shear (static wheel forces when steering while stopped).
Erosion Control	– Is the practice of preventing or controlling wind or water erosion in agriculture, land development, coastal areas, river banks and construction. – Effective erosion controls are important techniques in preventing water pollution, soil loss, wildlife habitat loss and human property loss.

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Tailings Pile	– Any static pile of material that is not exposed to vehicle or foot traffic. – Also includes storage piles.

Material Type:

The **Material Type** is a reflection of the size of the dominant aggregate particles in a road / soil, starting at the small end of the scale; Well Compacted Fines and getting larger as we reach the High Gravel Content end of the scale.

Sandy	– Granular material. – Finer than gravel and coarser than silt. – Particles range in diameter between 0.0625 mm to 2mm.
Well Compacted Fines	– High clay / silt content. – Cohesive soils (clay / silt) that are dense and tightly bound together.
Light Gravel Content	– Fine Sized / Dirty Gravel (more fines). – This is small (4–8 mm) particulate gravel.
Medium Gravel Content	– Medium Sized / Less Dirty (less fines). – This is medium (8-16 mm) particulate gravel.
High Gravel Content	– Coarse Gravel (Little to No Fines – difficult to compact) – This is larger (16-32 mm) particulate gravel.

Traffic Frequency:

The area i.e. dimensions of the surface are easily determined while other variables such as traffic type and traffic frequency are somewhat subjective. In order to provide some framework for understanding these terms, Cypher provides the following reference information:

Traffic Frequency	Per hour	Per 8 hour	Per 12 hour	Per 24 hour
Low	1 – 10	1 – 80	1 – 120	1 – 240
Medium	10 – 25	80 – 200	200 – 300	240 – 600
High	> 25	> 200	> 300	> 600
Constant	– Traffic that exceeds the 25 vehicles per hour and remains at a steady state for extended periods. Generally, traffic numbers are averages over a long period, encompassing high and low traffic periods. Constant traffic indicates regular passage of vehicles at stable intervals for long periods (e.g. every 2 minutes for 24 hours a day).			
Tailings Pile	– Any static pile of material that is not exposed to vehicle or foot traffic. – Also includes storage piles			

Traffic Type:

Traffic Type	**Vehicle Weight (tons)**	**Vehicle Weight (kg)**	**Vehicle Weight (lbs)**
Heavy	> 100	> 100,000	> 220,463
Medium	22 – 100	22,000 – 100,000	48,500 – 220,462
Light	< 22	< 22,000	< 48,500
Tailing Pile	– Any static pile of material that is not exposed to vehicle or foot traffic. – Also includes storage piles.		

Average Traffic Speed:

This represents the speed at which the majority of vehicles will travel on the road. Choose "Tailings Pile" for any projects that will not receive any traffic.

**Note that these definitions are for general familiarity; all roads will have a mixture of various sized aggregates in them but will have a visible maximum aggregate size that we are referring to here. If you are uncertain about the category of a road, a picture of the surface should be emailed to your Cypher representative for clarification.
**This information is provided as a guide only, specifics of the project should be discussed with your Cypher representative to clarify individual project details.

Dust Stop Municipal Blend

SECTION 1: IDENTIFICATION

Product Name:	Dust Stop Municipal Blend
Synonyms:	DSMB
CAS Number:	See Section 3
Product Use:	A water-based nonhazardous, environmentally friendly and biodegradable liquid used for dust control on roads
Manufacturer/Supplier:	Cypher Environmental Ltd.
General Information:	WHMIS Classification: Not Controlled
Address:	Cypher Environmental Ltd. 1149 St. Matthews Ave. Winnipeg Manitoba R3G 0J8 Canada
Emergency Number:	Tel: (204)-489-1214 Fax: (204)489-7372

Section 2: HAZARD IDENTIFICATION

Health Environmental Physical:	Biodegradable
Acute Toxicity:	Non- Toxic, pathogen free.
Skin/Eye Corrosion:	Contact with skin may result in mild irritation.
Mutagenicity/ Carcinogenicity/Developmental:	Non-mutagenic and non-carcinogenic Based on available information, none of the ingredients in Dust Stop Municipal Blend are regulated nor listed as potential cancer agents by Federal OSHA, NTP or IARC.
Reproductive/Developmental:	Not Determined
Target Organ Toxicity (Repeated):	Not Determined
Toxicity:	Non-Toxic, pathogen free

GHS Label:

Signal Word: DANGER!

Hazard Statements:

WHMIS HAZARD RATING INFORMATION	FLAMMABILITY	HEALTH	REACTIVITY
0-Minimal 1-Slight 2-Moderate 3-Serious 4-Severe	0	1	0

Section 3: COMPOSITION / INFORMATION ON INGREDIENTS

Unique Identifiers

INGREDIENTS (Complex mixture)	% by weight	CAS NO.
Water	5-10	-
Proprietary Anionic Polyelectrolyte Additive	Proprietary	CAS Listed
Proprietary Additive	Proprietary	CAS Listed
Reduced Sugars	Proprietary	CAS Listed
Silicates and Carbonates	Proprietary	Mixture

* Based on available information, none of the ingredients in Dust Stop Municipal Blend are regulated nor listed as potential cancer agents/hazardous by Federal OSHA, NTP or IARC.

Section 4: FIRST AID MEASURES

Eye: A slight eye irritant.

Skin: Contact with skin may result in mild irritation, rinse with plenty of water.

Inhalation and Ingestion: Considered non-harmful by all exposure routs , if breathing is difficult remove to fresh air.

Signs and Symptoms of Exposure: None. Ingestion may cause mild nausea or diarrhea.

Section 5: FIRE FIGHTING MEASURES

Suitable Extinguisher Media:	Treat the same as water
Fire Fighting Procedures:	Isolate fire area and deny unnecessary entry, Soak thoroughly with water to cool and prevent re ignition. Cool surroundings with water to localize fire zone. Hand held carbon dioxide or dry chemical hazard may result from forceful application of fire extinguishing agents. Do not enter fire area with out protective equipment.

Section 6: ACCIDENTAL RELEASE MEASURES

PPE:	Eye: Safety goggles Respirator: Not applicable Clothing: Regular on-Site clothing
Emergency Procedures:	In case of accidental spill or discharge, take up and containerize for disposal according to state and local regulations. This product displays ultimate biodegradability under both aerobic and anaerobic conditions and if spilled should not cause any adverse short or long term environmental impacts. Ventilation requirements as normal
Methods and Materials For Containment and Cleaning Up:	For smaller spills, Wash contaminated area with water and flush into sewage system or any other disposal system. For large spills, soak up with sand or sweeping compound and dispose at solid waste

Section 7: HANDLING AND STORAGE

Handling: **Keep container closed when not in use. If container is being stored for extended periods, provide minimal to moderate agitation every few weeks ensuring re-homogenization of product.**

Storage:

Storage Temperature (Degrees C/F)
Minimum: 10ºC (50ºF)
Maximum: 20-25ºC (68-77ºF)
Application Temperature:
Minimum: 10ºC (50ºF)
Maximum: 57ºC (135ºF)
Optimum Working Temperature Range:
18-45ºC (64-113ºF)
*Store product in an area that is not exposed to direct sunlight and in an environment within the conditions stated above.

Section 8: EXPOSURE TO CONTROLS AND PERSONAL PROTECTION

OSHA PEL's:	Not Applicable
Exposure Limits:	Dust Stop Municipal Blend presents no health hazards to the user, other than mild eye and skin irritancy.
Engineering Controls:	

No specific engineering controls needed, it is recommended to handle concentrated product in a well ventilated area

PPE:	
Eye Protection:	Safety goggles, avoid eye contact or exposure to concentrated amounts of product
Skin Protection:	Regular on-Site clothing , rinse from skin when exposed to product
Respiratory Protection:	Respirator: Not applicable, ventilation as normal

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Flashpoint:	Not flammable; not combustible
Auto Ignition:	None
Boiling Point:	>100°C
Melting Point:	Liquid
Freezing Point:	<0°C
Vapor Pressure:	Not Determined
Miscibility with water:	Miscible in all proportions
Solubility in Water:	Soluble
Lower and Upper Flammability Limits:	Not flammable
Specific Gravity:	1.24 @ 25 °
Density:	1.4 g/cm^2 @ 25 °
pH:	9.19
Ultimate Biodegradability:	DOC reduction >90% after 28 days
Appearance:	Brown slightly viscous liquid
Odor:	Sweet organic odor
Composition:	A blend of carbohydrates, water-soluble polymers, and solid mineral.

Section 10: STABILITY AND REACTIVITY

Stability/ Incompatibility:	Stable for a minimum of two years when stored in proper conditions (see above section 7)
Hazardous Reactions/Decomposition Products	Not determined
Reactivity:	Not determined
Chemical Stability:	Stable
Conditions To Avoid:	Storage above 50ºC (120ºF) or below 0ºC (32ºF). Avoid contact with strong oxidizing and reducing agents.
Incompatible Materials:	None
Hazardous Decomposition Products:	Not determined, None

Section 11: TOXILOGICAL INFORMATION

Signs, Symptoms of Over Exposure and First Aid Treatment:	Eye Contact: Reddening may develop. Immediately rinse the eye with large quantities of cool water. Continue 10-15 minutes or until material has been removed. Be sure to remove contact lenses, if present, and lift upper and lower lids during rinsing. Get medical attention if irritation persists. Skin Contact: Minimal effects, if any. Rinse skin with water. Rinse shoes and launder clothing before reuse. Swallowing: Essentially non-toxic. Product may cause a slight laxative condition. Give several glasses of water to dilute if swallowed. Do not induce vomiting. If stomach upset persists, consult a physician. Inhalation: Non-toxic. Prolonged exposure to product in a mist form (not recommended) could cause a mild irritation of the nasal passages and throat. Remove to get fresh air. Get medical attention if irritation persists.

Section 12: ECOLOGICAL INFORMATION

Bio Accumulative Potential:	The product exhibits ultimate biodegradability under anaerobic conditions as defined by US EPA methods (40 CFR part 796.3180).

Section 13: DISPOSAL CONSIDERATIONS

See section 6

Section 14: TRANSPORTATION INFORMATION

This product is non-toxic, transport in conditions described in section 7 above.
INTERNATIONAL AIR TRANSPORTATION ASSOCIATION: this product is not regulated by IATA, when shipped internationally.

Section 15: REGULATORY INFORMATION

SARA/TITLE III – CERCLA List of Hazardous Substances and Reportable Quantities (40 CFR 304.4): This product **does not** contain an ingredient(s) listed as a hazardous ingredient for Emergency Release Notification under section 304.

SARA/TITLE III – List of Extremely Hazardous Substances for Emergency Planning and Notification (40 CFR 300 & 305): This product **does not** contain an ingredient(s) listed as an extremely hazardous substance (EHS) for Emergency Planning under sections 301-303 and for Emergency Release Notification under section 304.
SARA/TITLE III – List of Toxic Chemical subject to Release Reporting (Community Right to Know) (40 CFR 372): This product **does not** contain an ingredient(s) listed as a toxic chemical for Annual Release Reporting Requirements under section 313.

Section 16: OTHER INFORMATION

Date of SDS Preparation:	August 2016
Original or Revised Copy:	Last Updated August 2016 **Reasonable care has been taken to ensure information and advice contained in this data sheet is accurate at the time of printing. However, Cypher Environmental Ltd. Accepts no liability for any loss or damages suffered as a consequence of reliance on the information contained herein.**
Changes Made to Original SDS:	
Disclaimers:	Please contact the supplier for application instructions, the application rate/procedure may fluctuate depending on specific uses of product and applications.

The above information pertains to this product as currently formulated, and is based on the information available at this time. Addition of reducers or other additives to this product may substantially alter the composition and hazards of the product. Since conditions of use are outside our control, we make no warranties, express or implied, and assume no liability in connection with any use of this information.

SMI, Inc.

12219 SW 131 Avenue
Miami, Florida 33186-6401 USA

Phone: (305) 971-7047
Fax: (305) 971-7048

Attn: Adrianne Veters
Cypher Environmental Ltd
1149 St Matthews Ave 2nd Floor,
Winnipeg, MB R3G 0J8
Canada

Date: 29-Sep-2017

SMI/REF: 1707-047

Product: **DUST STOP MUNICIPAL BLEND** *(received 07-Aug-2017)*

Dilution: As received and 10% by volume

BOEING D6-17487 REVISION T
Exterior and General Cleaners and Liquid Waxes,
Polishes and Polishing Compounds

Sandwich Corrosion Test	Conforms
Acrylic Crazing Test	Conforms
Paint Softening Test	Conforms
Hydrogen Embrittlement Test	Conforms

Respectfully submitted,

Patricia D. Viani, SMI, Inc.

Sandwich Corrosion Test : Specimen preparation, testing, and interpretation shall be in accordance with ASTM F1110 using the following materials and with the following exceptions:

a. Reagents and materials exception:
   (1). Clad 7075-T6 aluminum alloy in accordance with QQ-A-250/13 (AMS 4049 or AMS-QQ-A-250/13 optional) (2024-T3 Alclad specimens are neither required nor optional.)
   (2) Bare 7075-T6 aluminum alloy in accordance with QQ-A-250/12 (AMS 4045 or AMS-Q-A-250/12 optional) anodized in accordance with BAC 5019 or MIL-A-8625, Type I.
   (3) Anodize shall be sealed. (2024-T3 nonclad specimens are neither required nor optional).
   (4) Distilled or deionized water may be used in place of ASTM F1193, Type IV reagent grade water for control specimens.
   (5) The filter paper may be Whatman No. 5 or equivalent in place of Whatman GFA glass fiber paper.

b. Procedure exceptions:
   (1) The filter paper strips shall be 1 by 3 inches and shall be placed in the center of the sandwiched specimens.
   (2) Each sandwich specimen shall be held together with waterproof tape, with no more than 1 piece of tape (maximum width 0.75 inch) on each of two opposite edges.

c. Interpretation of result exceptions:
   (1) Leaching or lightening of the chromate sealed anodize coating shall not be cause for rejection.
   (2) Deposits or residues from the material being tested that are not products of corrosion of the test panel surface shall not be cause for rejection.
   (3) Special procedure for evaluation of fire extinguishing foams and liquids.

   Panels with very light darkening or staining, which have no obvious metal attack or pitting, may be swabbed (cotton-tipped swabs or cotton gauze) with a 0.26 mole/liter sulfuric acid solution and re-examined. If the coloration is substantially removed and there is no evidence of metal attack or pitting, the condition shall not be cause for rejection. (The 0.26 mole/liter sulfuric acid solution can be prepared by adding 1.5 cc of concentrated sulfuric acid (SG = 1.84) to 100 cc of distilled or deionized water.

   (4) Panels shall have a rating of 1 (no more than 5 percent of the surface area shall be corroded) or better in accordance with ASTM F 1110. The preferred method of determining the corroded area is by using image analysis. Other means approved by the purchaser may be substituted.
   (5) Any corrosion in excess of that shown by the control group shall be cause for rejection.

Sandwich Corrosion Test :continued

	Bare 7075-T6 (AMS 4045) Anodized per BAC 5019 (chromate seal) or MIL-A-8625 Type I with Dichromate Seal	Clad 7075-T6 Aluminum (AMS 4049)
CONCENTRATE	**1**	**1**
DILUTE	**1**	**1**
CONTROL	1	1

Result Conforms

Acrylic Crazing Test:

The material being tested shall not craze, crack, or etch acrylic test specimens when tested in accordance with ASTM F 484 using Type C (stretched acrylic plastic in accordance with MIL-P-25690) stressed to an outer fiber stress of 4500 psi.

Type C (MIL-P-25690) ***Concentrate: No crazing, cracking or etching.***
Dilute: No crazing, cracking, or etching.

Result Conforms

Paint Softening Test Procedure:

a. Testing shall be in accordance with ASTM F502 using the following coating systems.
   (1) BMS 10-79, Type II primer applied in accordance with BAC5882 plus BMS 10-60, Type II enamel in accordance with BAC5845.
   (2) BMS 10-79, Type III primer applied in accordance with BAC5882, plus BMS 10-100 coating in accordance with BAC5797.

b. Three specimens conforming to Section 12a.(1) and three specimens conforming to Section 12a(2) shall be used for each test condition.

c. The material being tested shall not produce a decrease in film hardness greater than two pencils, or any discoloration or staining.
   NOTE: Slight darkening of the BMS 10-100 surface is acceptable.

Concentrate: *Paint system 1: ≤ 1 pencil hardness change after 24 hour post-exposure dry time.*
Paint system 2: ≤ 1 pencil hardness change after 24 hour post-exposure dry time.

Dilute: *Paint system 1: ≤ 1 pencil hardness change after 24 hour post-exposure dry time.*
Paint system 2: ≤ 1 pencil hardness change after 24 hour post-exposure dry time.

Result Conforms

Hydrogen Embrittlement Test:
Hydrogen Embrittlement testing shall be in accordance with ASTM F 519 using cadmium plated Type 1a.2, Type 1c, or Type 2a specimens. All requirements of ASTM F519 for specimens, preparation, testing, and reporting shall apply. Type 1a.2 specimens shall meet the requirements of D6-4307.

Specimens: Type 1c, cadmium plated per MIL-STD-870.
(45% load, 150 hours, notched immersed for the duration, room temp.)

Concentrate:	***#1:***	***No failure occurred within 150 hours.***
	#2:	***No failure occurred within 150 hours.***
	#3:	***No failure occurred within 150 hours.***
	#4:	***No failure occurred within 150 hours.***
Dilute:	***#1:***	***No failure occurred within 150 hours.***
	#2:	***No failure occurred within 150 hours.***
	#3:	***No failure occurred within 150 hours.***
	#4:	***No failure occurred within 150 hours.***

Result Conforms

Cypher Environmental Ltd.
ATTN: Teaghan Wellman
1149 St. Matthews Avenue
2nd Floor
Winnipeg Manitoba R3G 0J8

Date Received: 03-FEB-17
Report Date: 10-FEB-17 13:06 (MT)
Version: FINAL

Client Phone: 204-489-1214

Certificate of Analysis

Lab Work Order #: L1886901
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

Judy Dalmaijer
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1886901-1 40L OF 0.25% DUST STOP							
Sampled By: CLIENT on 03-FEB-17							
Matrix: LIQUID							
Miscellaneous Parameters							
Trout Bioassay LC50	See attached.					03-FEB-17	R3649799

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
TROUT-LC50-WP	Water	Trout Bioassay LC50	EPS 1/RM/13, EPS 1/RM/9

Certified, disease-free rainbow trout (Oncorhynchus mykiss) are exposed to several concentrations of a sample including full strength, under static conditions in order to estimate the median lethal concentration (LC50) - the concentration of the sample in water that is estimated to be lethal to 50% of the test organisms within a 96-hour exposure period.

Samples with excessive salinity (reported as conductivity greater than 13700 µmhos/cm) discharging into marine waters will require alternate testing.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS
Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Rainbow Trout Bioassay Test Report - LC50

Sample ID:	L1886901-1

Summary Results

96-hour LC50 v/v (%):	Non-Lethal
95% Lower Confidence Interval (%):	n/a
95% Upper Confidence Interval (%):	n/a
Method of Calculation:	n/a
Confirmed by Graph:	n/a

Sample Information

Sample Origin:	Cypher Environmental
Sample Description:	40L of 0.25% Dust Stop
Sampling Date and Time:	03-Feb-17
Sampling Method:	Grab
Sampled By:	Not Provided
Container(s) Description:	2 x 20L polyethylene pails without liners
Sample Volume:	40L
Date and Time Received:	03-Feb-17 14:40
Transit Irregularities:	None
Storage Temperature (˚C):	n/a

Test Information

Test Organism:	Oncorhynchus mykiss
Test Description:	Acute, 96-hour, Static, LC50
Reference Method(s):	EPS 1/RM/13, 2nd Ed. Dec. 2000, with 2007 and 2016 amendments, Environment Canada EPS 1/RM/9, May 1996 with May 2007 amendments, Environment Canada
Performed By:	AGJ
Starting Date and Time:	03-Feb-17 16:45
Deviations from Reference Method:	None

Initial Parameters

Observations

Colour:	Dark Brown				
Odour:	Mild				
Turbidity:	High				
Solids:	High				
Hardness (mg/L):	2.5	mL Titration Solution/	10	mL of Sample x 1000 =	250
Alkalinity (mg/L):	1.4	mL Titration Solution/	10	mL of Sample x 1000 =	140
Temperature (℃):	14.4	Thermometer		S/N 91154465	
Dissolved Oxygen (mg/L):	6.15	YSI Dissolved Oxygen Meter		S/N 15M102668	
Conductivity (µS/cm):	696	VWR Portable Conductivity Meter		S/N 51071543	
pH (5.5-8.5 pH units):	8.86	VWR SympHony pH Meter		S/N D01908	
pH Adjustment:	Not Adjusted				
pH Adjustment Procedure:	n/a				

Pre-Aeration

Aeration Time (min):	30					
Sample Test Concentration (v/v):	0.250%	0.125%	0.063%	0.031%	0.016%	0%
Aeration Rate (5.5-7.5 mL/min/L):	6.1 ± 0.2	6.1 ± 0.2	6.1 ± 0.2	6.1 ± 0.2	6.1 ± 0.2	6.1 ± 0.2
xygen (D.O.) Before Pre-Aeration (%):	75.7	n/a	n/a	n/a	n/a	93.4
Average D.O. After Pre-Aeration (%):	83.2	n/a	n/a	n/a	n/a	96.3

Test Organism Data

Lot Number:	11/01/17 T3
Weekly Mortality Preceeding Test (%):	0
Sample Size:	10

Conditions Common to All Concentrations During Test

Source of Holding/Dilution Water:	Dechlorinated UV Treated City of Winnipeg Tap Water
Container Description:	20 L Polyethylene Pail with Liner
Aeration Method:	Compressed air bubbled through silica-glass air diffuser
Aeration Rate (5.5-7.5 mL/min/L):	(as set during pre-aeration above)
Test Solution Volume (L):	20
Test Solution Depth (cm):	34
Number of Test Organisms per Container:	10
Loading Density (g/L):	0.23

Conditions During Test

Concentration (% v/v)	Temperature (°C) (15 ± 1°C)					Dissolved Oxygen (mg/L)					pH (pH units)				
	0h	**24h**	**48h**	**72h**	**96h**	**0h**	**24h**	**48h**	**72h**	**96h**	**0h**	**24h**	**48h**	**72h**	**96h**
0	14	n/a	n/a	n/a	14	9.81	n/a	n/a	n/a	9.72	7.51	n/a	n/a	n/a	7.68
0.016	14	n/a	n/a	n/a	14	9.93	n/a	n/a	n/a	9.66	7.58	n/a	n/a	n/a	7.38
0.031	14	n/a	n/a	n/a	14	9.79	n/a	n/a	n/a	9.59	7.61	n/a	n/a	n/a	7.42
0.063	14	n/a	n/a	n/a	14	9.43	n/a	n/a	n/a	9.57	7.84	n/a	n/a	n/a	7.52
0.125	14	n/a	n/a	n/a	14	8.52	n/a	n/a	n/a	9.37	8.18	n/a	n/a	n/a	7.52
0.25	14	n/a	n/a	n/a	14	6.78	n/a	n/a	n/a	7.21	8.86	n/a	n/a	n/a	7.36

Conc. (% v/v)	Conductivity (µS/cm)	Number of Fish Dead				Number of Fish Stressed			
	0h	**24h**	**48h**	**72h**	**96h**	**24h**	**48h**	**72h**	**96h**
0	332	n/a	n/a	n/a	0	n/a	n/a	n/a	0
0.016	355	n/a	n/a	n/a	0	n/a	n/a	n/a	0
0.031	394	n/a	n/a	n/a	0	n/a	n/a	n/a	0
0.063	452	n/a	n/a	n/a	0	n/a	n/a	n/a	0
0.125	546	n/a	n/a	n/a	0	n/a	n/a	n/a	0
0.25	700	n/a	n/a	n/a	0	n/a	n/a	n/a	0

Control Fish Information at End of Test

Mean Fork Length (mm):	38
Lower Range Fork Length (mm):	36
Upper Range Fork Length (mm):	40
Mean Wet Weight (g):	0.47

Mortality and Stressed Behaviour Information

Conc. (% v/v)	Mean Number of Fish at End of Test		Mean Rate of Fish at End of Test (%)	
	Dead	Stressed	Dead	Stressed
0	0	0	0	0
0.016	0	0	0	0
0.031	0	0	0	0
0.063	0	0	0	0
0.125	0	0	0	0
0.25	0	0	0	0

Median Lethal Concentration Results for Multi-Concentration Tests

LC50:	Non-Lethal
LC50 Lower 95% Confidence Limit:	n/a
LC50 Upper 95% Confidence Limit:	n/a
Statistical Method:	n/a

Note: Non-lethal = 0 mortality

Reference Toxicant Test Results

Reference Toxicant:	Zinc Sulfate
Date Reference Toxicant Initiated:	26-Jan-17
Recent 96h Reference Toxicant Test LC50 (mg/L Zinc):	0.33
Lower 95% Confidence Limit (mg/L Zinc):	0.23
Upper 95% Confidence Limit (mg/L Zinc):	0.46
Historic Geometric Mean LC50 (mg/L Zinc):	0.64
Lower 95% Confidence Limit (mg/L Zinc):	0.27
Upper 95% Confidence Limit (mg/L Zinc):	1.51
Method of Calculation:	Stephan LC50 Program, Probit
Confirmed by Graph:	Yes

Sublethal Biological Effects

No sublethal biological effects observed.

Observations/Comments

No toxicity observed.

10- 231632

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

L1886901

Page ____ of ____

L1886901-COFC

Report To	**Report Format / Distribution**
Company: Cypher Environmental	Standard: X Other (specify):
Contact: Teaghan Wellman	Select: PDF X Excel Digital Fax
Address: 1149 St. Matthews Ave	Email 1: teaghan@cypherenvironmental
	Email 2: .com
Phone: 204-489-1214 Fax:	
Invoice To Same as Report ? (circle) Yes or No (if No, provide details)	**Client / Project Information**
Copy of Invoice with Report? (circle) Yes or No	Job #:
Company: Cypher Environmental	PO / AFE:
Contact: Maureen Sutherland	LSD:
Address: 1149 St. Matthews Ave	
Phone: 204-489-1214 Fax:	Quote #:
Lab Work Order # (lab use only)	**ALS Contact:** **Sampler:**

Service Request: (Rush subject to availability - Contact ALS to confirm TAT)

Regul... / Priorit... / Emer... / Same...

(Indicate Filtered or Preserved, F/P)

Contact Lee Ann for Test.

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Number of Containers
	40L of 0.25% DustStop.	2/3/17		liquid	2.

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by: [illegible]	Date: Feb 3/17	Time: 2:40p.	Temperature: 24°C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

THE RURAL MUNICIPALITY OF MACDONALD

October 7, 2016

To Whom It May Concern:

We have recently applied Cypher Environmental's new Dust Stop Municipal Blend (DSMB) product to on La Verendrye Road within the municipality. The site runs off the Perimeter Highway west, between Wilkes Avenue and McGillivray Blvd. and is a very heavily trafficked road. DSMB was advertised to be competitive with chlorides in terms of cost and effectiveness and so far has performed well and exhibited excellent properties during and after rain. The product has stood up to the elements very well thus far, with several periods of rain and hot, dry and windy weather.

We were also pleased with the great customer support, including both remotely and on-site assistance during the application of the product. We continue to see more than satisfactory results and are happy with the dust and erosion control provided.

We look forward to future projects involving Cypher Environmental.

Sincerely, G Baker

Grant Baker
Public Works Manager
Rural Municipality of MacDonald
161 Mandan Drive
Sanford, Manitoba, Canada
R0G 2J0
Phone: 204-736-2214
Email: gbaker@rmofmacdonald.com
www.rmofmacdonald.com

August 22, 2017

To Whom It May Concern:

We have recently applied Cypher Environmental's new Dust Stop Municipal Blend (DSMB) product to on Victor Avenue within the municipality. DSMB was advertised to be competitive with chlorides in terms of cost and effectiveness and so far has performed well and exhibited excellent properties during and after rain. The product has stood up to the elements very well thus far, with periods of rain and hot, dry and windy weather.

We were also pleased with the great customer support, including both remotely and on-site assistance during the application of the product. We continue to see more than satisfactory results and are happy with the dust and erosion control provided.

We look forward to future projects involving Cypher Environmental.

Sincerely,

Rick Gamble
Mayor
Village of Dunnottar
PO Box 321
Matlock, Manitoba, Canada
R0C 2B0
Phone: 204-389-4962
Email: info@dunnottar.ca
www.dunnottar.ca

OPERATIONS, MAINTENANCE AND SURVEILLANCE MANUAL: HOPE BAY DORIS TAILINGS IMPOUNDMENT AREA

HOPE BAY, NUNAVUT

Appendix D - Figures

srk consulting

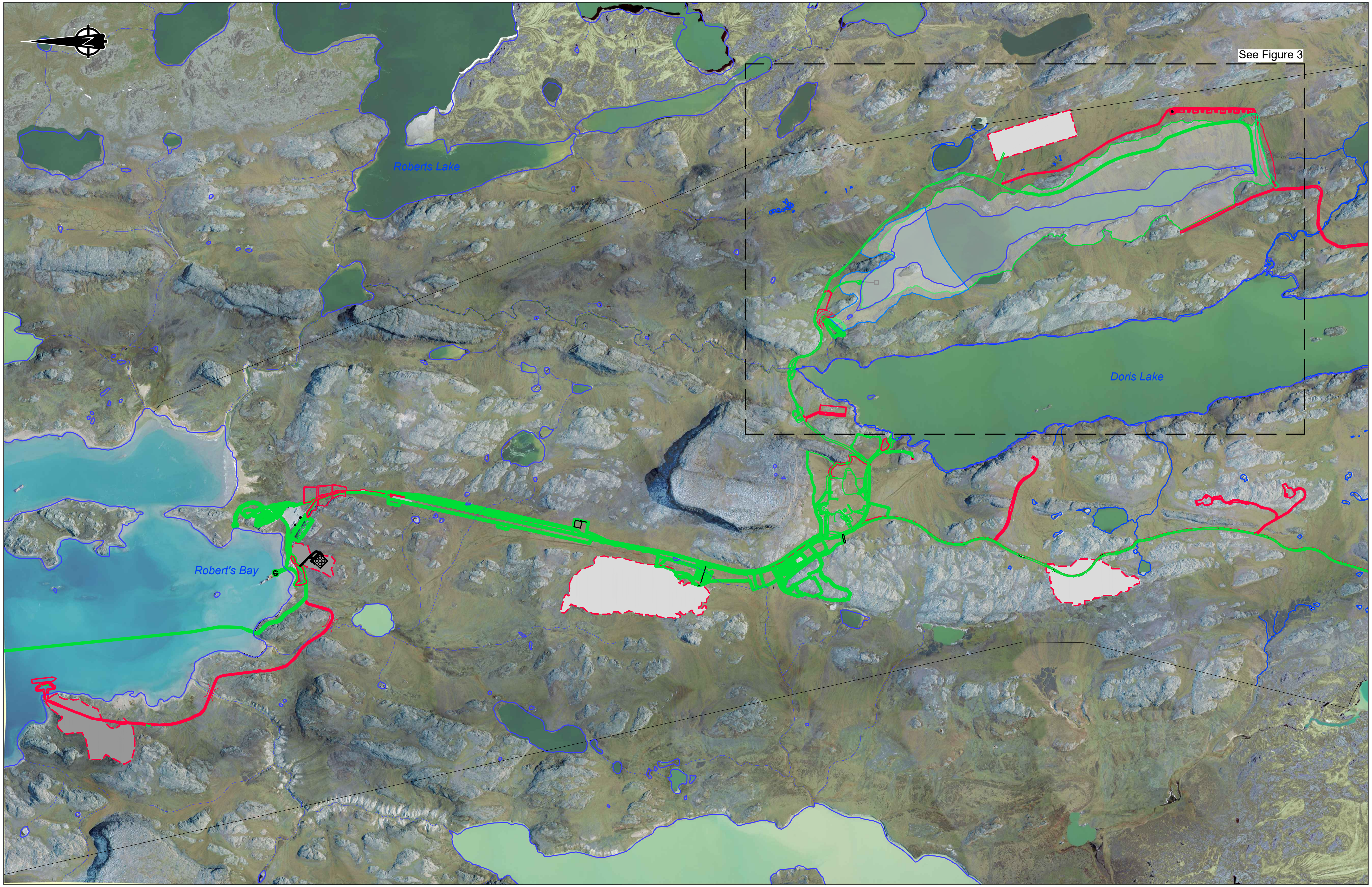
TMAC RESOURCES

DORIS TIA OMS MANUAL

Site Location Plan

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.004.600.10		DATE: May 2016	APPROVED: IM	FIGURE: 1
FILE NAME: 1CT022.004.600.10 - FIGURE 1.dwg				



LEGEND

- As-Built Infrastructure (Dec 2019)
- Proposed Infrastructure
- Quarries

REFERENCE

NAD83 UTM Zone 13.
Aerial image captured in 2007, provided by client.

0m 300 600 900 1200

srk consulting

MAC RESOURCES

DORIS TIA OMS MANUAL

Site General Arrangement

SRK JOB NO.: 1CT022.038

FILE NAME: 1CT022.038 - PLM.dwg

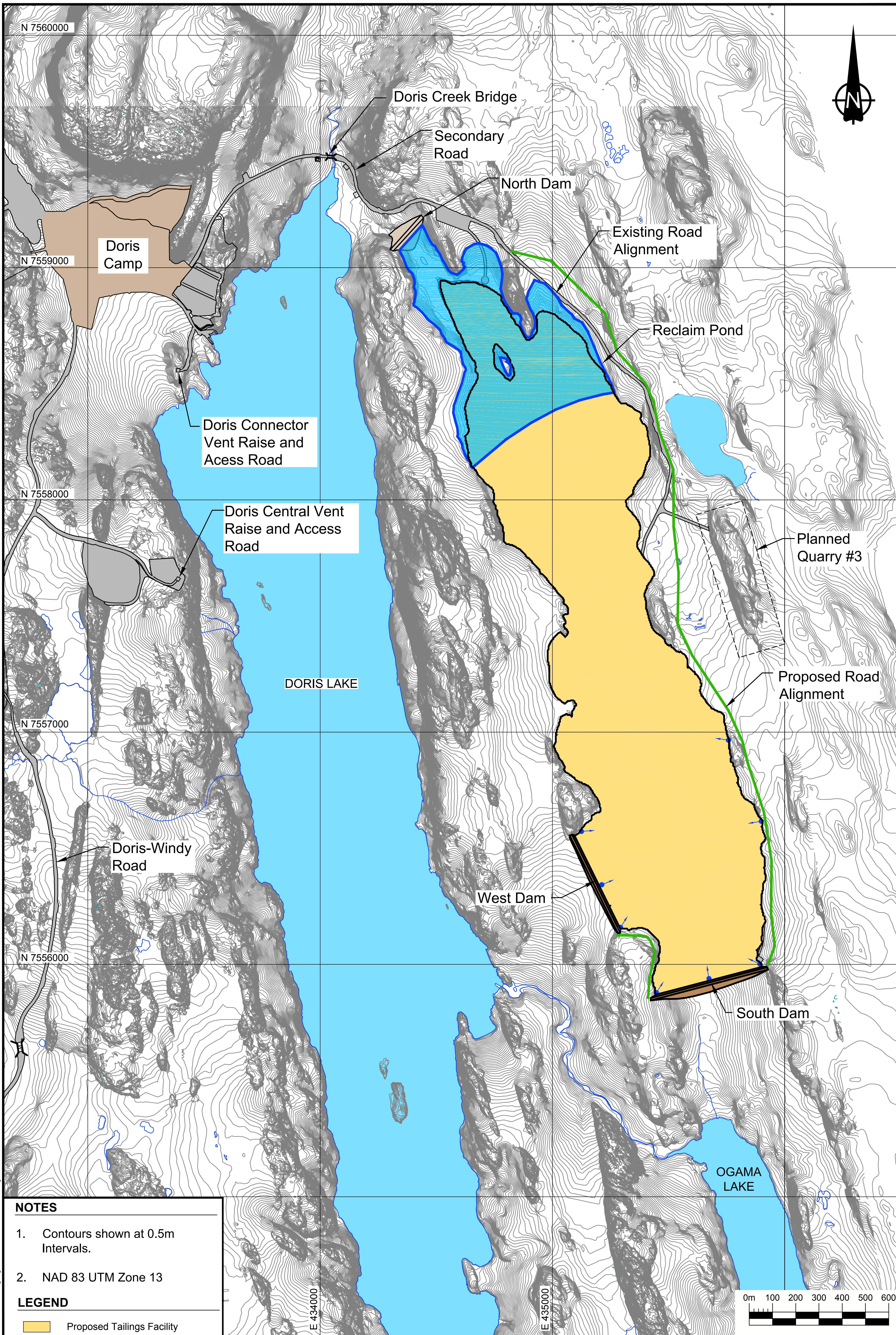
Doris TIA

DATE: June 2020

APPROVED: PDL

FIGURE: 2

P:\Projects\01_SITES\Hope Bay\!ACAD\2019 Drawings\AG\1CT022.038 - PLM.dwg



NOTES

1. Contours shown at 0.5m Intervals.
2. NAD 83 UTM Zone 13

LEGEND

- Proposed Tailings Facility
- Proposed Dam/Dikes
- Existing Facilities
- Existing Doris Camp
- Proposed Road Realignment

srk consulting

SRK JOB NO.: 1CT022.004.600.010

FILE NAME: 1CT022.004.600.10 - FIGURE 3.dwg

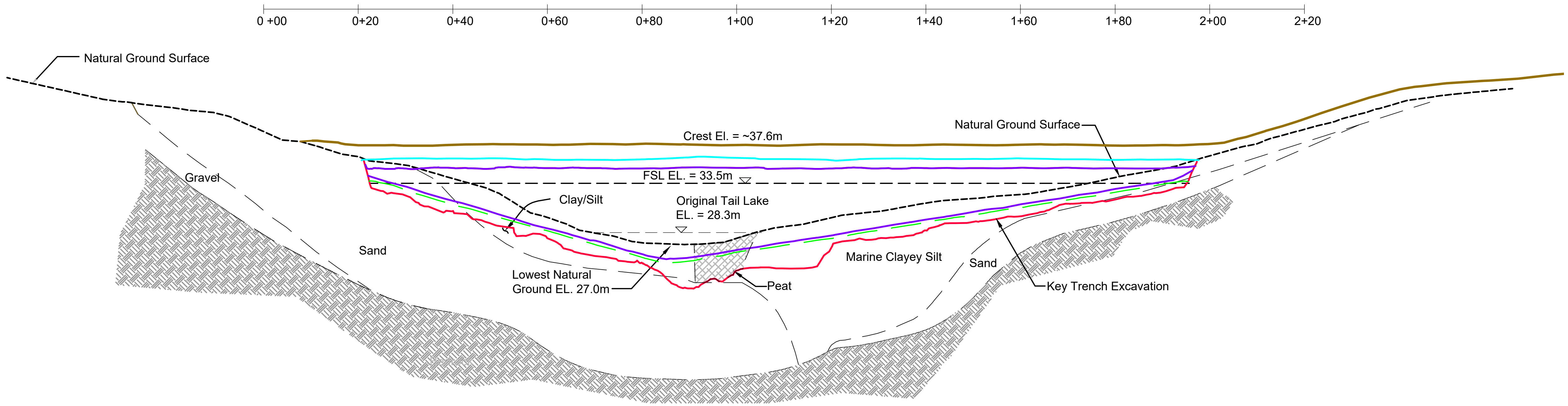
MAC RESOURCES

HOPE BAY PROJECT

DORIS TIA OMS MANUAL

TIA Site Overview
(End Phase 2)

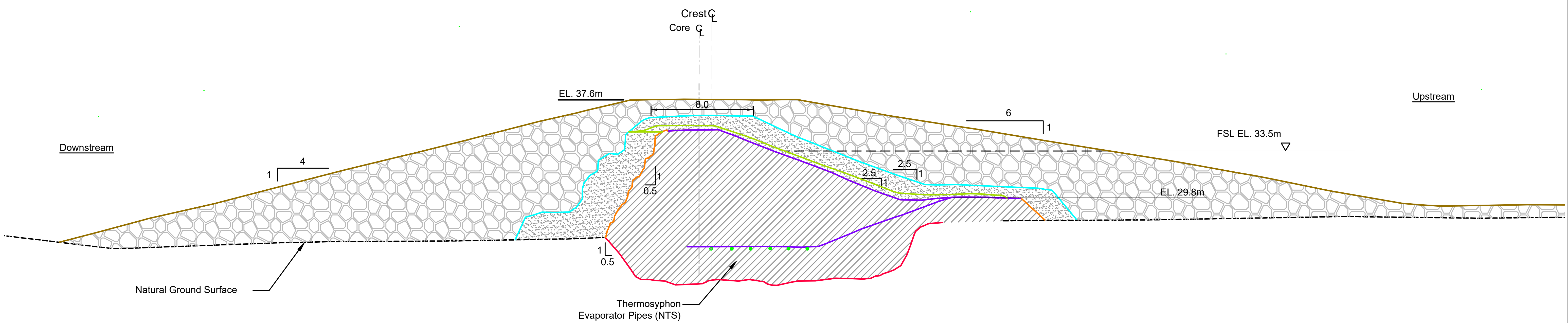
DATE: May 2016 | APPROVED: IM | FIGURE: 3



SECTION ALONG NORTH DAM CREST CENTERLINE

0m 10 20 30 40 Horizontal Scale

0m 50 100 150 200 Vertical Scale



NORTH DAM TYPICAL SECTION

0m 3 6 9 12

LEGEND

- Natural Ground
- Stratigraphic Boundary
- Core Material
- Transition Material
- Run of Quarry (ROQ)
- Surfacing Material
- Bedrock
- Peat
- Thermosyphon Evaporator Pipe (NTS)
- Geosynthetic Clay Liner (GCL)
- Core Material
- Key Trench
- GCL Cover Material
- Transition Material
- ROQ Material
- Thermosyphon Evaporator Pipes
- Thermosyphon Evaporator Pipes

NOTES

1. The subsurface geology has been extrapolated from a series of geotechnical investigations consisting of drill holes, auger holes and shallow test pits. Bedrock contact and geological unit contacts are therefore likely to vary somewhat.

srk consulting

MAC RESOURCES

DORIS TIA OMS MANUAL

North Dam Foundation Conditions and Typical As-Built Section

SRK JOB NO.: 1CT022.038	DATE: March 2020	APPROVED: PDL	FIGURE: 4
FILE NAME: 1CT022.038-North Dam Typical Sections.dwg	Doris TIA		

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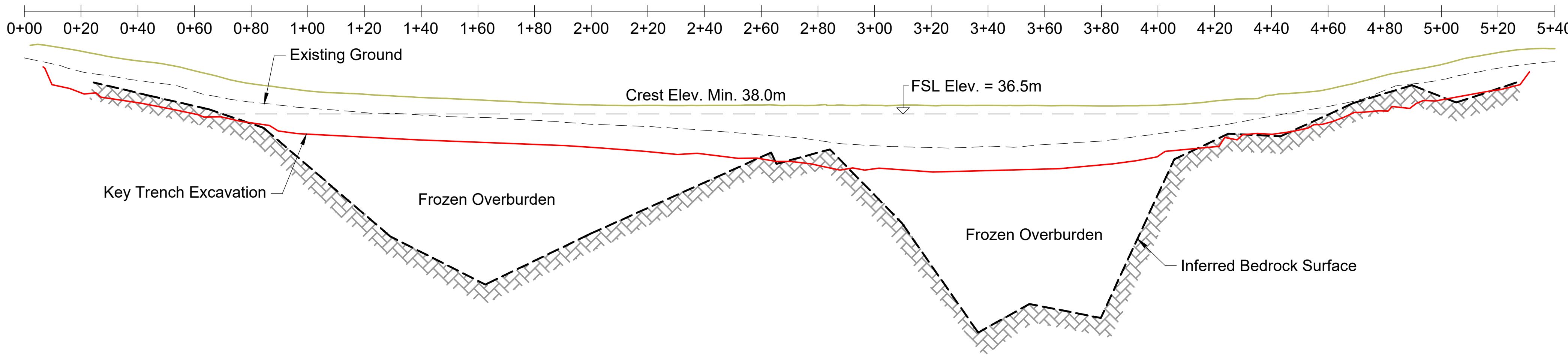
LEGEND

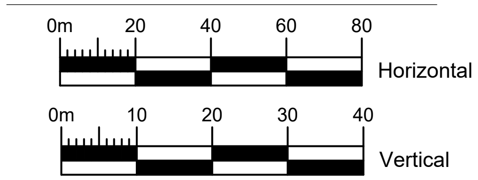
⊠	Thermistor Bead Location
purple dashed line	Lower GCL Liner
green dashed line	Upper GCL Liner
grey fill	Bedding Material
hatched fill	Transition Material
rock fill	Run of Quarry Backfill

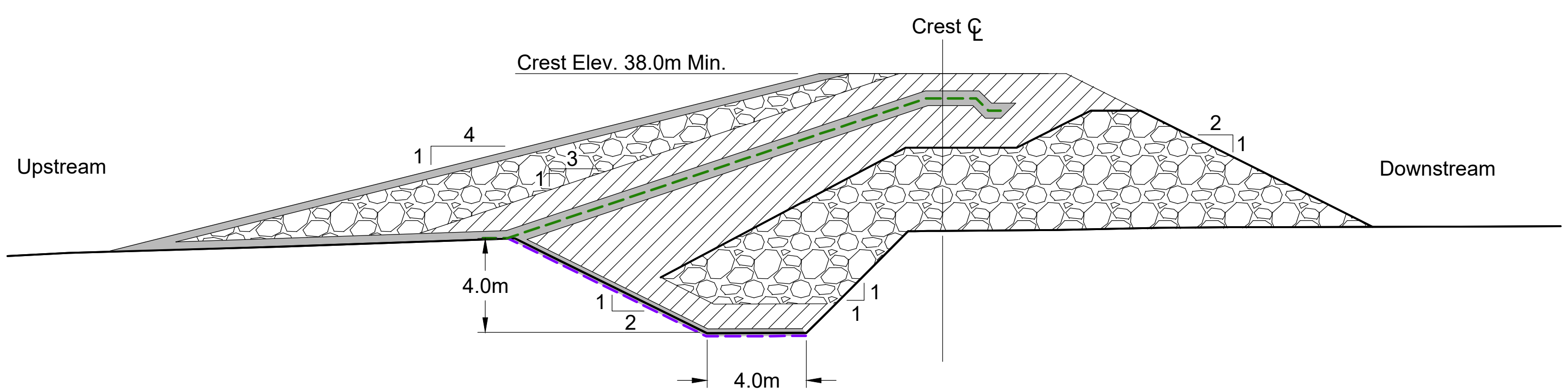
NOTES

1. Topographic and as-built contour data from the terrain model was provided by the Client (TMAC).
2. All units shown are in meters unless otherwise stated.

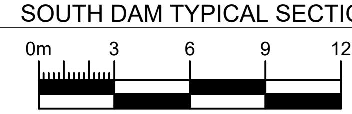


SECTION ALONG
SOUTH DAM CREST CENTERLINE





SOUTH DAM TYPICAL SECTION



srk consulting

SRK JOB NO.: 1CT022.038

FILE NAME: 1CT022.038 - Instrumentation Plan.dwg

TMAC RESOURCES

Doris TIA

DORIS TIA OMS MANUAL

South Dam Foundation Conditions and Typical As-Built Section

DATE:	APPROVED:	FIGURE:
March 2020	PDL	5

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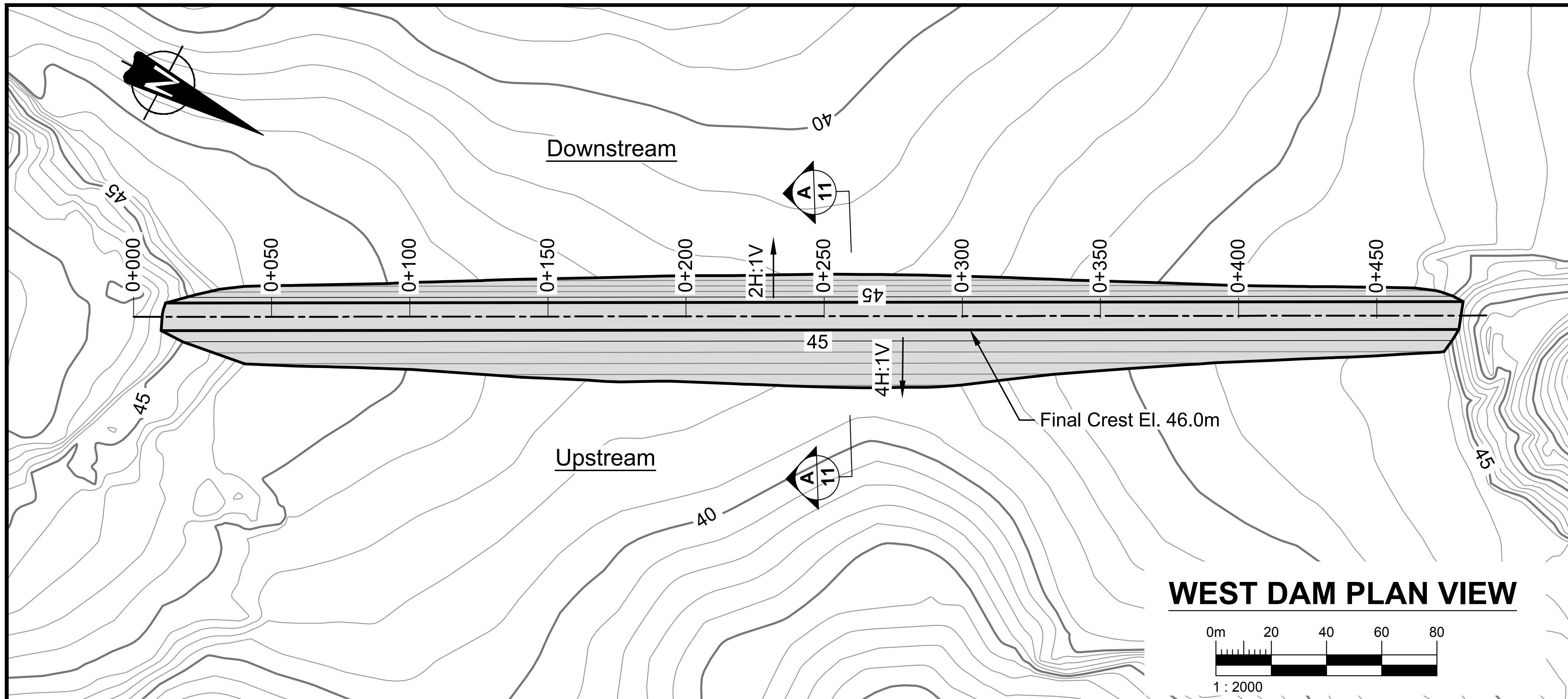
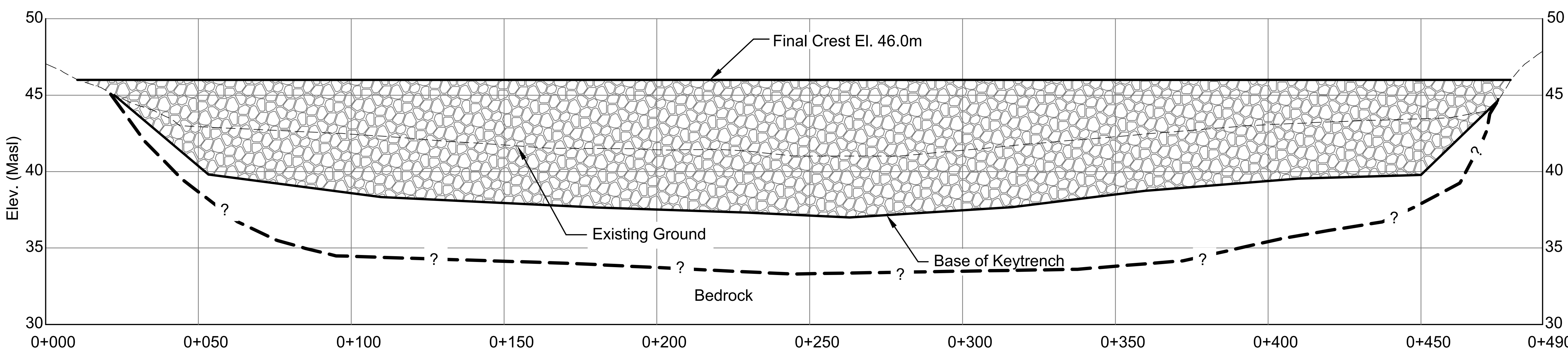


LEGEND

- Natural Ground
- Approximate Stratigraphic Boundary
- Run of Quarry (ROQ)

NOTES

1. All dimensions and elevations are in meters unless stated otherwise.
2. The subsurface geology has been extrapolated from a series of geotechnical investigations. Bedrock contact and geological unit contacts are therefore likely to vary somewhat during final excavation.



WEST DAM PROFILE
5x EXAGGERATION

0m 10 20 30 40 50 60
Horizontal Scale

srk consulting

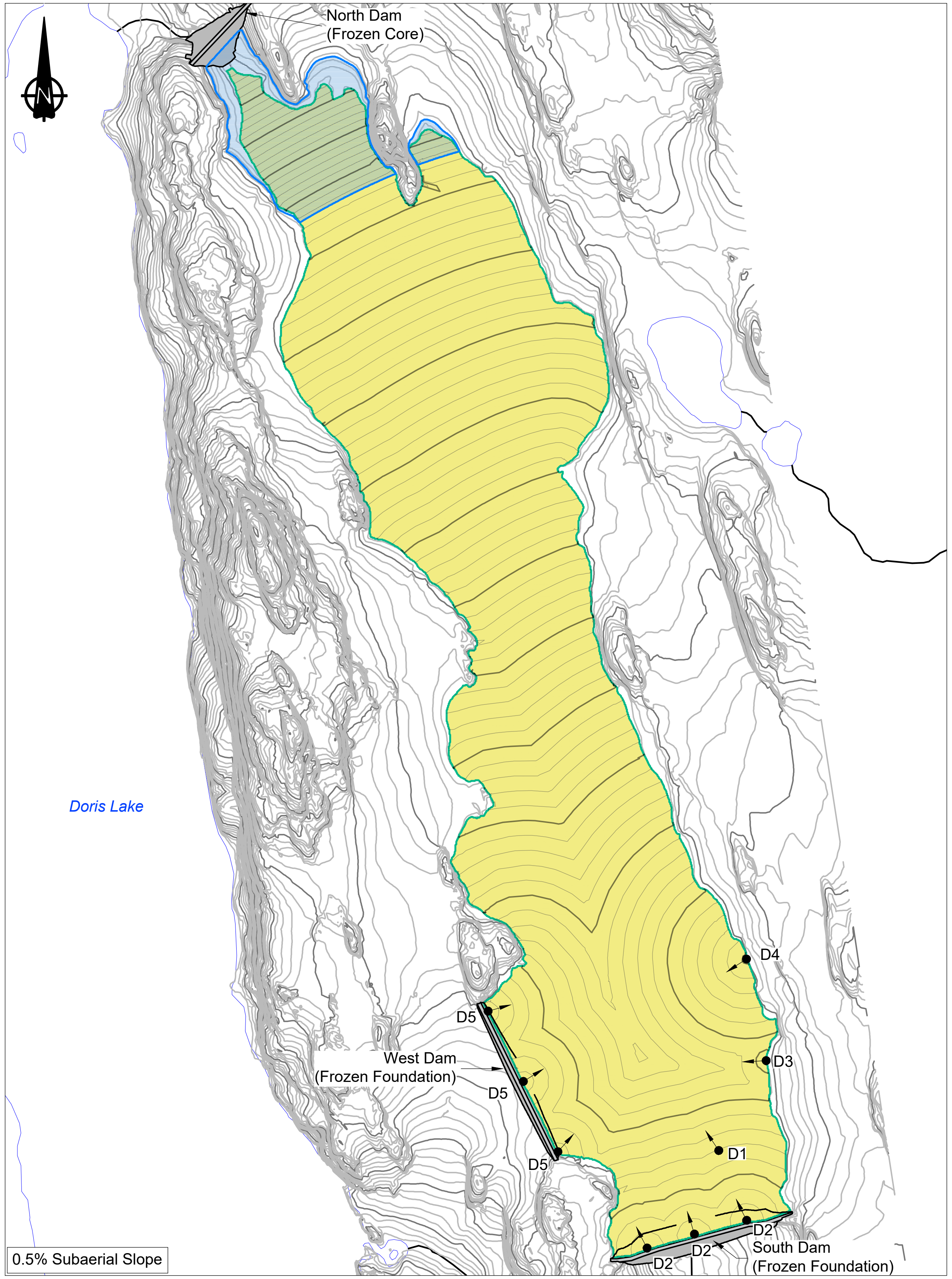
MAC RESOURCES

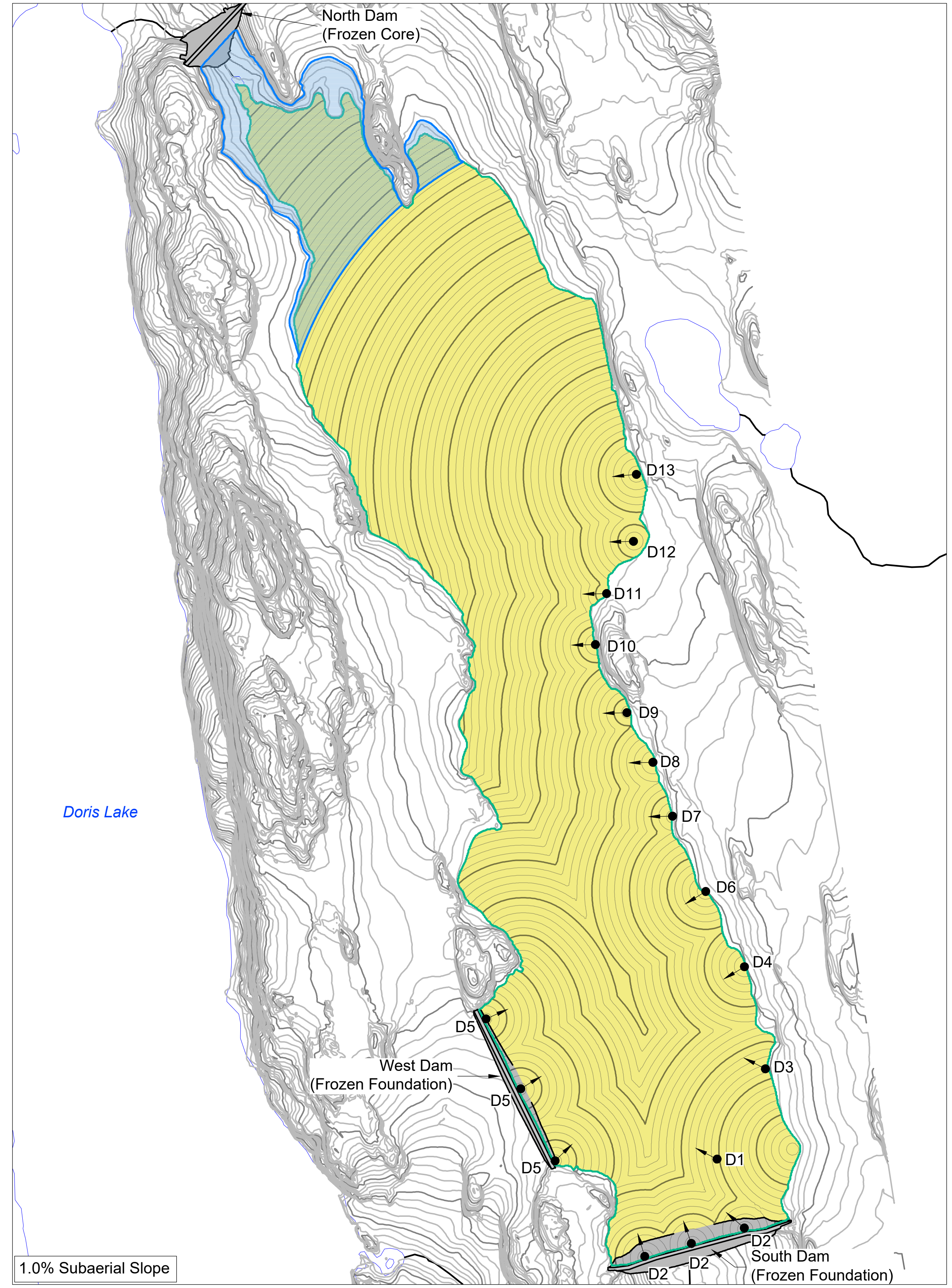
DORIS TIA OMS MANUAL
West Dam
Plan and Profile

SRK JOB NO.: 1CT022.004.600.10
FILE NAME: 1CT022.004.600.10 - FIGURE 10_11.dwg

HOPE BAY PROJECT

DATE: May 2016
APPROVED: IM
FIGURE: 6





LEGEND

- Spigot Location
- Deposited Tailings

NOTES

1. Deposition durations are approximate and were based on the Mine Plan average production rates provided by TMAC Resources.
2. A deposited tailings dry density of 1.3t/m³ was used.
3. All tailings volumes presented include ice entrainment at 20% of production.
4. Dam elevations shown were assumed constant throughout deposition.
5. Total storage requirements includes Madrid and Boston Tailings (Tailings 11.6Mm³ + Ice Entrainment 2.3Mm³).

REFERENCE

NAD83 UTM Zone 13.

0m 3 6 9 12

Note:
Final tailings beach slope will be based on operation. Tailings beach will be somewhere between 0.5% and 1% slope; based on latest as-built survey and operations data (as of December 2019).

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SRK JOB NO.: 1CT022.038

FILE NAME: 1CT022.038 - Planned Tailings.dwg

TMAC RESOURCES

Doris TIA

DORIS TIA OMS MANUAL

Planned Tailings Deposition
(Phase 1 & Phase 2) - End of Mine

DATE:	APPROVED:	FIGURE:
April 2020	PDL	7

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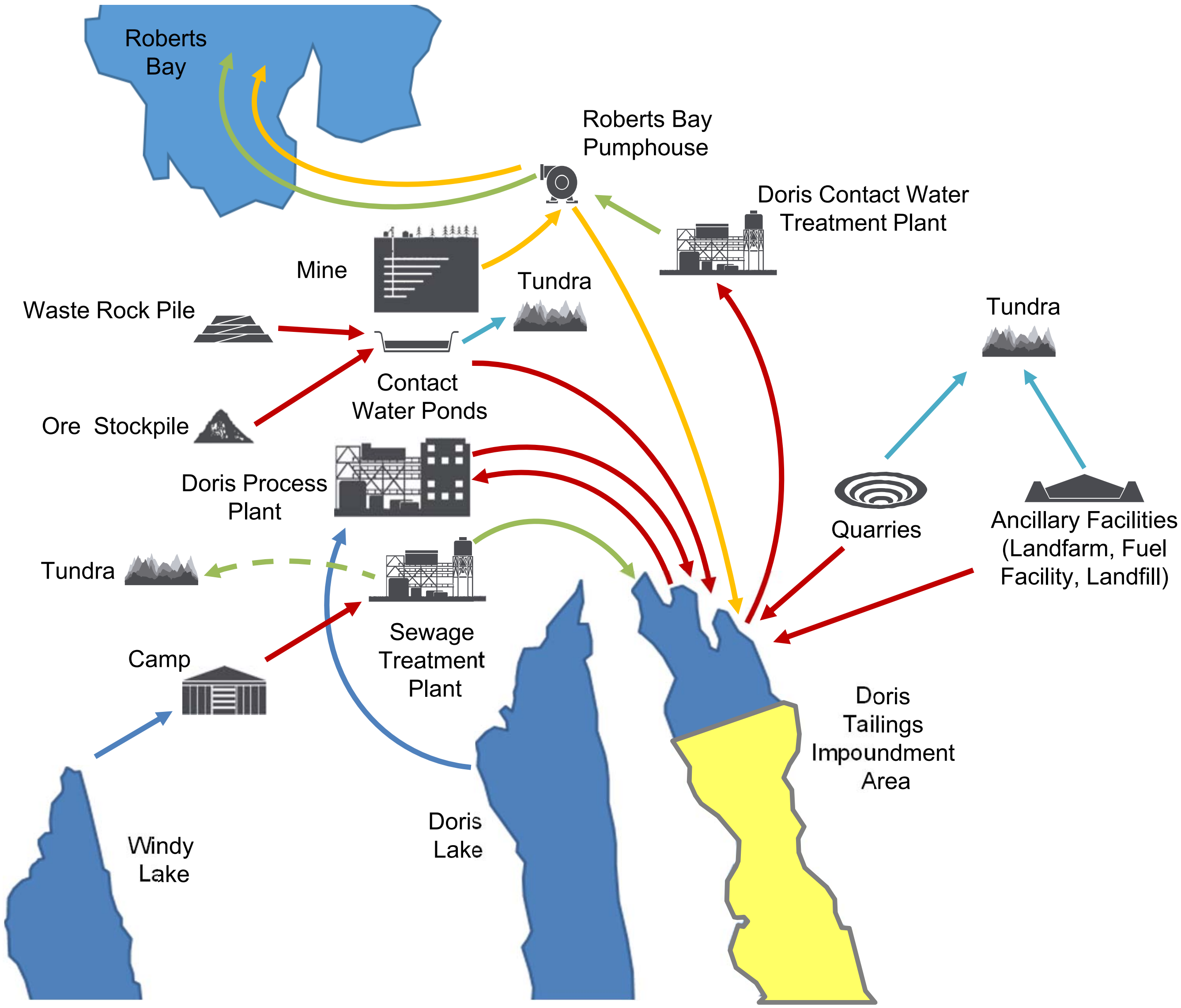
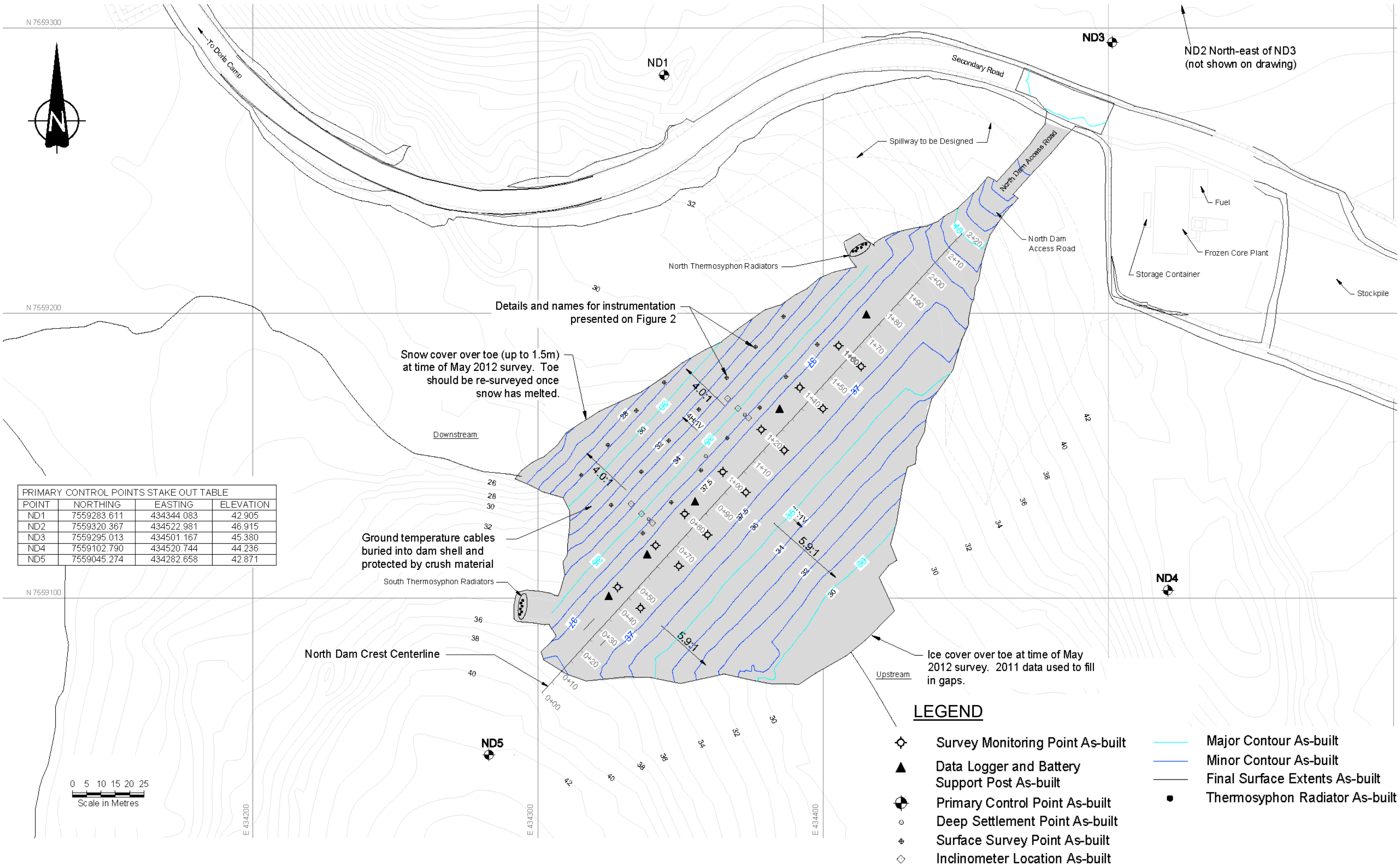


Legend

- Treated Water (Operations)
- Non-contact Water
- Freshwater
- Contact Water
- Mine Water
- Treated Water (Closure and Construction

srk consulting	MAC RESOURCES	DORIS TIA OMS MANUAL **Schematic of TIA Water Management**
Job No: 1CT022.038 Filename: DorisTIA_WaterMgmtSchematic_1CT022.038.pptx	Doris TIA	Date: Mar. 2020 / Approved: PDL / Figure: 8

J:\01_SITES\Hope.Bay\!ACAD\2013 Drawings\North Dam



PRIMARY CONTROL POINTS STAKE OUT TABLE

POINT	NORTHING	EASTING	ELEVATION
ND1	7559283.611	434344.083	42.905
ND2	7559320.367	434522.981	46.915
ND3	7559295.013	434501.167	45.380
ND4	7559102.790	434520.744	44.236
ND5	7559045.274	434282.658	42.871

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TMAC RESOURCES

DORIS TIA OMS MANUAL

North Dam General Arrangement and Primary Control Points

Job No: 1CT022.002.200 Task 2000

Filename: HopeBay_DorisNorthTIA_OMS_Manaul_SA.pptx

HOPE BAY PROJECT

Date: May 2016

Approved: EK/SA

Figure: 9

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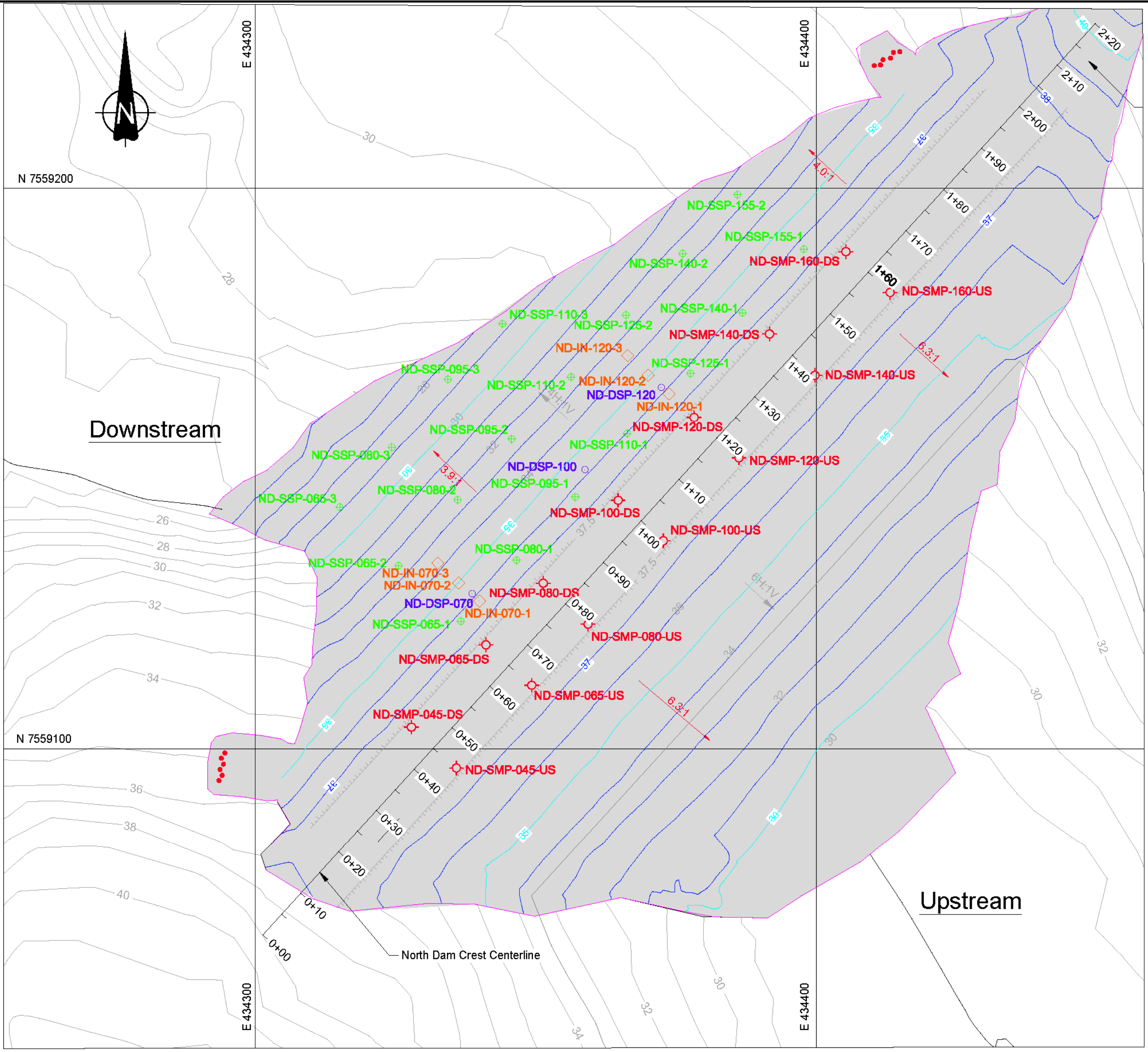

LEGEND

- Survey Monitoring Point As-built
- Deep Settlement Point As-built
- Surface Survey Point As-built
- Inclinometer Location As-built
- Major Contour As-built
- Minor Contour As-built
- Final Surface Extents As-built
- Thermosyphon Radiator As-built

AS-BUILT DEEP SETTLEMENT POINTS STAKEOUT TABLE

ID	Northing	Easting	Elev. (m)
ND-DSP-070	7559127.69	434338.65	36.95
ND-DSP-100	7559149.78	434358.75	36.86
ND-DSP-120	7559164.46	434372.37	36.92

AS-BUILT INCLINOMETER LOCATION STAKEOUT TABLE

ID	Northing	Easting	Elev. (m)
ND-IN-070-1	7559126.41	434340.00	37.44
ND-IN-070-2	7559129.63	434336.27	36.20
ND-IN-070-3	7559133.13	434332.57	34.85
ND-IN-120-1	7559163.31	434373.78	37.44
ND-IN-120-2	7559166.64	434370.03	36.05
ND-IN-120-3	7559170.15	434366.40	34.95

AS-BUILT SURFICIAL SURVEY POINTS STAKEOUT TABLE

ID	Northing	Easting	Elev. (m)
ND-SSP-065-1	7559122.80	434336.67	36.77
ND-SSP-065-2	7559132.67	434325.55	32.81
ND-SSP-065-3	7559143.10	434315.11	29.43
ND-SSP-080-1	7559133.65	434346.59	36.79
ND-SSP-080-2	7559144.37	434336.10	32.92
ND-SSP-080-3	7559153.75	434324.36	29.33
ND-SSP-095-1	7559144.90	434357.04	36.58
ND-SSP-095-2	7559155.21	434345.72	32.85
ND-SSP-095-3	7559165.92	434334.35	28.70
ND-SSP-110-1	7559156.20	434366.29	36.32
ND-SSP-110-2	7559166.31	434356.29	32.88
ND-SSP-110-3	7559175.79	434344.10	28.97
ND-SSP-125-1	7559166.97	434377.61	36.77
ND-SSP-125-2	7559177.37	434366.08	32.91
ND-SSP-140-1	7559177.75	434386.85	36.48
ND-SSP-140-2	7559188.28	434376.19	32.84
ND-SSP-155-1	7559189.07	434397.79	36.80
ND-SSP-155-2	7559198.85	434385.98	32.91

AS-BUILT SURVEY MONITORING POINTS STAKEOUT TABLE

ID	Northing	Easting	Elev. (m)
ND-SMP-065-DS	7559118.52	434341.14	38.46
ND-SMP-065-US	7559111.31	434349.30	38.36
ND-SMP-080-DS	7559129.57	434351.35	38.41
ND-SMP-080-US	7559122.27	434359.34	38.40
ND-SMP-100-DS	7559144.32	434364.71	38.39
ND-SMP-100-US	7559137.12	434372.77	38.46
ND-SMP-120-DS	7559159.12	434378.24	38.41
ND-SMP-120-US	7559151.88	434386.24	38.46
ND-SMP-140-DS	7559173.98	434391.69	38.39
ND-SMP-140-US	7559166.62	434399.77	38.42
ND-SMP-160-DS	7559188.64	434405.30	38.40
ND-SMP-160-US	7559181.37	434413.18	38.43

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MAC RESOURCES

Job No: 1CT022.002.200 Task 2000

Filename: HopeBay_DorisNorthTIA_OMS_Manaul_SA.pptx

HOPE BAY PROJECT

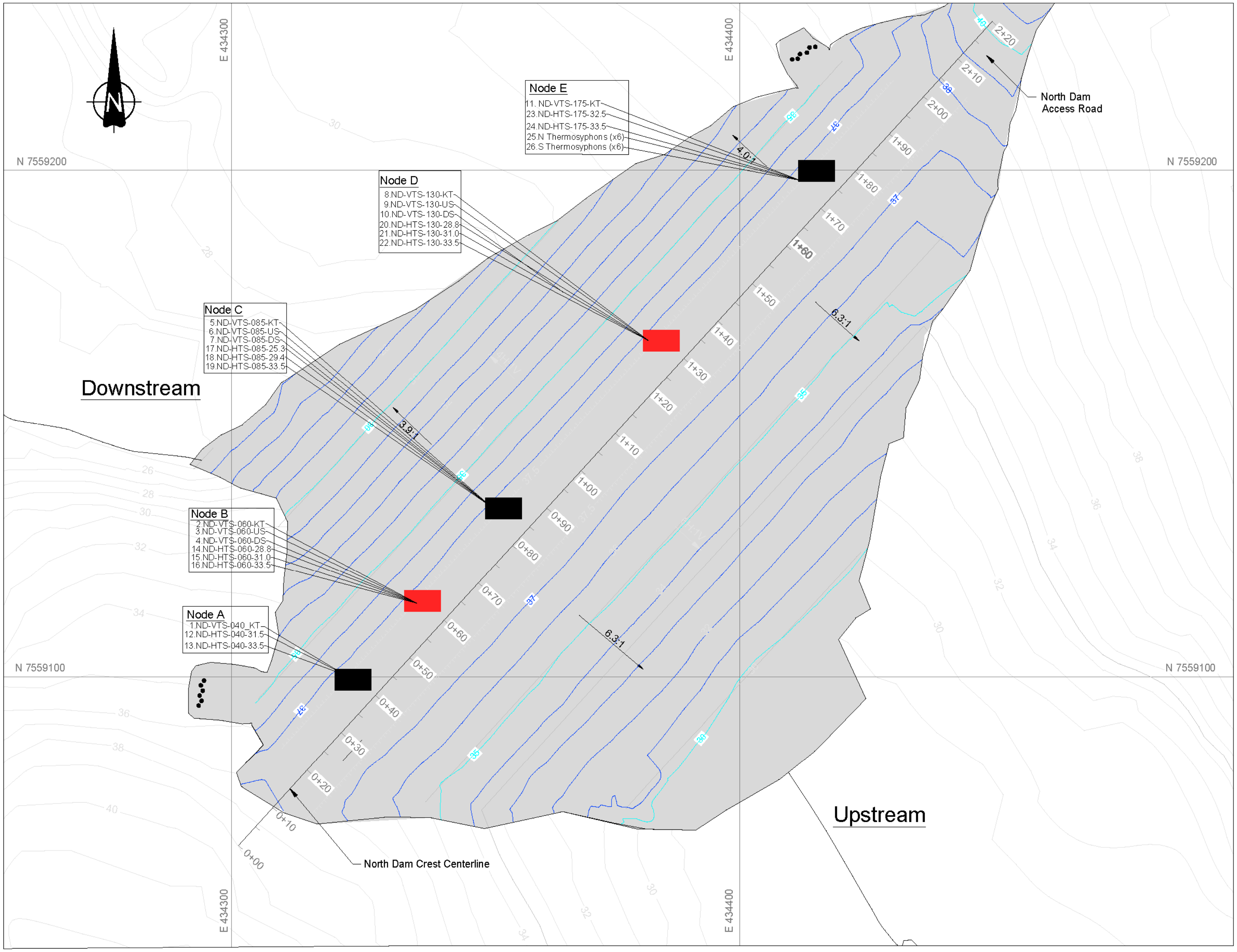
DORIS TIA OMS MANUAL

North Dam Instrumentation Layout

Date: May 2016

Approved: EK/SA

Figure: 10



LEGEND

- Major Contour As-built (5m)
- Major Contour As-built (1m)
- Final Surface Extents As-built
- Thermosyphon Radiator As-Built

Note: the two weatherproof enclosures which house the data loggers are shown in red.

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MAC RESOURCES

Job No: 1CT022.002.200 Task 2000

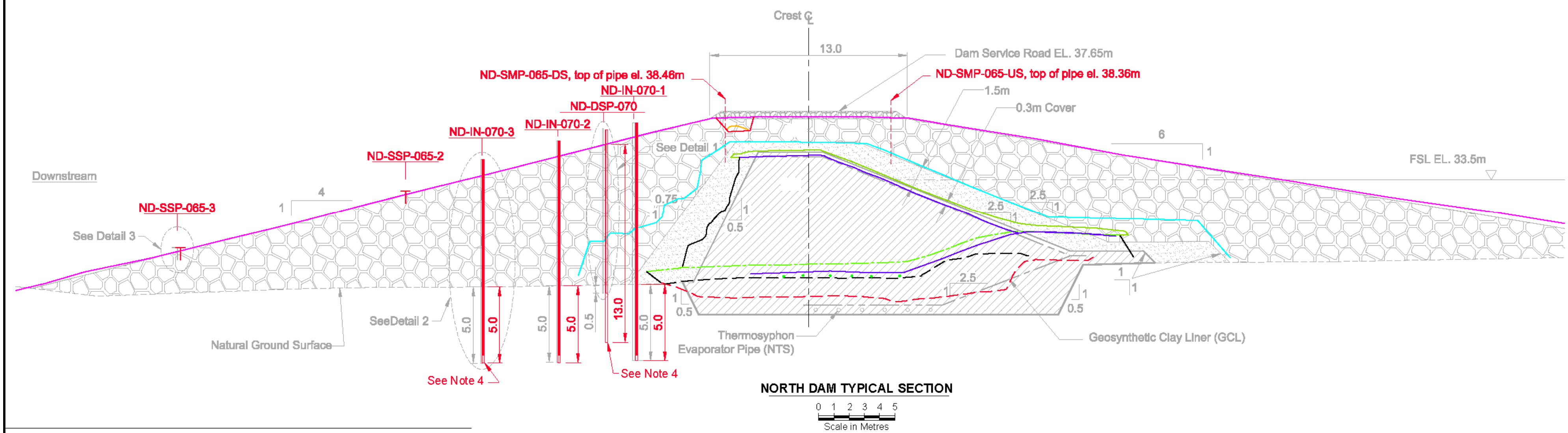
Filename: HopeBay_DorisNorthTIA_OMS_Manaul_SA.pptx

HOPE BAY PROJECT

DORIS TIA OMS MANUAL

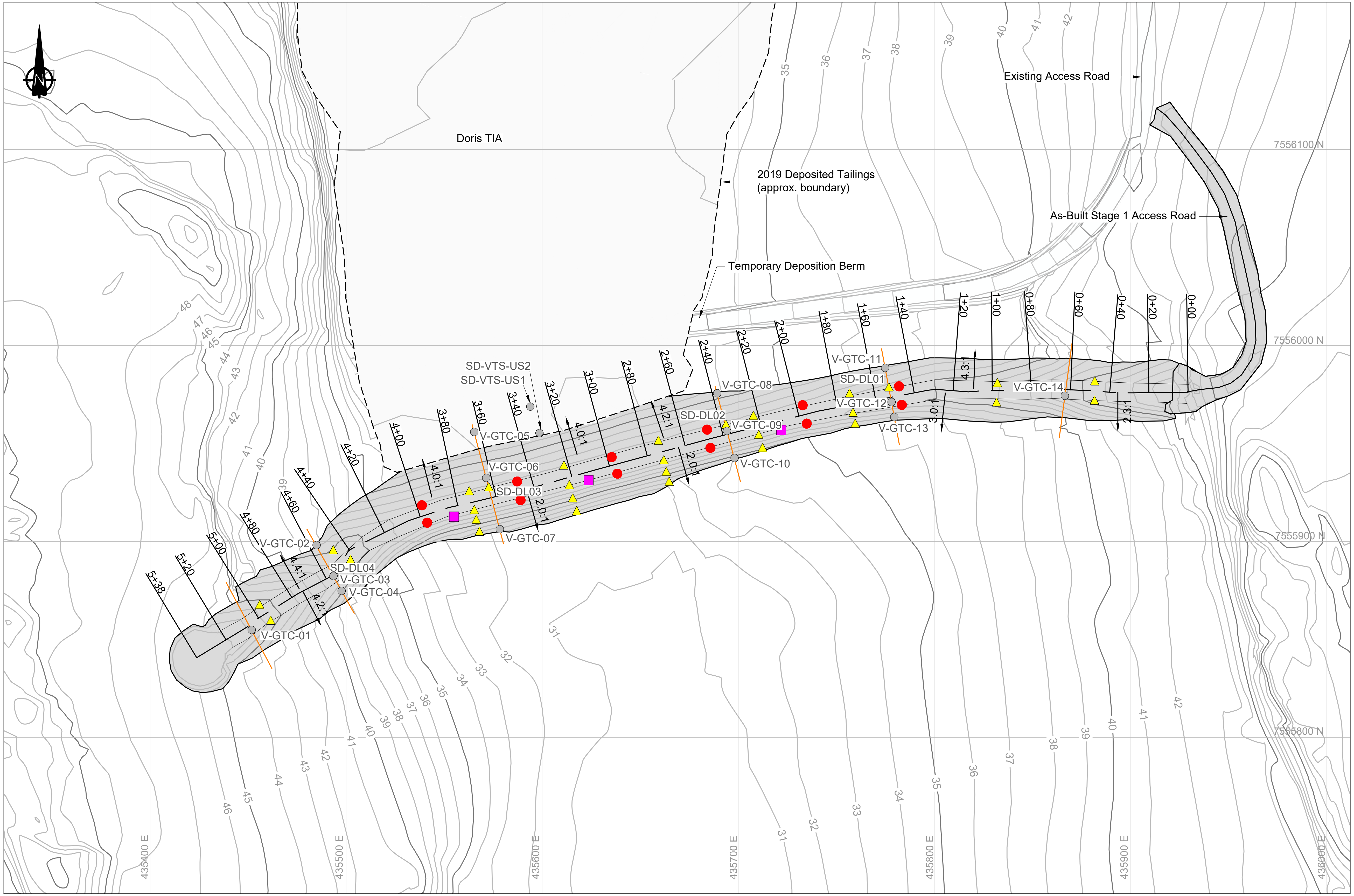
North Dam Ground and Thermosyphon Temperature Cable Locations

Date:	Approved:	Figure:
May 2016	EK/SA	11



Example of as-built instrumentation installed on the downstream of dam.

srk consulting	MAC RESOURCES	DORIS TIA OMS MANUAL
Job No: 1CT022.002.200 Task 2000		**North Dam Deformation Monitoring Instrumentation Layout**
Filename: HopeBay_DorisNorthTIA_OMS_Manaul_SA.pptx	HOPE BAY PROJECT	Date: May 2016 / Approved: EK/SA / Figure: 12



LEGEND

- As-Built Survey Monitoring Point
- Design Surface Monitoring Point
- Design Deep Settlement Point
- Datalogger Location
- Vertical Ground Temperature Cable

NOTES

1. Topographic and As-built data was provided by the Client
2. Contours shown at 1.0m interval.
3. All units shown are in meters unless otherwise stated.

REFERENCES

NAD83 UTM Zone 13.

0m 20 40 60 80

srk consulting

SRK JOB NO.: 1CT022.038

FILE NAME: 1CT022.038 - Instrumentation Plan.dwg

MAC RESOURCES

Doris TIA

DORIS TIA OMS MANUAL

South Dam General Arrangement and Instrumentation

DATE:	APPROVED:	FIGURE:
April 2020	PDL	13

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AGNICO EAGLE

OPERATIONS, MAINTENANCE AND SURVEILLANCE MANUAL: HOPE BAY DORIS TAILINGS IMPOUNDMENT AREA

HOPE BAY, NUNAVUT

Appendix E – Emergency Response Plan

HOPE BAY EMERGENCY RESPONSE PLAN

AGNICO EAGLE
HOPE BAY

HOPE BAY, NUNAVUT

FEBRUARY 2021

Hope Bay Emergency Response Plan

Plain Language Overview:

This document provides information about required action to handle emergencies at the Hope Bay Site in compliance with Nunavut Mine Health and Safety Regulations 8.32. The goal is to ensure personnel are aware of emergency situations and response procedures in order to avoid and diminish adverse consequences from an emergency by:

- Preventing injury or fatality;
- Reducing or avoiding damage to equipment, systems and property;
- Ensuring well trained and coordinated management and response personnel; and
- Ensuring return to normal operations safely and efficiently.

Hope Bay, Nunavut

Publication Date: February 2021

Document Control

Revision #	Date	Section	Changes Summary	Author	Approver
0	December 2017	Initial Document		D Brown HS Manager	D Brown HS Manager
1	March 2019	Throughout	Combined previous Surface Emergency Response Plan and Underground Emergency Response Plan into one document. Updates to Plan Management and Roles & Responsibilities sections.	B Towle	D Brown HS Manager
2	March 2020	Throughout		K Cook HS Superintendent	D Brown HS Manager
3	February 2021	Throughout	Entire plan revised to reflect Agnico Eagle as the operator.	K Cook HS Superintendent	Norm Ladouceur HS Manager
4	February 2021	6.0	Directions to reference Hope Bay Spill Contingency Plan Appendix Hazardous Materials and Products Specific Spill Response Plans	J Peterson ERT Coordinator	K Cook HS Superintendent

Prepared By: _______________________________
Ken Cook
Superintendent Health & Safety

Approved By: _______________________________
Norm Ladouceur
NU - Health & Safety Superintendent

Contents

Tables

Figures

No table of figures entries found.

Glossary

Term	Definition
Assembly Point Coordinator	The most senior employee at an assembly point or muster location during an emergency who takes control of the assembly point during an evacuation to take roll-call and account for each person at the assembly point.
Briefing Officer (BO)	The Briefing Officer is the liaison between the ICG and the ERT/MRT teams. The BO provides instructional direction to the ERT/MRT teams and is responsible for their safety during an emergency.
Emergency	A serious, unexpected, and often dangerous situation requiring immediate action.
Emergency Response Guidebook (ERG)	The Emergency Response Guidebook is a guide to aid first responders in quickly identifying the specific or generic hazards of the material(s) involved in an incident for protection of first responders and the general public during the initial response phase of an incident.
Emergency Response Team (ERT)	A group of Hope Bay employee's and contractors who voluntarily prepare for and respond to any emergency incident.
Incident Command System	The Incident Command System (ICS) is a standardized approach to the command, control, and coordination of emergency response providing a common hierarchy within which responders from multiple agencies can be effective.
Incident Command Group (ICG)	Members of management that assemble during an emergency to direct the response to the incident.
Mine Rescue	Mine rescue is a term used to refer to underground rescue operations performed by the Emergency Response Team.
Muster Station	A designated gathering area for the purpose of identifying and recording all occupants/evacuees present during an emergency and ensuring their safety until the emergency has ended.
Official-in-charge (OIC)	The Official-in-Charge is usually the General Manager, or most senior manager and oversees all decisions and emergency operations at Hope Bay.
Physician Assistant (PA)	Medical health care professional that provides overall site medical duties including critical care during emergency situations under the medical directive of a physician.
Stop Work	An instruction broadcast over the radio system by the Official-In-Charge instructing specific work to stop.
Stench Gas (Ethyl Mercaptan)	Stench Gas (Ethyl Mercaptan) is a colorless organic liquid (C_2H_5SH) that has a strong odor and is used as a warning agent to communicate an emergency in the underground mine.
WSCC	Workers' Safety and Compensation Commission

1 Introduction

This Hope Bay Emergency Response Plan (the Plan) for has been prepared by Agnico Eagle in accordance with various water licences held by AEM associated with developments throughout the Hope Bay region and in accordance with WSCC Nunavut Mine Health and Safety Regulations R-125-95 8.32.

1.1 Objectives

The Plan details emergency management principles to be used at Hope Bay including the Incident Command System (ICS) for the Onsite Official-in-Charge, Incident Command Group, Emergency Response Teams, First Responders, Physician Assistants and site employees. This Plan also provides guidelines for handling various potential on-site emergencies and outlines the steps that should be taken to reduce the risk of loss to persons, environment and property.

1.2 Relevant Legislation and Guidance

Emergency response management at the Hope Bay site is governed by the Nunavut Mine Health and Safety Regulations (R-125-95 8.32).

1.3 Related Documents

The documents listed in Table 1.1 are expected to be referenced and utilized in conjunction with the Emergency Response Plan.

Table 1.1. List of documents related to the Hope Bay Emergency Response Plan

Document Title	Year	Relevance
Hope Bay Spill Contingency Plan	2020	Outlines spill response procedures and actions to be taken in the event an emergency incident involves a spill of hazardous materials
Hope Bay Hazardous Waste Management Plan	2020	Reference for management of hazardous waste that may be generated during an emergency response
Hope Bay Non-Hazardous Waste Management Plan	2017	Reference for management of non-hazardous waste that may be generated during an emergency response
Oil Pollution and Emergency Preparedness Plan	2018	Outlines specific spill response procedures and actions to be taken in the event an emergency incident involves a spill of fuel during the annual sealift fuel transfer
Hope Bay Explosives Management Plan	2017	Reference for management of explosives material handling

1.4 Plan Management

The Vice President Health and Safety has the overall responsibility for implementing this management plan and will provide the on-site resources to respond to emergency events that occur in the Hope Bay Belt in accordance with this plan.

The General Manager (GM) is responsible for implementing this plan at the Hope Bay site, and providing on-site support and resources for emergency response management. The GM will act as the Official in Charge (OIC) in the event that an emergency occurs that requires activation of the Emergency Response Plan (ERP). As OIC, the GM will coordinate the emergency response efforts that protect the health and safety of all responders.

The Health and Safety Manager is responsible for reviewing and revising this Plan annually.

2 Emergency Response Structure

2.1 Incident Command System

The Incident Command System (ICS) is a standardized management system used to organize and manage a scalable response to emergency incidents of any magnitude. ICS includes procedures to select and form temporary management hierarchies to control funds, personnel, facilities, equipment, and communications during an emergency event. Personnel are assigned roles within the ICS according to established standards and procedures.

2.2 Incident Command Group

The Incident Command Group (ICG) is responsible for directing all work performed and managing all resources during an emergency incident. The ICG is typically formed by senior management or designates performing the various required functions to ensure the safety of all personnel involved. The ICG draws on resources from Safety, Operations, Technical Services, Environment and Maintenance personnel as necessary to complete emergency response tasks. Responsibilities of the ICG are outlined in Section 2.2.1 through 2.2.7 below. Depending on the nature of the emergency, additional managers and personnel may be added to the ICG.

2.2.1 Official-In-Charge

The General Manager or designate is considered the Official-In-Charge (OIC) of all emergency operations for Hope Bay. The Official-In-Charge is responsible for the overall safety of persons involved in the emergency response and has the primary goal of protecting personnel from injury or harm. Secondary priorities are to protect the environment, property and return to production. The OIC provides overall direction to the ICG during response to an emergency.

2.2.2 Health and Safety Manager

The Health and Safety Manager provides advice and technical knowledge to the OIC regarding safety processes and regulatory requirements during an emergency. When necessary the Health and Safety Manager will communicate with all of the appropriate external contacts and government officials in accordance with the NWT Mine Health and Safety Act and Regulations Section 16.07.

2.2.3 Maintenance Manager

The Maintenance Manager provides advice and technical knowledge to the OIC regarding surface operations. When necessary the Maintenance Manager will organize surface operational resources such as personnel and equipment to assist in the management of an emergency incident.

2.2.4 Mine Manager

The Mine Manager provides advice and technical knowledge to the OIC regarding the mining operations. When necessary the Mine Manager will organize underground operational resources such as personnel and equipment to assist in the management of an emergency incident.

2.2.5 Process Manager

The Process Manager provides advice and technical knowledge to the OIC regarding the Process Plant operations. When necessary the Process Manager will organize Process Plant operational resources such as personnel and equipment to assist in the management of an emergency incident.

2.2.6 Materials Manager

The Materials Manager provides advice and technical knowledge to the OIC on logistical processes and material supplies. When necessary the Materials Manager will organize logistical and warehouse resources such as personnel and equipment to assist in the management of an emergency incident.

2.2.7 Environmental Superintendent

The Environmental Superintendent provides advice and technical knowledge to the OIC regarding environmental resources at risk and reporting requirements in the event an emergency has impact or potential impact to the surrounding environment. When necessary the Environmental Superintendent will organize operational resources such as personnel and equipment to assist in the management of an emergency incident as outlined in the Hope Bay Spill Contingency Plan.

2.3 Physician Assistant

During an emergency the Physician Assistant (PA) advises the ICG and provides advanced medical support for injured persons. All patient care decisions are at the discretion of the PA with their primary focus being the well-being of the patient.

2.4 Emergency Response Team Coordinator

The Emergency Response Team (ERT) Coordinator is responsible for the implementation and training of the Emergency Response Team. During an emergency, the ERT Coordinator will initially direct the actions of the ERT. As the response progresses, the ERT Coordinator will be under the direction of the ICG and will act as the Briefing Officer.

The Briefing Officer will direct the ERT in rescue and recovery operations and is the only liaison to the active Emergency Response Team. At no time should the ICG communicate directly with the response team. Direction from the ICG will be communicated to the active Emergency Response Team through the Briefing Officer.

2.5 Emergency Response / Mine Rescue Team

The Emergency Response Team / Mine Rescue Team (ERT/MRT) are the primary responders to an emergency incident. The fundamental principles of mine rescue training are:

1. Ensuring the safety of self and the rescue team
2. Endeavouring to rescue or ensuring the safety of trapped or injured workers
3. Protection of the mine property from further damage
4. Rehabilitation of the affected work area and salvage of equipment

ERT/MRT responders operate under the principles and training outlined in the Western Canada Mine Rescue Manual which can be found at the following link:

http://www.wscc.nt.ca/sites/default/files/documents/Western%20Canada%20Mine%20Rescue%20Manual_June2015.pdf

3 Emergency Response Steps

Although every emergency is different, the basic steps in responding to an emergency and the order of priority are often the same.

- Ensure medical aid and protect personnel – Supervisors and First Responders must immediately assess the situation and take care to ensure the safety and well-being of injured personnel.
- Take control – Unless a senior manager is present, Supervisors and/or First Responders need to take control of the situation. The priority is always the protection and rescue of people. The second is the environment, followed by property and then production.
- Control potential secondary events – Secondary incidents are possible at a scene because normal controls may have been critically weakened by the incident. Positive temporary actions to secure the scene need to be taken after quick, but careful, thought of the consequences.
- Preserve evidence – When there is significant loss, good investigation is more important than getting back to work. Preserve the site until the investigation is complete and the proper authorities have been notified. Secure, sign or rope off to prevent further access to a scene.

3.1 Incident Rating System

The following Incident Rating System is designed to be used as an aid when determining the severity of an incident and determine whether the event is an emergency requiring activation of the ICG and ERT/MRT response.

Incident Rating System		
Rating	**Description**	**Action Required**
Level 1 Low	The incident resulted or could result in minor Property/Equipment Damage, First Aid/Occupational Injury, or a Non-reportable Environmental Spill.	Injury: Provide immediate first aid if required. Report incident to Supervisor and Physician Assistant.
		Property Damage: Secure the scene to prevent any further damage or loss. Report Damage to Supervisor.
		Environmental Spill: Immediately perform remedial action to contain the spill as outlined in Hope Bay Spill Contingency Plan. Report spill to Supervisor and Environmental department.
Level 2 Medium	The incident resulted or could result in moderate Property/Equipment Damage, Medical Aid/ Lost Time/Occupational Injury, Reportable Environmental Spill. Controlled Fire that has been extinguished.	Injury: Provide immediate first aid if required. Report incident to Supervisor and Physician Assistant.
		Property Damage: Secure the scene to prevent any further damage or loss. Report damage to Supervisor. Notify Safety Department.
		Fire: If safe to do so and the fire is in its beginning stages, immediately try to extinguish the fire. Call Supervisor and report fire has been extinguished. Maintain fire watch to ensure fire does not re-ignite.
		Environmental Spill: Immediately perform remedial action to contain the spill as outlined in Hope Bay Spill Contingency Plan. Report spill to supervisor and Environmental department.
Level 3 High	The incident resulted or could result in significant Injury/Fatality, Uncontrolled Fire, Significant Property/Equipment Loss, Hazardous material release with risk to people or environment, Uncontrolled fire with risk of spreading.	Injury/Fatality: Immediately call Mill Control Room on radio channel #1 or Dial Phone extension 911 or 150. Inform them of emergency and request immediate medical assistance. Give your name, location, type of injury and number of injured persons.
		Uncontrolled Fire: Immediately call Mill Control Room on radio channel #1 or Dial Phone extension 911 or 150. Inform them of uncontrolled fire. Evacuate the area to a safe location and alert others of the emergency. Underground: Contact Mill Control on radio channel #1 or by Femco Phone. Inform them of fire underground and request stench release and Mine Rescue call-out.
		Hazardous Environmental Spill: Immediately Evacuate the area and call emergency on radio channel #1 or Dial Phone Extension 911 or 150. Inform Mill Control Room operator of emergency and request ERT call-out for Hazardous Spill.

3.2 Emergency Notification Process

If an emergency arises, immediately contact the Mill Control Room Operator via radio on the emergency channel # 1, or by phone at extension 911 or 150 and say “Emergency, Emergency, Emergency”.

The caller will provide the Control Room Operator with their name, their location and the nature of the emergency. (Example: This is John Doe, I have a man in the gym with a suspected heart attack; I need medical assistance.). See Appendix A for the Emergency Notification Process procedure.

Once an emergency notification has been received the Roles and Responsibilities outlined in Section 3.4 below will come into effect.

3.3 General Incident Procedures

Not all incidents will be classified as emergencies. If an incident is identified quickly it can often be isolated and controlled to prevent the escalation of the incident into a full-scale emergency. The following section outlines response actions to be taken in potential emergency scenarios.

3.3.1 Injury

In the event of an incident involving injury, evaluate the situation and provide First Aid to your level of training and ability if safe to do so. If the injury is not life threatening and there is no risk of further injury contact your immediate supervisor and report the injury.

If the injury is life threatening, (eg. heart attack, stroke, severe bleed, amputation, breathing distress) evaluate the extent of injuries and administer First Aid if qualified.

- Initiate the Emergency Notification Process.
- If worker is unconscious, check for:
  - Breathing: If worker is not breathing, provide CPR immediately.
  - Bleeding: Control external bleeding immediately (“Direct Pressure” “Elevation” “Rest”).
- Secure the location of the injured worker to prevent further injuries to others. Keep the patient as comfortable as possible until Emergency Response personnel arrive on the scene.
- Where serious injury is the result of a hazardous chemical exposure, ensure Emergency Response personnel are advised of the type of chemical the injured worker was exposed to. Refer to product SDS sheets as required.

3.3.2 Fire

In the event of an incident involving fire, and the fire is small, use nearby fire extinguishers or fire suppression system to extinguish the fire provided it is safe to do so. Do not expose yourself to unnecessary risk and keep a clear area of retreat behind you. When the fire is out, notify your Supervisor immediately.

If the fire is uncontrollable and beginning to spread, evacuate the area and initiate the Emergency Notification Process.

3.3.3 Spill

In the event of an unanticipated discharge or spill, immediately assess the scene and if safe to do so stop the flow of the spill. Contact your supervisor and initiate the actions outlined in the Hope Bay Spill Contingency Plan. If not safe to do so, evacuate the area and initiate the Emergency Notification Process.

3.3.4 Evacuation

Upon being notified of an emergency evacuation either by radio, phone, stench warning system, siren, alarm or any other means, stop work immediately, note the time you received the warning and calmly evacuate using the safest route possible. Maps of evacuation routes are presented in Appendix B of this document.

- Stay calm.
- Notify others in the affected area.
- Do not rush unnecessarily.
- Evacuate in an orderly manner.
- Evacuate by the shortest safe route possible.
- Never return to work or lunch areas to retrieve personal effects, lunches, etc.
- Underground: when smoke or toxic gases are encountered – do not hesitate – don a personal self-rescue device and proceed to the closest refuge station.

Once safely out of your work area, report immediately to the nearest Assembly Area and report to the Tag Board or Assembly Point Coordinator. Remain at the Assembly Point for further instructions. Examples of the Incident Command Group Tag Board Accounting Form and Refuge Station Accounting Form are provided in Appendix C and Appendix D of this Plan.

3.4 Roles and Responsibilities

3.4.1 Mill Control Room Operator

The Control Room Operator will use specific emergency check sheets to record the emergency details and response requirements for surface, mill (see Appendix E) and underground emergencies (see Appendix F). Duties of the Control Room Operator include:

- Responding to the emergency communication;
- Selecting the appropriate emergency check sheet;
- Documenting all relevant information about the emergency;

- Announcing an emergency on channel one;
- Announcing any stop work directive when directed by the Official-In-Charge;
- Initiating the Emergency Pager System;
- Initiating the stench gas system; and
- Any other duties assigned by the ICG.

3.4.2 Emergency Response Team

3.4.2.1 Surface Emergency

ERT members responding to the emergency will report to the Mine Rescue Room and will start preparing their standard equipment and SCBAs (if required) and wait for a briefing from the Briefing Officer.

3.4.2.2 Underground Emergency

ERT members responding to the emergency will report to the Mine Rescue Room and will start preparing their standard equipment and BG4s (if required) and wait for a briefing from the Briefing Officer.

3.4.3 Emergency Response Coordinator

The Emergency Response Coordinator will report to the Mine Rescue Room and will ensure the proper ERT members have been selected for the emergency. The ERT Coordinator will act as Briefing Officer to the team on their objectives. The Briefing Officer will document the progress of the active ERT team, and remain in contact with the ERT members and the ICG throughout the emergency.

3.4.4 Physician Assistant

Upon hearing the announcement of an emergency on the radio or pager the on-site Physician Assistant will immediately report to the Physician Assistant's Office.

3.4.4.1 Medical Evacuation

In the event that a patient requires a medical evacuation, the PA will follow procedure VII-0002 Medical Air Evacuation (see Appendix G) outlining the steps required to initiate a Medical Evacuation.

3.4.5 Incident Command Group

During a site emergency, the Incident Command Group will assemble in the main conference room. If this room is compromised, then the ICG will assemble in the Geo-Hub conference room. The ICG team will direct all work and control the frontline response during an emergency incident.

Appendix H outlines the ICG Duties for Mill/Surface Emergencies. Appendix I outlines the ICG Duties for an Underground Emergency.

3.4.5.1 Initiating Stop Work

The Official-In-Charge in consultation with the senior management team will determine what work is required to stop. The work stopped could range from high risk non-routine hazardous work to all work at the site, on surface or in the underground. The decision could encompass one area, one department or the entire site. When the Stop Work order is initiated the relevant area personnel will Stop Work and report to their supervisor. Underground personnel will report to a refuge station and wait to be contacted. Radio silence must take effect, except to communicate emergency information.

3.4.5.2 All Clear / Stand Down

When the emergency is over the OIC will issue the "All Clear" instruction and normal site operations can resume.

4 Potential Surface Emergencies

4.1 Surface Fire

In the event of a surface fire that is uncontrolled, initiate the Emergency Notification Process.

During a surface fire the Emergency Response Team shall assemble in the Mine Rescue room. The Emergency Response Coordinator or ERT Captain shall provide instruction to the ERT members to proceed to the muster station and prepare bunker gear and SCBAs for a surface fire response.

If the assembly point is no longer a safe location due to fire, the Assembly Point Coordinator will evacuate all personnel to the nearest safe location and contact the ICG.

The Incident Command Group shall begin to assign duties as per the Incident Command Group Duties Mill/Surface Emergency Check sheet. (See Appendix H)

The Emergency Response Coordinator or ERT Captain shall coordinate with the Assembly Point Coordinator to ensure that all personnel in the affected area are accounted for. If all persons are not accounted for ERT shall perform a primary search of the location.

The primary focus of ERT shall be to protect personnel from injury, prevent to spread of fire, protect the environment and protect company property from loss.

4.2 Serious Injury

In the event of a serious injury, initiate the Emergency Notification Process.

If safe to do so, first responders must act to prevent further injury, suffering or loss of life. If possible, do not leave the injured person unattended.

Once the Emergency Response Team arrives at the scene, they will immediately assume control of the incident, secure the scene and provide any required life saving first aid. The ERT members will stabilize the patient and prepare for transport to the Physician Assistant.

The Physician Assistant will prepare the medical station for the arrival of the patient.

Once the patient has been transported to the medial station the ERT team shall provide any assistance required by the Physician Assistant.

The Incident Command Group shall ensure the scene has been frozen and begin preparations for an incident investigation.

Considerations should be given to initiating Employee Assistance depending upon the severity of the incident.

4.3 Fatality

In the event of a fatal accident/incident, the ERT will secure all material and equipment involved at the scene to preserve evidence until required investigations are complete and cleared by all regulatory agencies.

The Incident Command Group shall ensure the scene has been frozen and notify Corporate Management.

All media requests and public statements will be conducted by the Agnico Eagle Corporate Office.

The WSCC Mines Inspector and Cambridge Bay RCMP shall be immediately contacted in the event of a work-related fatal incident.

The Official-In-Charge in consultation with the senior management team will determine what work is required to stop.

The Official-In-Charge in consultation with the senior management team and Human Resources will ensure that Employee Assistance is available.

4.4 Missing Persons

In the event that an employee is missing or their whereabouts is unknown for an extended period of time, the supervisor of the worker shall contact Security personnel to conduct a preliminary search of the accommodations area of the missing worker, and the area surrounding. A person may be declared missing if they cannot be accounted for by their supervisor or fellow workers and cannot be located in other areas of the camp or worksite by Security personnel.

Once a person is declared missing, Security personnel will initiate the Emergency Notification Process. The ICG will assess the situation, and initiate and assign responsibility for the following actions, where required:

- Mobilize the ERT and security personnel to conduct a property-wide search.
- The ICG shall determine the requirement to conduct a ground search outside of the property footprint.

- The Cambridge Bay RCMP shall be notified as instructed by the ICG.
- The ERT shall formulate search patterns and assign priority areas based on information obtained from Security personnel.

To reduce the potential for missing persons, personnel will check-in regularly and execute proper remote work practices. Resources such as personnel, equipment, land vehicles, and aircraft will be mobilized to aid search and rescue operations.

When the ICG deems that local efforts to locate a missing person are unsuccessful or not possible, outside assistance will be requested through the RCMP. Additional resources and services from local communities will be drawn upon as needed and if available access external Search and Rescue (SAR).

4.5 Pandemic

In the event of large scale spread of influenza or similar virus / disease, it is critical to limit human exposure.

Isolate affected personnel and consider separation from the general population.

Use extra care to disinfect camp areas and prevent contamination of public areas.

Contact the NWT Office of the Chief Public Health Officer to notify them of the severity of the outbreak.

Follow the “Hope Bay Infectious Disease Control Plan”.

4.6 Suspended Worker

In the case where a worker has fallen and is suspended from his/her anchor point by means of their fall arrest harness; work in the area shall cease immediately and preparations to initiate the rescue plan shall begin immediately.

Regardless of whether a worker can self-rescue or must rely upon others, time is of the essence because a worker may lose consciousness in only a few minutes.

Workers must be trained to try to move their legs in the harness and try to push against any footholds or stirrups that are available on each harness issued.

If the attempt at self-rescue or the rescue plan fails to retrieve the fallen worker. Initiate the Emergency Notification Process.

Immediately following the retrieval of a worker who has been suspended from height due to a fall, the worker will be escorted to the Medic Station.

Do not make the worker walk any distance. Bring transport directly to the worker.

The worker must then be transported to the Physician Assistant for evaluation and for transport to a medical facility to ensure there is no effects from suspension trauma.

Even if the worker was only suspended for a short time they will be required to be examined by a Physician.

4.7 Confined Space Rescue

4.7.1 Self Rescue

In the event that a rescue is required in a confined space, the worker in cooperation with the confined space attendant shall attempt a self-rescue. A detailed rescue plan shall be provided prior to entry into a confined space. Refer to IV-0003 Confined Space Entry Work Procedure prior to beginning any confined space work (Appendix J).

4.7.2 Non-Entry Rescue

If the rescue plan fails to extricate the worker in the confined space immediately begin the Emergency Notification Process.

A non-entry rescue involves attempting to extricate an incapacitated person without having anyone else enter the confined space. This can be done via a safety line attached to the personnel in the confined space or by grabbing the worker with a rope, strap or pole and pulling them to safety.

4.7.3 Entry Rescue

Entry rescue shall only be completed by trained and competent Mine Rescue / Emergency Response Team personnel. Due to the unique nature of confined space rescues, specialized equipment and training are required in order to perform a safe and successful rescue.

One of the initial pieces of equipment employed in a confined space is a method of ventilation to disperse collected hazardous gases and introduce fresh air into the environment.

In the event that an entry rescue must be performed, rescue personnel will wear protective clothing appropriate for the situation. This may include a self-contained breathing apparatus (SCBA), protective headgear and the use of explosion proof lighting (to prevent igniting any gases). The rescuer may also wear a full body harness with an attached safety line, especially if a vertical descent is required. To assist in vertical descents, a mechanical winch and tripod may be set up over the access point, if the bottom of the confined space is more than five feet from the entrance.

The rescuers may also carry monitoring equipment by which they can ascertain the quality of the air in the environment. Even if the air quality reading does not indicate any hazardous conditions, it is still recommended that rescuers wear SCBA.

4.8 Severe Weather

Severe weather events can come in a variety of forms including heavy snow, white out, rain, and wind events. Depending on the event, numerous aspects of the operation may be affected including but not limited to potential harm to people, site access, transportation methods, stability of facilities, and environmental aspects.

Determine the threat of the severe weather event. Supervisors will be required to follow the III-0009 Severe Weather Conditions Procedure (Appendix K) to ensure proper steps are taken in the event of a severe weather threat.

Where it has been determined that a severe weather event such as snow storm/whiteout conditions, heavy rain or high winds pose a threat to the safety and well being of personnel working on site, Supervision will initiate the Emergency Notification Process.

All personnel responding to the Emergency will stop work immediately and proceed to the Administration Building or Assembly Area and contact the Assembly Point Coordinator. Personnel will remain in the Administration Building or Assembly Area and await further instructions.

Supervision will ensure all personnel are accounted for.

A determination will be made on whether safe routine access and egress from the site to the Main Vent Fans can be maintained. If safe access to the Mine Vent Fans cannot be maintained, Supervision will evacuate the underground workings.

If safe egress from the underground cannot be maintained; advise all site employees to remain in refuge in the refuge stations until the severe weather event has passed or lessened to the point where safe egress from the site is assured for all employees.

If travel on site by Emergency Response teams is necessary, determine the hazards of traveling during the weather event and advise responders of the precautions to be taken to ensure safe travel.

4.9 Bomb Threat – Threat of Terrorism

Bomb threats can be received by telephone, note, letter or E-mail. Most bomb threats are made by persons wanting to create an atmosphere of general anxiety and panic. All such threats must be taken seriously and handled as though an explosive device is in the building.

In the event of a bomb threat or act of terrorism, workers must evacuate the work site and assemble at the Muster Point and remain together until receiving the All Clear communication from the Official-In-Charge or designate.

Employees must remain calm, survey and assess their work area. Should a suspect looking device or a foreign object be found do not touch it. Calmly move away for the foreign looking device, contact your Supervisor and Security.

Personnel must refrain from smoking while being in the Muster Point. The Assembly Point Coordinator will conduct a roll-call to account for all employees at the Muster Point and communicate the results of the roll-call to the ICG via radio communication.

4.10 Aircraft Emergency

Plane on fire on airstrip: Plane crew activates fire suppression system and uses hand handle fire extinguisher if safe to do so. If plane continues to burn move employees away from plane and set up spill control for fluids and burnt material.

Plane crash on airstrip: Move firefighting extinguishers as close as safe to do so. Remove crewmembers from plane following safe rescue practices. If the aircraft blocks the airstrip for incoming aircraft take pictures of the affected area and move parts that are blocking airstrip.

Plane crash off airstrip: If helicopters on site use them to access the crash site with onsite emergency crews. In winter months with a good snow pack use snowmobile or Tucker to access site up to an estimated maximum distance of 15 kilometers. Aerial drones may be utilized as a means to inspect the downed aircraft if physical access cannot be achieved.

5 Underground Emergencies

Doris Mine

If an underground emergency arises, call the Mill Control Room Operator on radio channel #1 or by Femco phone and say you have an underground emergency.

Give your name, location, type of emergency, number of persons injured and if you need to have stench released.

Madrid Mine

The supervisor in charge of the underground operations will ensure that a Femco phone on surface is manned while there are workers underground.

Every person working at the Madrid Mine will be trained on the manual activation of the underground stench gas system.

Surface must contact the Mill Control Room Operator ASAP (**Radio Channel #1 or Satellite Phone #**) as they will initiate the ERP procedure.

Give as much info as possible as it will help determine what help is needed.

Clearing state you are at the Madrid Mine.

5.1 Underground Fire

In the event of an underground emergency due to fire, initiate the Emergency Notification Process. Immediately don your MSA W65 self-rescuer and go to the nearest refuge station location and warn anyone on the way.

When you arrive at the refuge station wait to be contacted by surface. The most experienced person must take charge immediately and start filling out the Refuge Station Accounting form (Appendix D).

If you smell stench gas, then go to the nearest Refuge Station.

If workers are unable to make their way to a refuge station or fresh air source, they are to utilize the Ocenco EBA 6.5 SCSR which are located strategically throughout the mine and seek alternate means of refuge.

During an underground fire the Emergency Response Team shall assemble in the Mine Rescue room. The Emergency Response Coordinator or ERT Captain shall provide instruction to the ERT members to proceed and prepare standard equipment and BG4s for an underground fire response.

The Incident Command Group shall begin to assign duties as per the Incident Command Group Duties Underground Emergency Check sheet. (See Appendix I)

Efforts will be undertaken to ensure ventilation to the Mine is maintained. Operation of the Mine ventilation fans will be guarded and monitored to ensure continuous operation of the fans.

During a fire in the Mine, there will be no alteration to the operation of the surface fans without the authorization of the Incident Command Group. The effects of the alteration to the mine ventilation fans shall be clearly understood before any changes are made.

5.2 Ventilation Fan Failure

In the event of a surface fan failure due to a malfunction, incident, power failure, or other such unplanned or unscheduled event that affects ventilation to the Mine the following will apply:

All work will cease in all areas supplied by mechanical ventilation until the main ventilation system can be restored. Personnel who are underground will retreat to the underground refuge stations and will await the restoration of power and ventilation.

There will be no entry of persons into the mine until the ventilation is restored. Personnel will remain in the underground refuge stations until the all clear is given or the order has been given to evacuate to surface.

Upon restoration of ventilation, air quality testing will be performed in the active workings of the mine affected by the ventilation interruption before personnel are allowed to return to work.

6 Process Plant Emergencies

6.1 Reagent Release to Environment

Identify the reagent that has been spilled. Depending on type of product that has been spilled, activate the ERP accordingly. If the release is not contained to the Mill Building, activate the **Hope Bay Spill Contingency Plan**.

Evacuate the general area of the spill immediately. Only required personnel essential for containment and cleanup are required to be in the area.

Contact the Process Plant Supervisor, Safety Department and Environment Department once area has been evacuated.

Barricade the area and restrict entry into the area of the spill.

Ensure required PPE is utilized to contain or cleanup the area that is affected.

Ventilate the work area as necessary to eliminate any airborne contaminants.

6.2 High Hydrogen Cyanide Gas (HCN) Evacuation

A Process Plant evacuation due to cyanide gas (HCN) is not considered an emergency. However, this is an extremely dangerous situation and can quickly turn into an emergency. Hydrogen cyanide gas is produced through the decomposition of sodium cyanide solution. If the release is not contained to the Mill Building, activate the **Hope Bay Spill Contingency Plan**.

Hydrogen cyanide gas will be created if the pH of the cyanide solution or process slurry containing sodium cyanide is not maintained above a pH of 10.8.

High concentrations of hydrogen cyanide gas will form very quickly if sodium cyanide were to be exposed to nitric acid.

Hydrogen cyanide gas is very poisonous. Inhalation of this gas can be fatal. HCN alarms are positioned throughout the Process Plant. When these alarms sound, personnel will evacuate to the Process Plant Tag In Board.

7 Training

The Hope Bay ERT Standard outlines the training and standards taken by our emergency response personnel (Appendix L). Emergency response training follows the Nunavut/Northwest Territory Mine Rescue Training Standards (Appendix M).

At least once every year, all persons who are employed at the Hope Bay site shall participate in scheduled evacuation drills and procedures including the fire warning signals in effect at the residence.

At least once every year, all persons who work in Mill and Surface Operations shall participate in the escape and evacuation drills and procedures including the fire warning signals in effect at the Mill.

At least once every year, all persons who work in the Underground Operations at Hope Bay shall participate in the escape and evacuation plans and procedures including the fire warning signals in effect at the mine. Underground evacuation drills shall be held to assess the ability of all persons in the underground operation to seek refuge and report into the ICG to account for personnel.

The underground evacuation drills shall:

- Be held for each shift at some time other than a shift change;

- Involve activation of all fire alarm systems;
- Include evacuation of all persons from their work areas to refuge station / surface.
- Whenever a change is made in escape/evacuation plans and procedures for any area of the mine site, all persons affected shall be instructed in the new plans or procedures.

8 Emergency Response Tools and Equipment

A list of emergency response tools and equipment available at the Hope Bay site is presented in Table 8.1 below.

Table 8.1. Available Emergency Response Tools and Equipment

Emergency Equipment and Tools			
Location	**Category**	**Unit**	**Quantity**
Mine Rescue Room	SCBA	Draeger Pss-5000	8
		4500 Psi Composite Cylinders	16
	CCBA	Draeger BG4	15
		Composite O2 Cylinder	30
		Draegersorb	500 lb.
		Ocenco	2
	Oxygen Therapy	Care vent	2
		BVM	1
	Rope Rescue	Static Rope 300 Ft	2
		MPD	3
		Carabiner	20
		Large Carabiner	2
		Prussic Long	4
		Prussic Short	4
		Break Rack Bar	2
		Single Pulley	6
		Double Pulley	6
		Figure 8	2
		Rope Grab	2
		Rescue Harness	2
	Gas Monitors	Draeger X-AM 5000	1
		Draeger Pac-7000	1
	Extrication Tools	Power Hawk Extrication Set Jaws Cutter	 1 1

Emergency Equipment and Tools			
Location	**Category**	**Unit**	**Quantity**
		Spreader Power Pusher Rams	1 3
	First Aid	Stretcher Basket	2
		Backboard	2
		Ferno Head Restraint	2
		First Aid Kits	8
		Arm Speed Splints	4
		Leg Speed Splints	2
		Blankets	9
	Confined Space	FAN8-12V Portable Ventilating Fan	1
		FAN-7004CL 25 Ft. Canister Duct	1
	Bunker Gear	Bunker Gear Set	12
	Nozzles	VIPER X 2 30 to 125 GPM	1
		ELKHART X 2 60 TO 150 GPM	1
		Fire Caddy 12 foam inductor	1
		Gated Y's 2 inch to 1.5 inch	3
		Gated Y's 2.5 inch to 2.5 inch	2
	Lay Flat Hose	lengths 2.5" rubber lined 50ft	11
		lengths 1.5" rubber lined 50ft	8
		lengths 1.5" fiber 50ft	2
	Ventilation Fans	Electric air pusher on wheels 110volt	1
		Electric air pusher carry only 110volt	1
		Gas powered air pusher on wheels	1
	Ice Water Rescue Gear	Ice water rescue suits	2
		100ft ice water rescue rope	1
		20ft ice water rescue throw rope	1
		Life jackets	10
		Ice rescue flotation rescue back board	1
	Confined space	Sked rescue body wraps	2
	First Aid	Trauma kits with oxygen	2
Fire Truck	CABINET 1	2.5" inch to 1.5" adaptors	3
		2.5" to 2.5" male female couplers	3
		2.5" to 2.5" female to female couplers	2
		2.5 female cam-lock to 2.5" threaded male adaptor	1

Emergency Equipment and Tools			
Location	**Category**	**Unit**	**Quantity**
		4” female y to 2.5” male ends	1
		2.5” threaded to 2.5” male cam-lock	1
		2.5” female to 1.5” female cam-lock	1
		6” female cam-lock to 4” male cam-lock adaptor	1
		4” female to 2.5” male cam-lock	1
		2.5” end cap cam-lock	1
		2.5” female gated y to 1.5” male ends	2
		Twist lock to a 2.5” threaded female end	1
		30-125 psi water flow 1.5” nozzles	3
		90-250 psi water flow 2.5” nozzle	1
		foam tube adapter to 1.5” nozzle	1
		2.5” hose wrenches	2
		1.5” foam educator	1
		Small pry bars	2
		Flash light with spare battery	1
		Large pry bar on top cabinet	1
		1.5” hose wrenches on top of cabinet	2
	CABINET 2	1.5” ground mount 1.5” hose connection fan sprayer	1
		50FT 1.5” Fire hose	4
		10ft rubber lined 1.5” fire hose	1
		100ft 1.5” fire hose	1
		1.5” 20ft hard suction line with no connections	1
		Fire extinguishers	2
	CABINET 3	5 gallon can fuel	1
	TOP OF TRUCK	2.5” 50ft fire hose	1
		2.5” 100ft fire hose	1
		1.5” 50ft fire hose	1
		1.5” 100ft fire hose	1
	CROSS LAY	1.5” 100ft rubber fire hose	1
		1.5” 100ft fire hose	1
	CABINET 4	Tool Box	1
		Pail 2% foam	1

Emergency Equipment and Tools			
Location	**Category**	**Unit**	**Quantity**
	CABINET 5	2.5” 50ft fire hose	3
		Tank / drum plug kit	1
		bolt cutter	1
		3/4” foam hose	2
		2.5” hose wrenches	3
		Cleaning brush	1
	TOP	Large Halogen Bar	1
		Broom	1
		Large pry bar	1
		Hockey stick electrical	1
		Pick pole	1
	INSIDE CAB	PFD	3

9 Mutual Aid

Hope Bay has a signed Mutual Aid Agreement (Appendix N) with the following mines:

- Dominion Diamond Mines
- Diavik Diamond Mines
- De Beers Canada - Gahcho Kue
- Agnico Eagle Mines
- Deton’Cho / Nuna JV (Giant Mine)
- Yellowknife Fire Department (YKFD)

Each mine recognizes that having Crisis and Emergency Response capability is essential in the event that extraordinary circumstances put human life, operational infrastructure or the environment in extreme danger.

Each operation also recognizes that, at times, the scale of an emergency or crisis may overwhelm their individual resources. It is both desirable and prudent to establish terms for a combined response should such circumstances arise.

9.1 Mutual Aid Contacts

Diavik Diamond Mines Inc.

Call (867) 669-6500 Ext. 5903. Phone number is monitored by Security Control 24 Hours a day.

State that the call is a mutual aid request for the Chief Operating Officer (or Duty Manager on the weekend). Security will transfer the call to the requested Manager. He or She will contact the ERT Advisor to coordinate the requested mutual aid.

DDMI ERT Advisors: Richard Kretzschmar and Dave Arthur (867) 669-6500 ext. 5462

Agnico Eagle Mines Limited (Nunavut Operations):

Call (819) 860-6258 or (819) 759-3555 ext. 6720 Meadowbank, or

Call (819) 759-3555 ext. 3911 Meliadine.

State that the call is a mutual aid request for the Mine Manager (or designate – Manager on Duty). Person will transfer the telephone call to the requested Mine Manager immediately and the ERT team will be paged, or the ERT Coordinators contacted.

Meadowbank ERT Coordinators are Markus Uchtenhagen and Philippe Beaudoin. Office phone number is (819) 7593555 ext. 6809

Meliadine ERT Coordinators are Dave Loder and Ken Ludwig. Office phone number is

(819) 759-3555 ext. 3906

Deton'Cho / Nuna JV (Giant Mine Reclamation Project):

Call (867) 669-3702 or Cell (867) 446-2387. Mine Manager Joe Heimbach

Call (867) 669-3722 or Cell (867) 445-2884. Safety Coordinator Randy Thompson

State that the call is for a mutual aid request for the Mine Manager.

Mine Manager is Doug Hayes. Office (867) 669-3715, Cell (867) 444-0355

ERT Coordinator is Steve Millar, Office (867) 669-3717, Cell (867) 445-5620

De Beers Canada – Gahcho Kué:

Call (416) 645-1695 Ext. 6699. Phone number is monitored by Security Control 24 Hours a day.

State that the call is a mutual aid request for the President/COO (or Manager on the weekend). Security will transfer the call to the requested Manager. Security will contact the ERT Advisor to coordinate the requested mutual aid.

Gahcho Kué ERT Advisors: John Gale and Richard Church (416) 645 1695 extension 6701

Dominion Diamond Mines:

Call (867) 880-2201 or (867) 880-4400. Both phone numbers are answered and monitored by Dominion Diamond Mines Security Control 24 hours a day.

State that the call is a mutual aid request for the Mine Manager (or designate on the weekend). Security will transfer the telephone call to the requested Mine Manager immediately and the ERT team will be paged, or the ERT Coordinators contacted.

Dominion Diamond Mines ERT Coordinators are David English and Nathan Pitre. Office phone number is (867) 880-2394.

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Yellowknife Fire Department (YKFD):

YFFD would be utilized for backfilling the ERT for surface emergencies. This allows Ekati ERT members to focus on an underground incident or for emergency assistance on large surface emergencies.

Call the 867-873-2222 (Yellowknife Fire Department Dispatch) and request that the on-call command officer call the BRT Team leader for a mutual aid request. If a message is taken for relay (after hours) to the designated person, provide a telephone number that is guaranteed to be answered by the Operations Manager (IMT).

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10 Contact Lists

A Telephone Record sheet (Appendix O) will be used to document all communications during the event of an emergency.

10.1 Hope Bay Internal Emergency Phone Numbers

Hope Bay Main Phone Number: 867-988-6882 February 5, 2021					
Health and Safety			**IT**		
Health & Safety Manager/Super	Doug Brown / Ken Cook	138	IT HelpDesk.	Francis Renaud	118
Medics Office	Genady Isal / Kwame Sarpong	105	http://helpdesk.tmacresources.com		
Medic's Dorm Room	After Hours **EMERGENCY ONLY**	115	**Enviro Dept.**		
Security Officer	Bob Fogarty / Mitch Bernier	165	Enviro Superintendent	Sarah Warnock	102
ERT Coordinator	Jeff Peterson / Ron Levasseur	103	Enviro Project Tech	Patrick J. /Andrea H.	168
Health & Safety Trainer		166	Waste Management	Kevin L. / Jason Silverwood.	187
Haztech Medical Lab		147			
Surface Operations			**Site Contractors**		
EVP	Calum Semple	168	Kitikmeot Catering Manager	Tony Price / Allie Maas	107
Maintenance Superintendent	Chris McMahon / Scott Pye	131	Geotech Supervisor	Geotech Drilling	108
Electrical/Inst. Supervisors	Cody Kerr / Brad Jamieson	117	Exploration Core Shack Office		148
Site Services Supervisor	Scott Lessley / Derek Trahan	126			
Powerhouse	Frank Lake / Norm Bertholds	127			
Warehouse Manager/ Super.	Larry Geeraert / Dan Izzard	154			
Warehouse Team Lead	Dave Thomas / Jerry Gill	172			
Warehouse General		158	**Public Phones**		
Mobile Maintenance Supervisor	Andre Martin / Craig Little	130	Outside Kitchen	Public #1	111
Mechanical Lead Hand		140	Outside Kitchen	Public #2	112
Light Vehicle Shop	LV Mechanics	157	Camp	Public #3	120
Electrical Shop	Site Electricians	139	Camp	Public #4	121
Plumber's Shop		109	D Wing	Public #5	136
Human Resources	Ginette Bisson	160	D Wing	Public #6	137
			E Wing	Public #7	181
			E Wing	Public #8	182
			G Wing	Public #9	183
			G Wing	Public #10	184
			G Wing	Public #11	185
Mine Department					
Mining Manager/ Super.	Vince Kapinus / Greg Scammell	179			
Shift Supers / Wicket		163			
KCMD Superintendent	Rod Keats/Charlie Riley	113			
KCMD Safety/Trainer	Mike Martin / Jason Cole	119			
Chief Mine Engineer	Rob Baldwin	125			
Senior Mining Engineer	Jian Yong Chen	155			
Mine Planning	Mike Tanasa / Evan Gentile	132			
Senior Geologist	Annette George/Eric Alexander	128			
Survey		129			
Geology		164			
Beat Geology	Chris Annan	161			
Process Plant Superintendent	Paul Simms	145			
Mill Shifters & Training		152			
Mill Trainer		178			
Mill Chief Metallurgist	Paul Grady	156			
Mill Metallurgy	Jamie Power	153			
Mill Control Room		150			
Mill Instrumentation	Chris, Karl	170			
Mill Refinery		188			
Assay Lab Supervisor	Marco Gomez-Jofre	173			
Fixed Plant Maint Supervisor	Russel Edwards / Brandon Steckley	143			
Fixed Plant Maint Planner	Dave Heemskerk	149			

10.2 Agnico Eagle Corporate Emergency Phone Numbers

Name	Position	Office Phone	Cell Phone	Home Phone	E-Mail	Role
Carol Plummer	**Senior Vice President, Sustainability,**	**416-644-2056** **Ext. 4012056**	**819-354-9877**		carol.plummer@agnicoeagle.com	**Chair**
Yvon Sylvestre	**Senior Vice President, Strategic Advisor - Operations**	**416-847-3711 Ext. 4013711**	**819-856-5365**	**905-990-1854**	yvon.sylvestre@agnicoeagle.com	**Co-Chair**
Dominique Girard	**Senior Vice President, Operations – Canada and Europe**	**416-947-1212 Ext. 4013747**	***416-568-8513***	**450-744-1975**	Dominique.girard@agnicoeagle.com	**Co-Chair**
Guy Gosselin	**SVP Exploration**	**819-874-5980 Ext. 4103600**	**819-856-8124**		guy.gosselin@agnicoeagle.com	**Co-Chair**
Marc Legault	**SVP Operations, U.S.A. and Latin America**	**416-847-3715 Ext. 4013715**	**416-271-3460**	**905-990-1993**	marc.legault@agnicoeagle.com	**Co-Chair**
Patrice Gilbert	**VP, Health Safety Social and Public Affairs**	**416-644-2058 Ext. 4012058**	**647-281-1193**	***H: 905-842-9112***	patrice.gilbert@agnicoeagle.com	**Crisis Management Team Coordinator**
Louise Grondin	**Senior Vice President, People & Culture**	**416-847-8656** **Ext. 4018656**	**819-724-2020**		louise.grondin@agnicoeagle.com	**Alternate Chair**
Sean Boyd	**Vice-Chairman and Chief Executive Officer**	**416-847-3706 Ext. 4013706**	**416-419-4431**	**416-343-3002**	sean.boyd@agnicoeagle.com	**Spokesperson**

Name	Position	Office Phone	Cell Phone	Home Phone	E-Mail	Role
Ammar Al-Joundi	**President**	**647-260-3776 Ext. 4013776**	**416-560-5945**	***416-233-9536***	ammar.aljoundi@agnicoeagle.com	**Alternate Spokesperson** **Co-Chair**
Jason Allaire	***Senior Corporate Director, Communications, Social and Public Affairs***	**819-759-3555 x4608004**	**819-355-2608**		jason.allaire@agnicoeagle.com	**Communication Coordinator**
Dale Coffin	**Senior Communications Advisor**	**416-847-8669 Ext. 4018669**	**647-274-4154**	**905-844-2197**	dale.coffin@agnicoeagle.com	**Communication Coordinator**
Brian Christie	**Vice-President, Investor Relations**	**416-847-3708 Ext. 4013708**	**416-625-2518**		brian.christie@agnicoeagle.com	**Investor Relations Coordinator**
Jean-Marie Clouet	**Director, Investor Relations**	**416-947-1212 x4013808**	**416-457-9464**		Jeanmarie.clouet@agnicoeagle.com	**Alternate Investor Relations**
David Smith	***SVP, Finance & CFO***	**416-847-3710 Ext. 4013710**	**416-917-9713**	**416-544-8887**	david.smith@agnicoeagle.com	**Financial Coordinator**
Mathew Cook	***Vice-President, Finance***	**416-847-3704 Ext. 4013704**	**416-820-3178**	**905-677-5765**	mathew.cook@agnicoeagle.com	***Alternate Financial Coordinator***
Keith Harris-Lowe	**Vice President, People**	**647-260-3775 Ext. 4013775**	**647-638-8799**	**905-237-9397**	keith.harrislowe@agnicoeagle.com	**HR Coordinator**

Name	Position	Office Phone	Cell Phone	Home Phone	E-Mail	Role
Michelle Edwards	Corporate Director, Global Rewards & Culture	416-847-1212 Ext. 4018672	647-248-4117	647-242-9889	michelle.edwards@agnicoeagle.com	Alternate HR Coordinator
Cecelia Mimbela	Director, Human Resources	647-260-3784 Ext. 4013784			Cecilia.Mimbela@agnicoeagle.com	Resource
Chris Vollmershausen	SVP Legal, General Counsel and Corporate Secretary	647-260-3771 Ext. 4013771	647-308-9878		Chris.vollmershausen@agnicoeagle.com	Legal Counsel
Greg Laing	General Counsel, SVP Legal	416-644-2052 Ext. 4012052	416-662-9550	905-842-7907	greg.laing@agnicoeagle.com	Alternated Legal Counsel
Alisha Morrison	HR Generalist	416-847-3701 Ext. 4013701	416-669-2258		Alisha.morrison@agnicoeagle.com	Support Coordinator
Jean Robitaille	Senior Vice President, Corporate Development, Business Strategy & Technical Services	416-847-3720 Ext. 4013720	416-270-2832	905-825-4836	jean.robitaille@agnicoeagle.com	Technical and Strategic Support
Lino Cafazzo	VP Information Technology	416-644-2060 Ext. 4012060	416-278-4148	905-850-1644	Lino-cafazzo@agnicoeagle.com	IT Support
Sam Singh	Corporate Director, Information Technology & Infrastructure Services	647-260-3785 Ext. 4013785	647-988-5632		Sam.Singh@agnicoeagle.com	Alternate IT Support

Name	Position	Office Phone	Cell Phone	Home Phone	E-Mail	Role
Michel Julien	**Vice President, Environment and Critical Infrastructures**	**416-947-1212** **Ext. 4013738**	**514-244-5876**		**Michel.julien@agnicoeagle.com**	**Environment, critical infrastructure, legacy and regulatory affairs**

External Emergency Phone Numbers

WSCC Accident Reporting Line (24 hours)	Use 1st	1-800-661-0792
WSCC General Mines Inspector		867-669-4412
WSCC General line (Yellowknife)		867-920-3888
WSCC General line (Iqaluit)		867-979-8500
Stanton Hospital (Emergency)		867-669-4100
Stanton 24-hour hot line		867-669-4115
Stanton Hospital (General Inquires)		867-669-4111
Cambridge Bay Health Center		867-983-4500
RCMP Cambridge Bay		867-983-0123 867-983-1111
RCMP Yellowknife		867-669-1111
RCMP Iqaluit		867-979-0123 867-979-1111
Nunavut Coroner’s Office		867-975-7292 867-222-0393
Yellowknife Coroner’s Office		867-920-8713
Adlair (Cambridge Bay)		867-983-2569 867-983-2247
Air Tindi		867-669-8218 (Ext. 8292)
Summit Air		867-669-9789 (Ext. 221)
Arctic Sunwest		867-873-4464
Great Slave Helicopters		867-873-2081
Nunavut Emergency Management “Medevac”		800-693-1666
Keewatin Air Medevac		1-867-9202400 1-867-920-2300

HOPE BAY EMERGENCY RESPONSE PLAN

HOPE B AY, NUNAVUT

Appendix A: Emergency Notification Procedure

HOPE BAY STANDARD OPERATING PROCEDURE			
Title:	Emergency Notification Process		
Document #:	VII-0007		
Owner:	Health and Safety Manager	Effective Date:	February 5 2021
Revision:	B	Replaces:	February 15 2019

1. PURPOSE

1.1. To provide guidelines on how to initiate emergency procedures when an emergency situation occurs.

2. INTRODUCTION

2.1. During an emergency this procedure will outline what steps need to be taken to ensure that effective controls and emergency response measures are conducted.

3. SCOPE

3.1. This procedure describes activities that will be required to safely and effectively manage an emergency at site. It applies to all activities, facilities, equipment, processes, employees, contractors, and vendors at the Hope Bay site.

4. RESPONSIBILITIES

Mine General Manager:

a. Ensures the requirements of this procedure are applied and maintained.

Department Managers:

a. Communicate the requirements of this procedure to their employees; and
b. Manage activities in accordance with this procedure.

Supervisors:

a. Implement this procedure;
b. Ensure their employees have been adequately trained and are competent to identify changes requiring MOC Authorization;
c. Make sure this procedure is followed by workers under their supervision; and
d. Perform investigation of non-conformance with the requirements of this procedure.

Health & Safety Manager or designate:

a. Monitors the implementation of this procedure; and
b. Verifies this procedure is maintained.

Employees (including Contractors) involved in procuring, maintaining or operating UME:

a. Understand and practice this procedure; and
b. Ask their supervisor for clarification if they are unsure of any aspect of this procedure.

Emergency Response Team (ERT) Members are responsible for:

a. Understand and practice this procedure; and
b. Responding in an efficient manner to the ERT room.

Joint Occupational Health and Safety Committee (JOHSC)

a. Provides input during the periodic review of this procedure.

AGNICO EAGLE HOPE BAY	HOPE BAY Emergency Notification Process	DOCUMENT NO. VII-0007

5. DEFENITIONS

Incident Command Group: During a site emergency, the Incident Command Group will assemble in the Main Conference Room. If this room is compromised then the ICG will assemble in the Geo Hub Conference Room. This team directs all work and controls the frontline response during an emergency incident. This is group is usually the Senior Management Team.

Official-In-Charge (OIC): Usually this person is the General Manager (GM) or his designate and will be in charge of the Incident Command Group during an emergency. The GM or his designate may at his discretion delegate the OIC role to the department manager or his designate where the incident is occurring if the situation so dictates based on area knowledge and experience.

Briefing Officer: Is the liaison between the Incident Command Group and the ERT members. The Briefing Officer provides technical assistance to the Incident Command Group and receives directives from the Official-In-Charge. The Briefing Officer is responsible for the safety of the ERT members and is the only person that provides directives to the ERT members.

Code One: Is a call over the radio system stating an emergency has occurred. The Emergency call is initiated by the Process Plant Control Room Operator. This is used as a communication tool to warn all other personnel onsite that a significant event has occurred. The site does not Stop Work when an Emergency is initiated.

ERT Coordinator / HS Coordinator: Upon hearing the announcement of an emergency on the radio or pager the ERT & HS Coordinator will immediately report to the Mine Rescue Room.

Senior Management: Upon hearing the announcement of an emergency on the radio or pager all senior management will immediately report to the Main Conference Room.

Emergency Response Team (ERT) Members: Upon hearing the announcement of an emergency on the radio or pager all ERT members will immediately report to the Mine Rescue Room

Physician Assistant: Upon hearing the announcement of an emergency on the radio or pager the on-site Physician Assistant will immediately report to the Physician Assistant's Office.

Stop Work: An instruction broadcast over the radio system by the Official-In-Charge instructing specific work to stop. The Official-In-Charge in consultation with the senior management team will determine what work is required to stop. The work stopped could range from high risk non-routine hazardous work to all work at the site, on surface or in the underground. The decision could encompass one area, one department or the entire site. When the Stop Work order is initiated the relevant area personnel will Stop Work and report to their supervisor. Underground personnel will report to a refuge station and wait to be contacted. Radio silence must take effect, except to communicate emergency information.

All Clear: An instruction broadcast over the radio system by the Official-In-Charge to alert personnel that the emergency is over and that normal operations can resume.

High Risk Work: Work that has the potential to require and additional emergency response in the event of an accident or failure.

6. REFERENCES AND RELATED DOCUMENTS

6.1. 2021 Emergency Response Plan

7. PREPARATION

N/A

AGNICO EAGLE HOPE BAY	HOPE BAY Emergency Notification Process	DOCUMENT NO. VII-0007

8. **TOOLS**
   N/A

9. **PROCEDURE**

9.1. If an emergency arises, immediately contact the Process Plant Control Room Operator via radio on the emergency channel # 1, or by phone at extension 911 OR 150 and say "Emergency, Emergency, Emergency".
The caller will provide the Control Room Operator with their name, their location and the nature of the emergency. (Example: This is John Doe, I have a man in the gym with a suspected heart attack; I need medical assistance.)

9.2. The Control Room Operator will use specific emergency check sheet to direct the emergency response for surface, mill and underground emergencies. Duties of the Control Room Operator include: responding to the emergency communication, selecting the appropriate emergency check sheet, documenting all relevant information about the emergency, announcing an emergency on Channel one, announcing any stop work directive when directed by the Official-in-Charge. Initiating the Emergency Pager System, initiating the stench gas system, and any other duties assigned by the Incident Command Group.

9.3. Once alerted to the emergency, personnel on site must refrain from using the radio in the affected area unless it is directly related to the emergency, or a separate additional emergency. All high risk work must cease. Such as; confined space, working at heights or working alone.

9.4. ERT members responding to the Mine Rescue Room will start preparing their standard equipment and the appropriate breathing apparatus and wait for a briefing from the Briefing Officer.

9.5. The Incident Command Group will assemble and start filling out their Check Sheets and start gathering information regarding the emergency. Once the necessary information has been gathered and a plan established, the Official-In-Charge will provide directives to the Briefing Officer. The ICG will decide if a Stop Work directive is required. If a Stop Work directive is given by the Official-In-Charge then radio silence must take effect, except to communicate emergency information.

9.6. The Briefing Officer will leave the Incident Command Group and report to the Mine Rescue Room. The Briefing Officer will ensure the proper ERT members have been selected for the emergency and will provide a briefing to the team on their objectives. The Briefing Officer will document the team's progress and remain in contact with the ERT members throughout the emergency.

9.7. When the emergency is over the OIC will issue the "All Clear" instruction and normal site operations can resume.

AGNICO EAGLE HOPE BAY	HOPE BAY Emergency Notification Process	DOCUMENT NO. VII-0007

9.8. Below are events some which constitute the initiation of an emergency and may require a Stop Work decision to be made by the OIC:

Serious Injury or Fatality

If a worker has sustained a serious or fatal injury or illness and requires immediate emergency response intervention; or the Physician Assistant is managing a Level 1 or Level 2 serious injury as defined in the "Canadian Triage & Acuity Scale" (CTAS).

Surface or Underground Fire

If a fire has initiated in the surface or underground operations.

Process Plant High Concentration Alarm

When a high concentration alarm has been activated in the process plant requiring personnel evacuation and all personnel have NOT been accounted.

Aircraft Emergency

An Aircraft is on fire on the airstrip, or has crashed on/off the airstrip.

Bomb Threat

When the site is notified of a bomb threat a Emergency call will be initiated to muster the senior management team to the main conference room; discussions will determine if a STOP Work order will be initiated.

Suspended Worker

While working at heights a situation whereby a worker has fallen and is suspended in their fall arrest harness and requires rescue.

Person Falling Through Ice

The first person at the scene shall call an emergency.

Severe Weather and/or Lightning

Where it has been determined that a severe weather event poses a threat to the safety and well-being of personnel working on site.

Watercraft Emergencies

In the event of a boat capsizing or other emergency during operation of a watercraft.

Wildlife Encounter

All wildlife encounters which threaten life or has the potential to threaten life.

10. ATTACHMENTS

AGNICO EAGLE HOPE BAY	**HOPE BAY** Emergency Notification Process	**DOCUMENT NO.** VII-0007

11. TECHNICAL REVIEW

Name	Title	Date	Signature
	General Manager		
	Mining Superintendent		
	Process Manager		
	Maintenance Manager		
	Health & Safety Manager		
Review Schedule: Every 3 years			

12. APPROVAL

Name	Title	Date	Signature
Doug Brown	Health & Safety Manager or designate		

13. REVISION HISTORY

Revision	Date	Comments
A		Initial Issue
B		Reviewer Comments incorporated
C		Approved for Use

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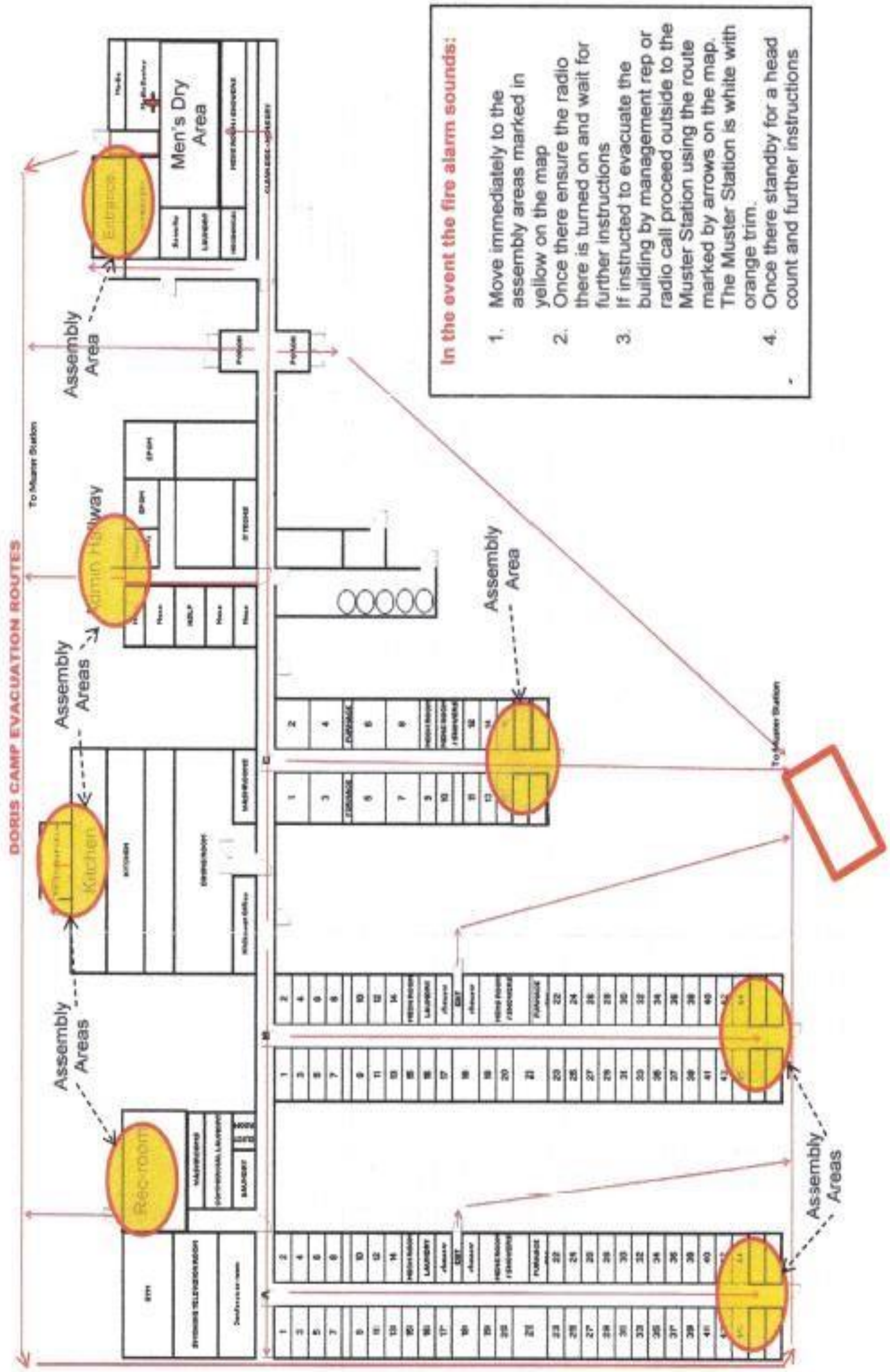
Rev A. *Page 5 of 5*

HOPE BAY EMERGENCY RESPONSE PLAN

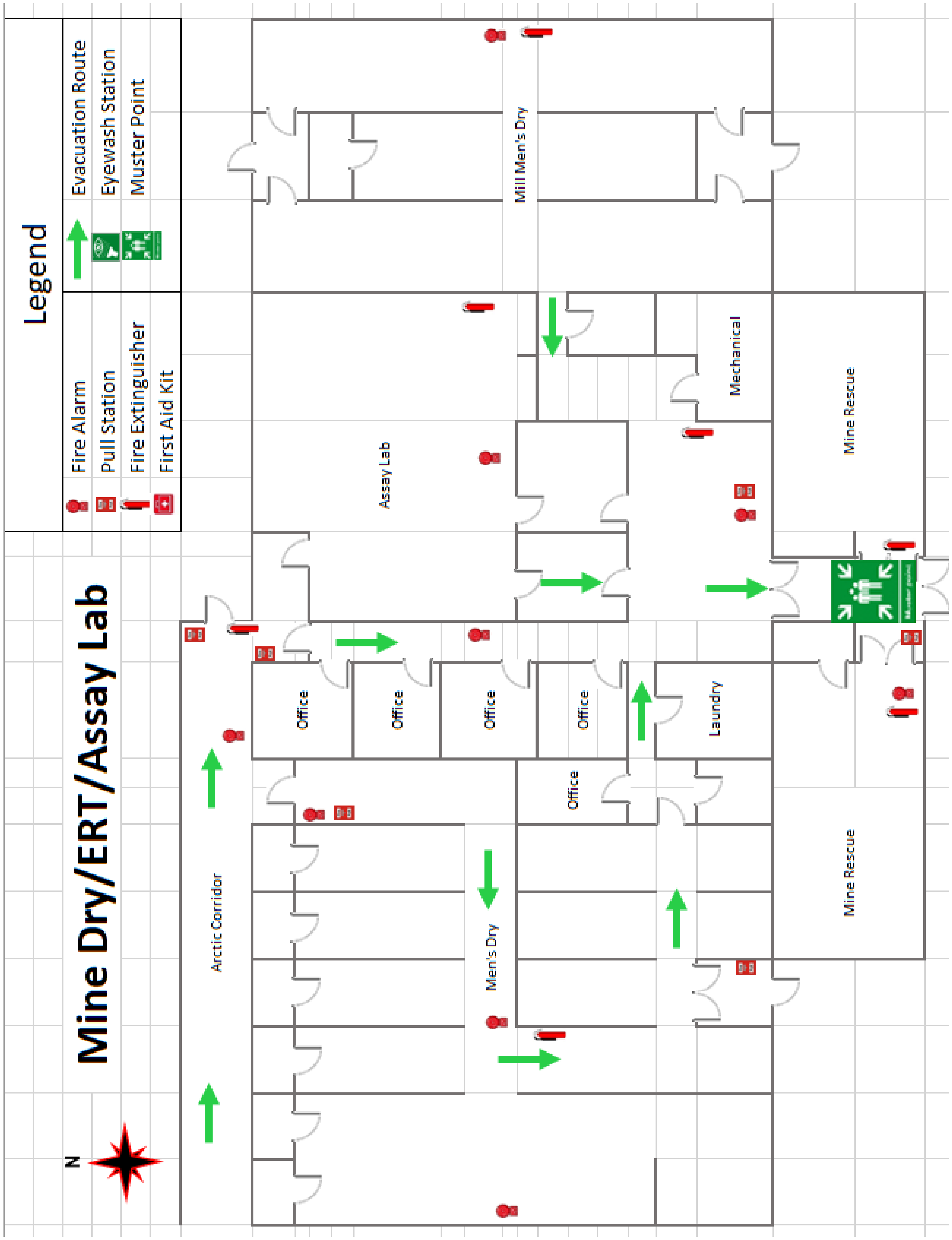
HOPE BAY, NUNAVUT

Appendix B: Evacuation Routes

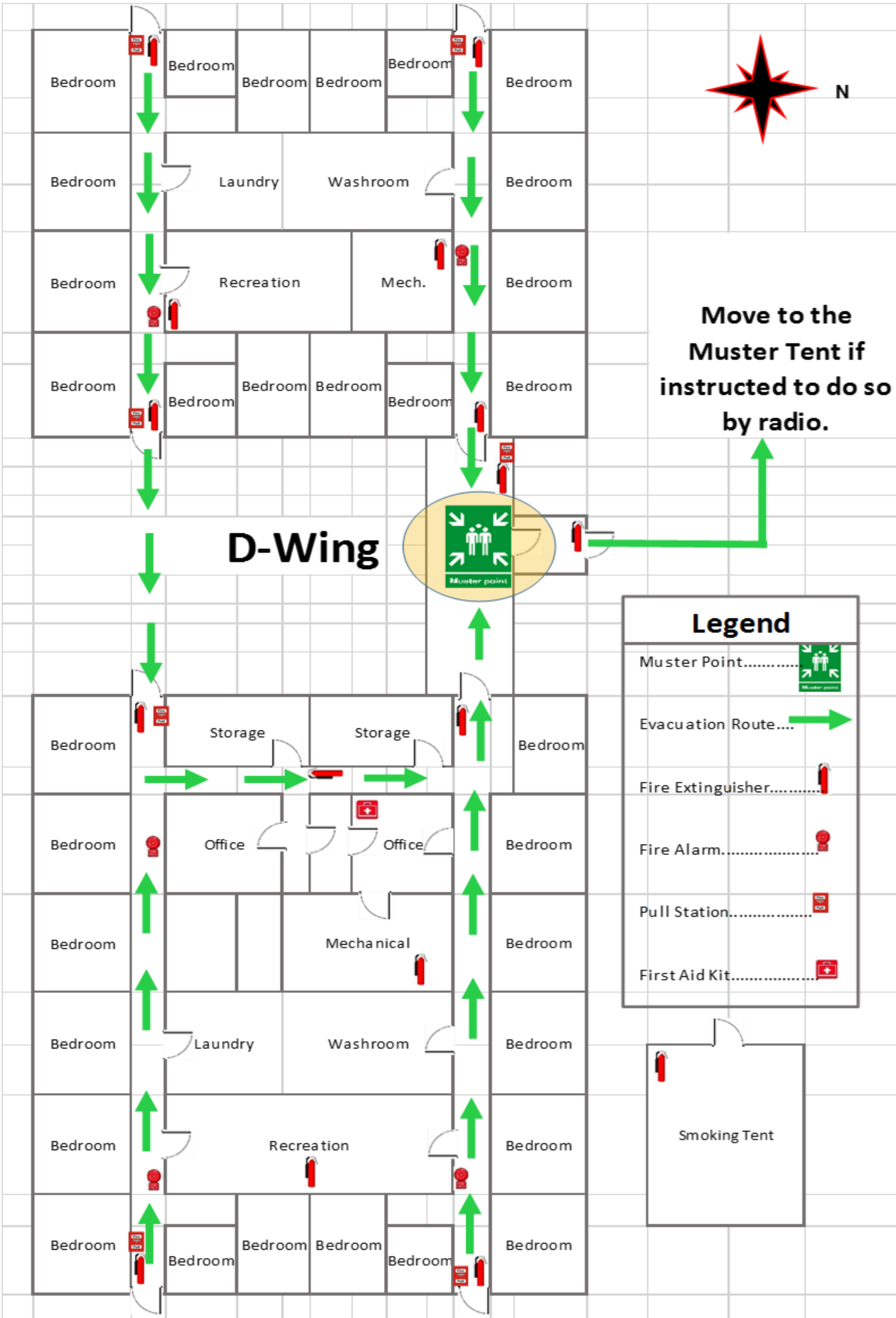
Doris Camp Evacuation Route



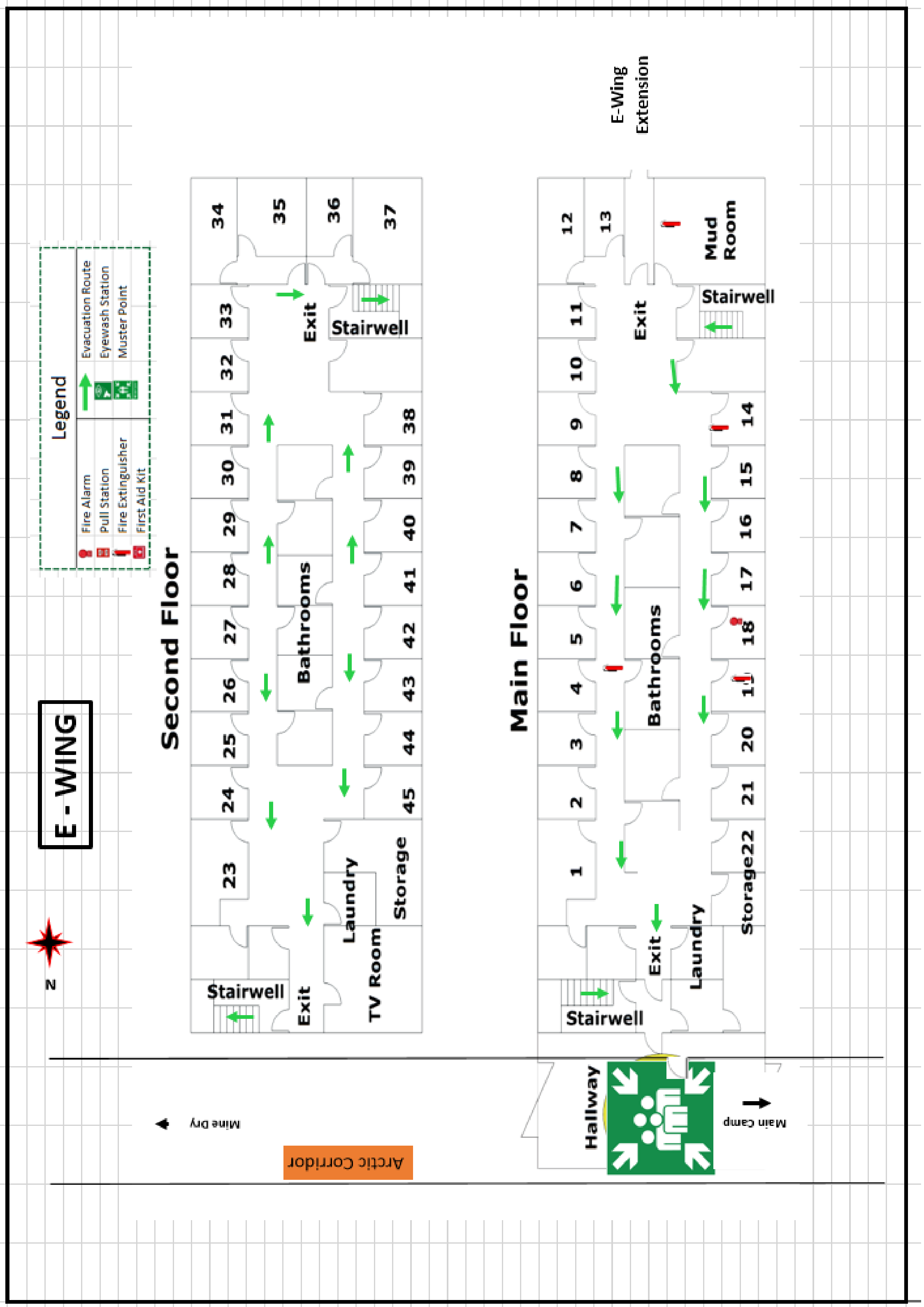
Mine Dry, ERT & Assay Lab Complex Evacuation Route



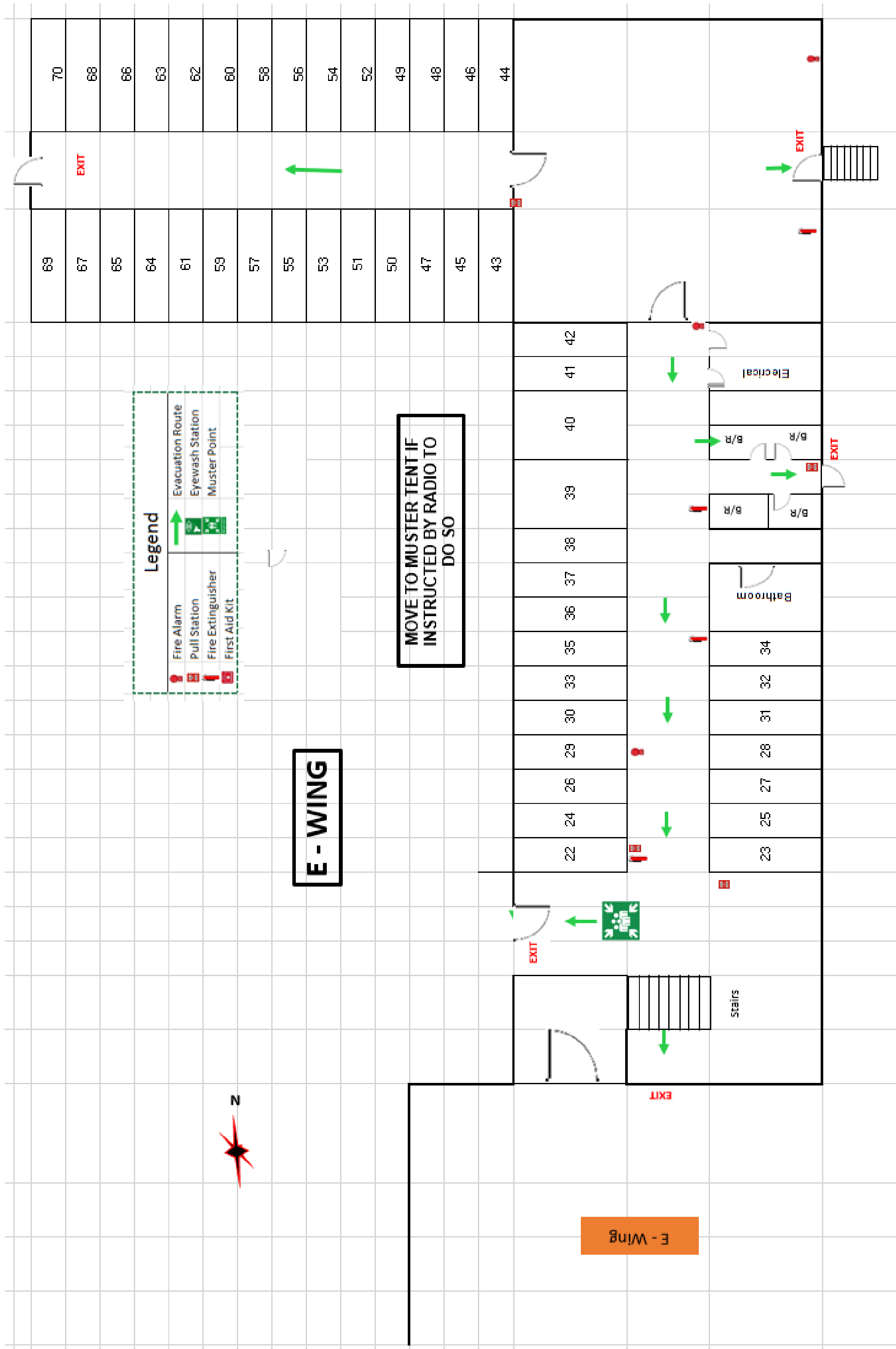
D-Wing Camp Facility Evacuation Route



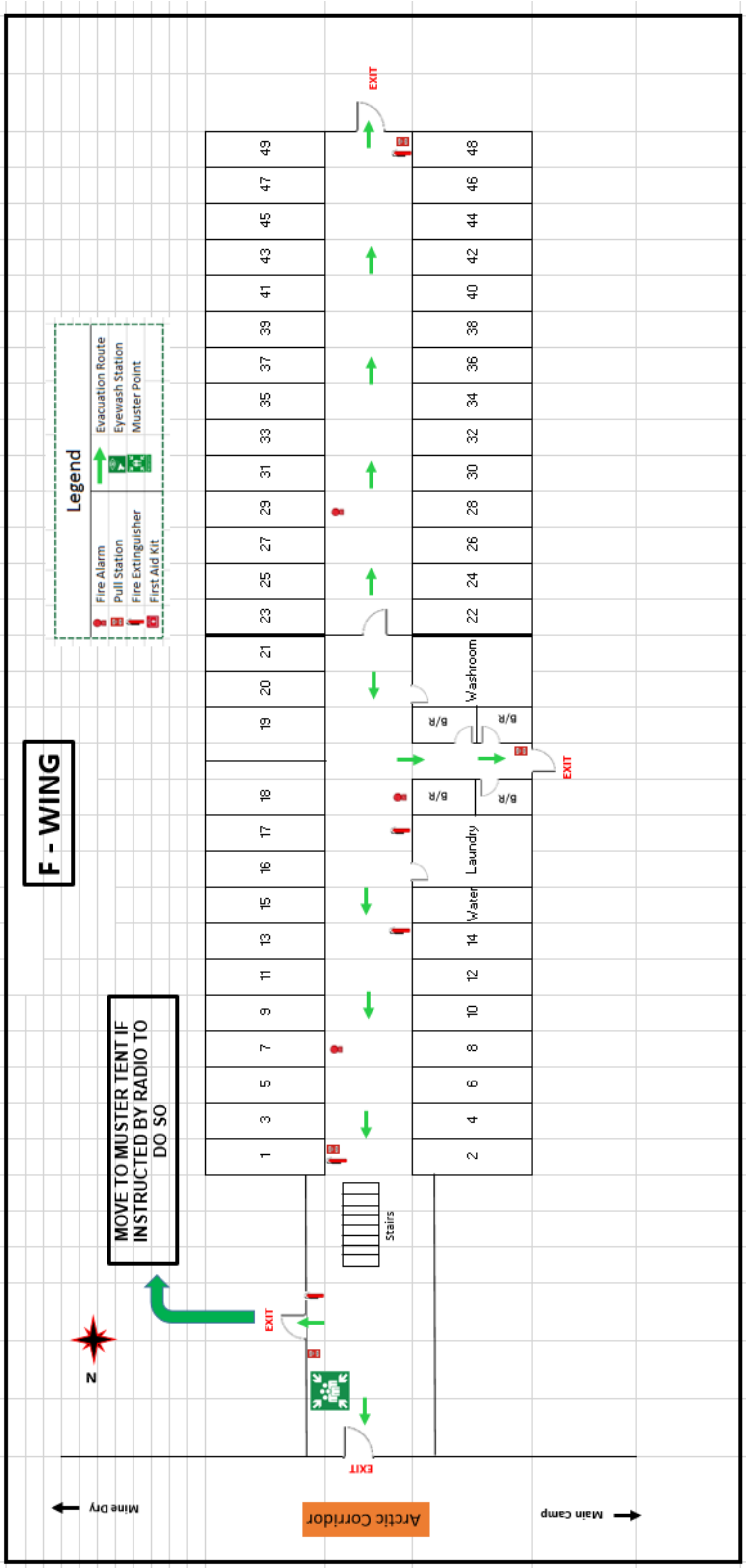
E-Wing Camp Facility Evacuation Route



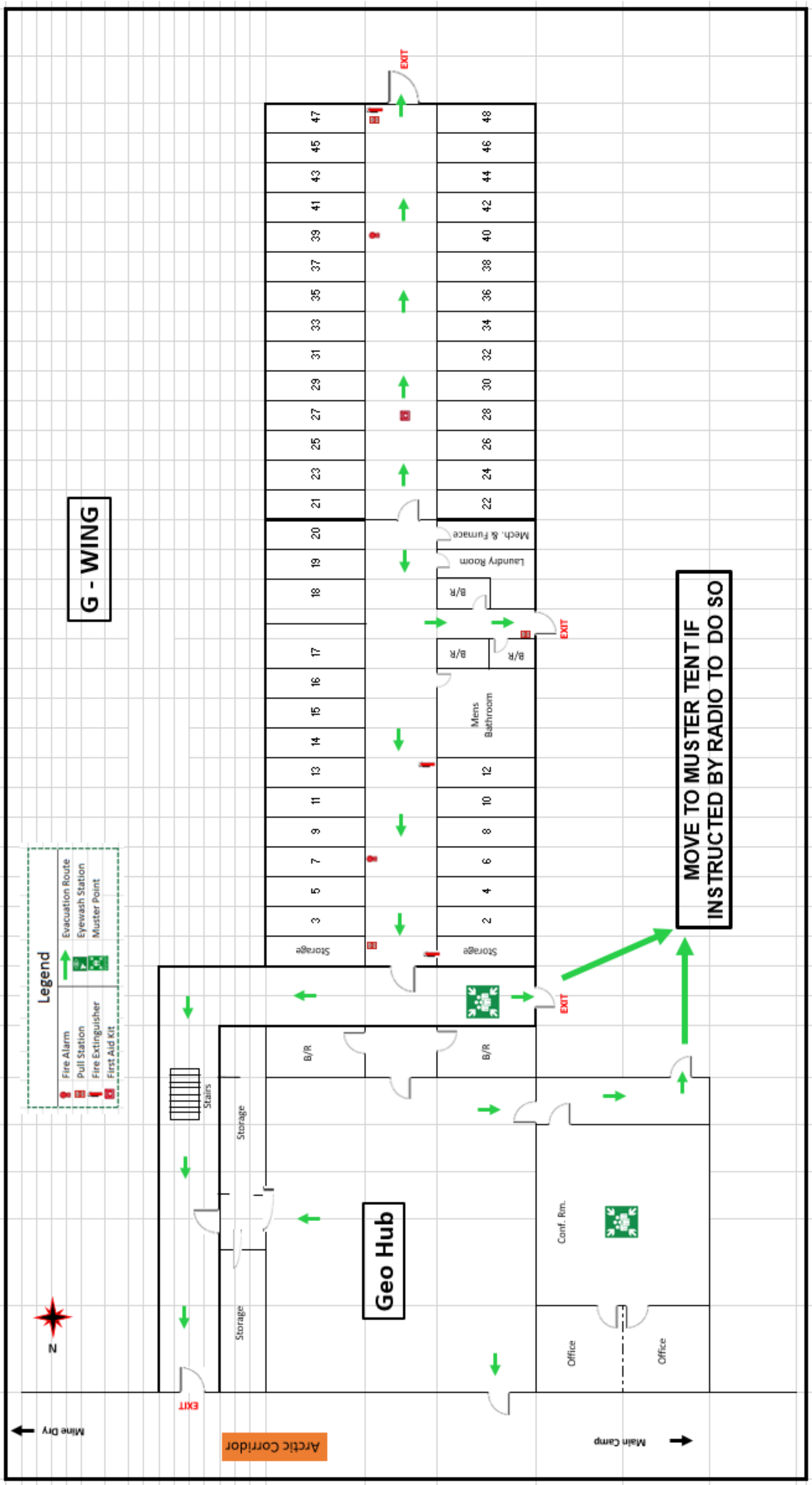
E-Wing Camp Extension Facility Evacuation Route



F-Wing Camp Facility Evacuation Route



G-Wing Camp Facility Evacuation Route



HOPE BAY EMERGENCY RESPONSE PLAN

HOPE BAY, NUNAVUT

Appendix C: Incident Command Group Tag Board Accounting Form

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HOPE BAY
UNDERGROUND EVACUATION PROCEDURE

INCIDENT COMMAND GROUP TAG BOARD R/S ACCOUNTING FORM

DATE:________________________

NAME	Time Called	SCSR Used	MINE RESCUE TRAINED (Y - N)	STATUS OK	STATUS INJURED	NAME	Time Called	SCSR Used	MINE RESCUE TRAINED (Y - N)	STATUS OK	STATUS INJURED

THIS FORM MUST BE GIVEN TO SENIOR PERSON IN CHARGE.

PERSON ACCOUNTING FOR U/G PERSONNEL: ____

W:\Safety\Emergency Response\Emergency Checksheets\Central Group Tag Board Accounting Form

*Remind Personel in Refuge Statio - Ensure Compress air is ON. Turn ON Oxygen System if compressed air shuts down.
- Ensure door is sealed with clay.
- Ensure everyone is ok and willing to stay.

HOPE BAY EMERGENCY RESPONSE PLAN

HOPE BAY, NUNAVUT

Appendix D: Refuge Station Accounting Form

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HOPE BAY
UNDERGROUND EVACUATION PROCEDURE

STANDARD REFUGE STATION ACCOUNTING FORM

REFUGE STATION: 4660 BTD Vent Access

DATE:____________________

NAME	STENCH DETECTED TIME	STENCH DETECTED WORKPLACE	TIME IN REFUGE	MINE RESCUE TRAINED (Y - N)	STATUS OK	STATUS INJURED	COMMENTS

THIS FORM MUST BE RETURNED TO SURFACE TO THE SENIOR PERSON IN CHARGE.

REFUGE STATION PERSON IN CHARGE: ______________________________

W:\Safety\Emergency Response\Emergency Checksheets\Refuge Stations Accounting Form

HOPE BAY EMERGENCY RESPONSE PLAN

HOPE BAY, NUNAVUT

Appendix E: Control Room Operator Duties - Mill/Surface Emergency

Incident Command: Ext. 198
Physician Assistant: Ext. 105
Mine Rescue Room: Ext. 196
Main Boardroom: Ext 198

February 4, 2021

SURFACE EMERGENCY

MILL CONTROL ROOM OPERATOR'S DUTIES

DATE: ______________________

Control Room Operator: _________________________ (Print Name)

Emergency Call received at: ___________ Test: Yes ☐ No ☐

Name of person who called: _____________________________

Location and type of Emergency: _________________________

- ☐ Serious Injury
- ☐ Chemical Spill
- ☐ Cyanide Spill
- ☐ Fire
- ☐ Gas Leak
- ☐ HCN Release
- ☐ Vehicle Accident
- ☐ Tailing Spill
- ☐ SO2 Release
- ☐ Other

Any Injuries? YES NO DON'T KNOW

If Yes, How may? ____________________

Type of injuries, if known: ____

____

Details of the Emergency: ____

____

____

____

____

____

1

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HOPE BAY

IMMEDIATE ACTIONS

1) Initiate pertinent Emergency alarm.

   Time Initiated: ____________________

2) Announce Emergency, Emergency, Emergency, on radio channel #1 stating the type of emergency (Fire, Vehicle Accident, Gas Leak, etc.).

   Time Announced: ____________________

3) For a Mill Emergency request for an operator to provide assistance in the Control Room, the operator must be trained in the use of an SCBA-RIT.

   Name Contacted: ____________________ Time: ____________________

4) Each Control Room person must put on a Self-Contained Breathing Apparatus (SCBA - RIT), and record the bottle pressures.

   Bottle Pressure #1: ____________________ Time: ____________________

   Bottle Pressure #2: ____________________ Time: ____________________

5) Initiate the emergency pager system (On Computer) to inform all ERT, Security, Physician Assistant, and senior management of a site emergency. (If the pagers are in-active then rebroadcast the emergency over the radio). ***Once the first page is sent then re-send a second page***!

   Time 1st Page Made: _______________ Time 2nd Page Made: _______________

6) Contact the medic (via radio or ext. 105) to ensure they are emergency ready and on stand-by in the Medic's Office. (If required)

   Name Contacted: ____________________ Time: ____________________

7) Notify the maintenance shop, to start up the ambulance and/or fire truck to ensure its emergency ready and on stand-by (ext. 130), or call maintenance shop on radio. Channel#8

   Note: No maintenance shop coverage on night shift, notify Incident Command at Ext 198). (if required)

   Person Contacted: ____________________ Time: ____________________

8) Contact Mill Muster Point (for a mill emergency) via radio (ask to speak with most senior mill supervisor) and check that all personnel are tagged off the tag in board.

Name Contacted: ____________________ Time: _____________________

Number of people Unaccounted for: ________

9) Notify the Incident Command Ground (ext. 198 or ext. 199) of status of Muster Point tag board and confirm the name of the Official-In-Charge.

Official-In-Charge: ____________________ Time: _____________________

10) Any other duties as per instructions from the Incident Command Group – Keep a log of all activities.

11) Go through steps 1 – 9 above and ensure all items have been completed.

Time Confirmed: __________________

12) Informed of the ALL CLEAR, and instructed to resume normal activities by the Official-In-Charge.

Contacted By: _____________________, Time: __________________

*****Forward a copy of this report to the Safety Department*****

Sign: _______________________, Date: ___________________, Time: ____________

CONTROL ROOM OPERATOR'S - GENERAL NOTES

(Use this space for general notations or problems encountered)

W:\Safety\Emergency Response\Emergency Checksheets\Control Room Operator Duties Surface Emergency

HOPE BAY EMERGENCY RESPONSE PLAN

HOPE BAY, NUNAVUT

Appendix F: Control Room Operator Duties - Underground Emergency

Incident Command: 198
Physician Assistant: Ext. 105
Mine Rescue Room: Ext 196
Main Boardroom: 198

February 4, 2021

UNDERGROUND EMERGENCY

MILL CONTROL ROOM OPERATOR'S DUTIES

DATE: ______________________

Control Room Operator: ________________________ (Print Name)

Emergency Call received at: ___________ Test: Yes ☐ No ☐

Name of person who called: ____________________________

Where are they calling from: ____________________________

Location of Emergency: ☐ Doris ☐ Madrid ________________________

Type of Emergency: ________________________________

Does Stench Gas need to be Released? YES NO

Is the caller aware of any Injuries? YES NO DON'T KNOW

If Yes, How may? ___________________

Type of injuries, if known: ____

____

Details of the Emergency: ____

____

____

____

____

____

____

____

1

IMMEDIATE ACTIONS

1) If stench gas needs to be released then activate the Stench Gas Button on your computer screen.

   Time Stench Gas Released: ____________________

2) Announce Emergency, Emergency, Emergency, on channel #1 stating that "stench gas has been released and that all underground personnel must report to the nearest refuge station immediately."

   Time Announced Made: ____________________

3) Broadcast over channel #1 for someone to travel to the surface vent raise building to verity that the Stench Gas systems released in the fresh air system. If no one replies then contact the maintenance shop (Ext. 140) to have someone go to confirm the pressure gauge inside the panel is at 0 psi.

   Person Contacted: ____________________ Time Contacted: ____________________

   Confirmation Time That Pressure Gauge reads 0 psi: ____________________

4) If the stench gas system in the fresh air failed to release, then have the person manually release the stench gas (following the procedure posted on the stench gas panel).

   Time Manually Released: ____________________

5) Initiate the emergency pager system (On Computer) to inform all ERT, Security, Physician Assistant, and senior management of a site emergency. (If the pagers are in-active then rebroadcast the Emergency over the radio). ***Once the first page is sent then re-send a second page***!

   Time 1st Page Made: _______________ Time 2nd Page Made: _______________

6) Request for another mill operator to provide assistance in the Control Room.

   Name Contacted: ______________________ Time: ______________________

7) When contacted by the Official-In-Charge document name.

   Official-In-Charge: ______________________ Time: ______________________

8) Contact the medic (via radio or ext. 105) to ensure they are emergency ready and on stand-by in the Medic's Office. (If required)

Name Contacted: ____________________ Time: ____________________

9) On Dayshift notify the maintenance shop, to start up the ambulance and/or fire truck to ensure its emergency ready and on stand-by (ext. 130), or call maintenance shop on radio. Channel#8

Note: No maintenance shop coverage on night shift, notify Incident Command at Ext 198).

Person Contacted: ____________________ Time: ____________________

10) Any other duties as per instructions from the Incident Command Group – Keep a log of all activities.

11) Go through steps 1 – 9 above and ensure all items have been completed.

Time Confirmed: ____________________

12) Informed of the ALL CLEAR, and instructed to resume normal activities by the Official-In-Charge.

Contacted By: ____________________, Time: ____________________

*****Forward a copy of this report to the Safety Department*****

Sign:____________________, Date:____________________, Time:____________

CONTROL ROOM OPERATOR'S - GENERAL NOTES

(Use this space for general notations or problems encountered)

W:\Safety\Emergency Response\Emergency Checksheets\Control Room Operator Duties Underground Emergency

HOPE BAY EMERGENCY RESPONSE PLAN

HOPE BAY, NUNAVUT

Appendix G: Medical Evacuation Procedure

TMAC HOPE BAY STANDARD OPERATING PROCEDURE			
Title:	Medical Air Evacuation		
Document #:	VII-0002		
Owner:	Health and Safety Manager	Effective Date:	December 2018
Revision:	A	Replaces:	November 2014

1. PURPOSE

To ensure detailed protocols are established and followed to ensure the timely and efficient transportation of an injured person can be effective executed.

2. INTRODUCTION

This procedure has been established to ensure a detailed process is in place should an injured person require medical air evacuation.

3. SCOPE

This procedure applies to all activities, facilities, equipment, processes, employees, contractors, and vendors at the Hope Bay site.

4. RESPONSIBILITIES

Mine General Manager:

a. Ensures the requirements of this procedure are applied and maintained.

Department Managers:

a. Communicate the requirements of this procedure to their employees; and

b. Manage activities in accordance with this procedure.

Health & Safety Manager or designate:

a. Monitors the implementation of this procedure; and

b. Verifies this procedure is maintained.

Physician Assistants and Logistics Coordinators:

a. Understand and practice this procedure; and

b. Ask their supervisor for clarification if they are unsure of any aspect of this procedure.

Joint Occupational Health and Safety Committee (JOHSC) provides input during the periodic review of this procedure.

AGNICO EAGLE HOPE BAY	HOPE BAY Medical Air Evacuation	DOCUMENT NO. VII-0002

5. DEFINITIONS

5.1. Air Medical Evacuation

A timely and efficient transportation of an injured worker being evacuated from the scene of an accident/incident on a remote worksite to a receiving medical facilities using medically equipped aircraft.

5.2. **Load & Go** - A situation where an employee is critically injured or ill and would not survive or would have a diminished prognosis if surgical or advanced medical intervention was delayed.

5.3. **Flight Weather Outage** - When the ceiling is less than 1000 feet this may suspend air travel and is at the discretion of the pilots and flight control. Low ceilings do not suspend departures unless weather and/or visibility become severely compromised. This also is at the discretion of the pilots and flight control.

5.4. **Medflight** - A plane designed solely for the purpose of continued life support and will not be considered the same as a charter or emergency charter flight.

5.5. **Medical Control** - A process of care and accountability of the injured worker. There is a professional "hand off" to further qualified personnel for the purposes of continued care. This practice will continue until the injured worker has received proper care for their injuries.

6. PROCEDURE

6.1. If a serious medical condition occurs at site, the Physician Assistant (P.A.) will consult with the AMS Medical Director and request for Medevac Approval.

6.2. If the Medical Director denies the Medevac request, then the P.A. continues with onsite patient care.

6.3. If the Medical Director agrees to the Medivac request, then the P.A. will contact Nunavut Emergency Management providing then with all the necessary patient information.

6.4. The P.A. will then notify the Health & Safety Manager or designate regarding the medevac request.

6.5. The Health & Safety Manager or designate will notify the Mine General Manager or designate and the Logistics Coordinator of the request for a medevac.

6.6. The P.A. will monitor patient and wait for a phone call from Stanton Hospital Medical Response and Emergency Physician. The P.A. will update the Emergency Physician on patient's condition.

6.7. When the Emergency Physician approves the medevac flight, the Stanton Hospital Medical Response will call Keewatin Air to arrange the Medevac.

6.8. Keewatin Air flight dispatcher and TMAC Logistics Coordinator will arrange flight details.

6.9. The Keewatin Air flight nurse/paramedic will call the P.A. for update information, and provide ETA to Hope Bay.

AGNICO EAGLE HOPE BAY	HOPE BAY Medical Air Evacuation	DOCUMENT NO. VII-0002

6.10. The P.A. or Logistics Coordinator will update the Health & Safety Manager and Mine General Manager or designates on medevac ETA.

6.11. The Logistics Coordinator will establish all airstrip procedures to ensure the safe arrival of the Keewatin Air flight and keep the P.A. inform of flight ETA.

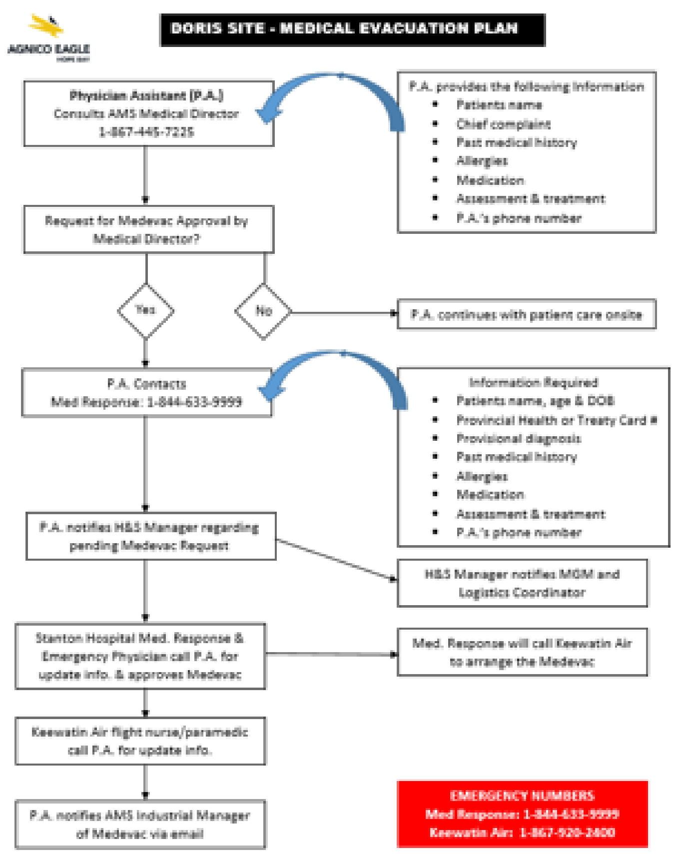
6.12. Prior to Keewatin Air Medevac flight arrival to Hope Bay, the P.A. with the assistance from the Emergency Response Coordinator or a trained First Aid Responder will prepare the patient and then transport the patient to the Hope Bay airstrip.

6.13. P.A. will hand over the patient to the Keewatin Air nurse/paramedic, and remain at the airstrip until the flight is airborne and confirmed on route to Yellowknife.

6.14. The P.A. will notify AMS Industrial Manager of medevac via email.

7. ATTACHMENTS

7.1.



AGNICO EAGLE HOPE BAY	HOPE BAY Medical Air Evacuation	DOCUMENT NO. VII-0002

8. TECHNICAL REVIEW

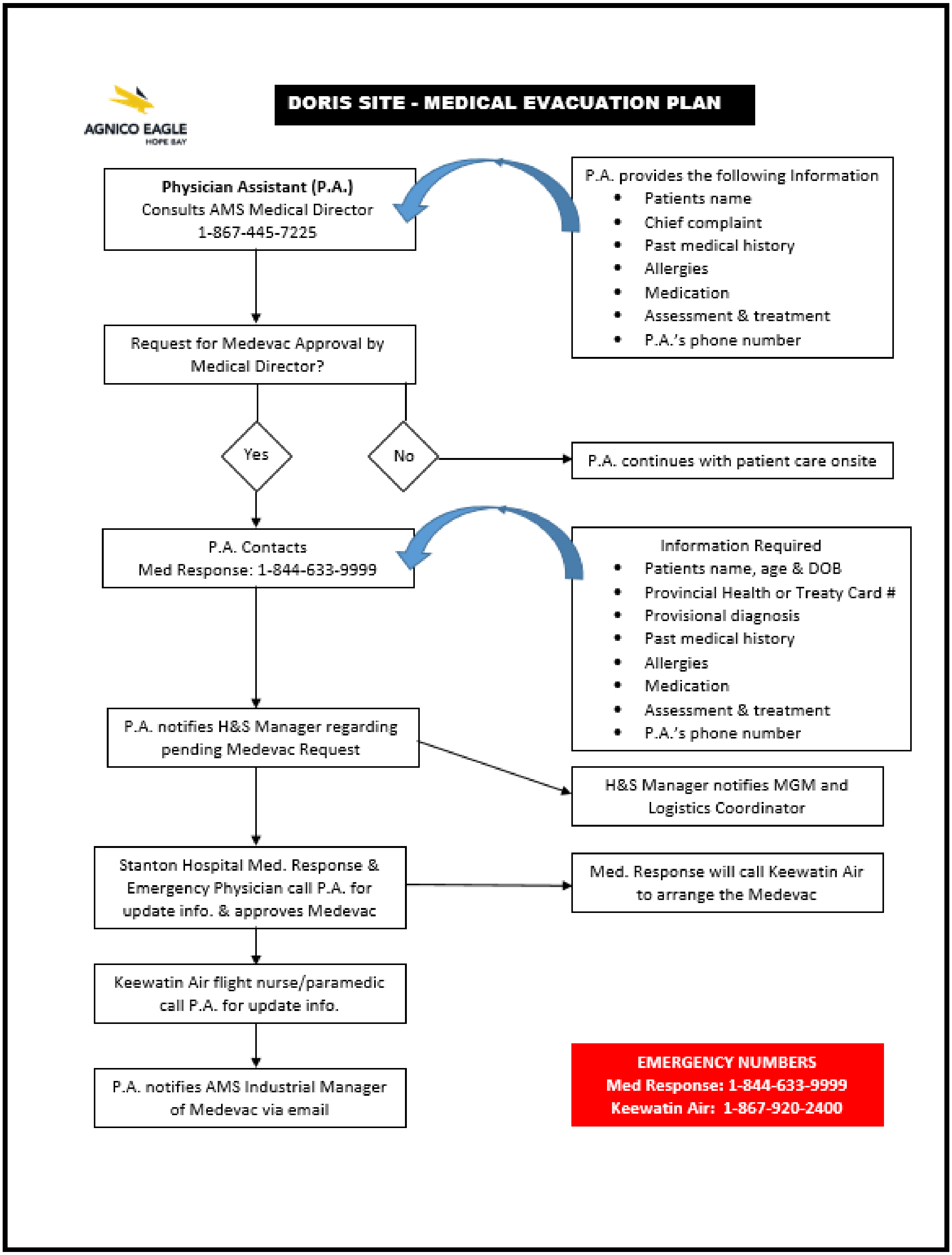
Name	Title	Date	Signature
	Mine General Manager		
	Assistant MGM		
	Maintenance Manager		
Review Schedule: Every 3 years			

9. APPROVAL

Name	Title	Date	Signature
Doug Brown	Health & Safety Manager		

10. REVISION HISTORY

Revision	Date	Comments
A	November 2014	Initial Issue
B		TMAC Reviewer Comments incorporated
C		Approved for Use


DORIS SITE - MEDICAL EVACUATION PLAN
AGNICO EAGLE
HOPE BAY
Physician Assistant (P.A.)
Consults AMS Medical Director
1-867-445-7225
P.A. provides the following Information
• Patients name
• Chief complaint
• Past medical history
• Allergies
• Medication
• Assessment & treatment
• P.A.'s phone number
Request for Medevac Approval by Medical Director?
Yes
No
P.A. continues with patient care onsite
P.A. Contacts
Med Response: 1-844-633-9999
Information Required
• Patients name, age & DOB
• Provincial Health or Treaty Card #
• Provisional diagnosis
• Past medical history
• Allergies
• Medication
• Assessment & treatment
• P.A.'s phone number
P.A. notifies H&S Manager regarding pending Medevac Request
H&S Manager notifies MGM and Logistics Coordinator
Stanton Hospital Med. Response & Emergency Physician call P.A. for update info. & approves Medevac
Med. Response will call Keewatin Air to arrange the Medevac
Keewatin Air flight nurse/paramedic call P.A. for update info.
P.A. notifies AMS Industrial Manager of Medevac via email
EMERGENCY NUMBERS
Med Response: 1-844-633-9999
Keewatin Air: 1-867-920-2400

HOPE BAY EMERGENCY RESPONSE PLAN

HOPE BAY, NUNAVUT

Appendix H: Incident Command Group Duties - Mill/Surface Emergency

Mill Control Room: Ext. 150
Main Boardroom: 198
Medic: Ext. 105
Mine Rescue Room: Ext. 196

February 4, 2021

MILL/SURFACE EMERGENCY

INCIDENT COMMAND GROUP DUTIES: (General Manager or Designate)

DATE: ______________ **Time of Incident:** ____________ **Location:** ________________

Note: The location of the incident command room will be the Main Conf. room (ext. 198)

1) Form the incident command group and appoint a scribe to take notes.

   Official-In-Charge: ____________________ Scribe: __________________________

   Time:_______________

2) Inform the Mill Control Room Operator (ext. 150) that you are the Official-in-Charge. Verify with Mill Control Room Operator that full emergency procedures have been implemented. Ask for the following information.

a) Who called? ____

b) Where did they call from? ____

c) Location of emergency: _______________________________________

d) Type of emergency: ____

e) Time call was made: ____

f) Are both Control Room personnel wearing their SCBA-Rit (Time and Jumbo Bottle Pressure):
   #1______________________________ #2______________________________

g) **Number of unaccounted for personnel:** ___________________________

h) Include any other information: ___________________________________

   ____

   Name Contacted:______________________, Time: __________________

1

3) Ensure that ERT members are reporting to the Mine Rescue Room.
YES _______

Name Contacted: ____________________ Time: __________________

4) Determine if a "STOP WORK" is required, if Yes then broadcast over radio:

Yes______ No______ Time Stop Work Broadcasted: ______________

5) Designate two trained operators (or ERT members) as **S.C.B.A. Partners.**

Name Contacted: ____________________ Time: __________________

Name Contacted: ____________________ Time: __________________

6) Designate two other trained operators (ERT members) as an **S.C.B.A Back-Up Team for team #1.**

Name Contacted: ____________________ Time: __________________

Name Contacted: ____________________ Time: __________________

7) Appoint a Briefing Officer for both S.C.B.A. teams.

Person Assigned: ____________________ Time: __________________

8) Contact the Control Room Operator to verify if all Mill personnel have been accounted for at Muster Point (Ext. 150)

Name Contacted: ____________________ Time: __________________

9) Designate someone to notify the medic (ext. 105), to ensure they are emergency ready and on stand-by in the Medic Office. (If Required)

Person Assigned: ____________________ Time: __________________

2

10) Designate someone to notify the maintenance shop, to start up the ambulance, fire truck and/or water truck to ensure its emergency ready and on stand-by (ext. 130), or call maintenance shop on radio Channel #8. (If Required)

Person Contacted: ____________________ Time: _________________

11) Notify Corporate Officials and General Manager/Assistant General Manager if offsite.

Norman Ladouceur: **1-819-860-6258** Time: _________________

Gerald MacDonald: **1-819-856-0535** Time: _________________

Patrice Gilbert: **1-647-281-1193** Time: _________________

12) Ensure availability of Mill & Surface Site plans for the Incident Command Group and emergency crews **(3 Complete Sets of Prints)**.

Plans Provided By: ____________________ Time: _________________

13) Ensure an Engineer is available to assist.

Name Contacted: ____________________ Time: _________________

14) Ensure a Maintenance person is available for information on equipment and electrical installations.

Name Contacted: ____________________ Time: _________________

15) Appoint someone to call the WSCC Inspector; **1-800-661-0792**

Person Assigned: ____________________ Time: _________________

WSCC Person Contacted: ____________________ Time: _________________

Ensure notice in writing of the occurrence is provided to the WSCC within 72 hours.

16) **Arrange for stench to be injected into the fresh air raise and / or the compressed air line if U/G employees will be affected by the mill/surface emergency. Then start using the Incident Command Group Duties "Underground Emergency Form".**

Required ___________ **Not Required** ___________

Name Contacted: _____________________ **Time:** __________________

17) Broadcast the **ALL CLEAR** once the emergency is over! If a Stop Work was ordered then broadcast over the radio system for all site personnel to Stand Down and resume normal duties.

Time: _____________________________

Notify the Control Room Operator of the all clear and to resume normal operations!

Note:
Incident Command to determine if site WIFI capabilities to be suspended to limit the chance of social media information leaving site (i.e. facebook, text etc)

Now

GO THROUGH STEPS 1 – 16 ABOVE INFORMING ALL APPROPRIATE PEOPLE THAT THE "ALL CLEAR" HAS BEEN GIVEN. Time: __________________

Names of Incident Command Group Members:

__________________ ____________________ __________________ _________________

__________________ ____________________ __________________ _________________

__________________ ____________________ __________________ _________________

Sign: ______________________ **Date:** ____________________ **Time:** ____________

*****Forward this form to the Safety Department*****

4

In the event that there is a need to organize Critical Incident Stress Debriefing sessions, contact the Manager of Human Resources so that they can make the arrangements through our EAP provider VCARS.

Sandra Marseille
Cell: (819-860-3723)
Office (819-759-3555 ext. 4608040)

Person Assigned to contact Human Resources: ______________________

Date and Time that HR was contacted: ______________________

W:\Safety\Emergency Response\Emergency Checksheets\Incident Command Group Duties Mill Emergency

HOPE BAY EMERGENCY RESPONSE PLAN

HOPE BAY, NUNAVUT

Appendix I: Incident Command Group Duties - Underground Emergency

Mill Control Room: Ext. 150
Main Boardroom: 198
Medic: Ext. 105
U/G Wicket: Ext. 163
Mine Rescue Room: Ext. 196

February 4, 2021

UNDERGROUND EMERGENCY

INCIDENT COMMAND GROUP DUTIES: (General Manager or Designate)

DATE: ______________ **Time of Incident:** ____________ **Location:** ________________

Note: The location of the incident command room will be the Main Conf. room (ext. 199)

1) Form the incident command group and appoint a scribe to take notes.

   Official-In-Charge: ____________________ Scribe: __________________________

   Time: _________________

2) Inform the Mill Control Room Operator (ext. 150) that you are the Official-In-Charge. Verify with the Mill Control Room Operator that the stench gas system has been released in the fresh air and compressed air systems. Ask for the following information.

a) Who called? ____

b) Where did they call from: ________________________________

c) Location of emergency, fire or smoke: ____________________________

d) Type of emergency or fire: ______________________________________

e) Time call was made: ____

f) Time Stench Gas was released: _____________________________

g) Include any other information:

____

____

Mill Control Room Operator Name: _____________________,

Time: __________________

1

3) Ensure that ERT members are reporting to the Mine Rescue Room.

Name Contacted: ______________________ Time: ___________________

4) On Dayshift notify the maintenance shop, to start up the ambulance and/or fire truck to ensure its emergency ready and on stand-by (ext. 130), or call maintenance shop on radio. Channel#8

On Nightshift wake up Mobile Maintenance Supervisor:
Mike Levesque Room A34
Craig Little Room A21

Person Contacted: ______________________ Time: ___________________

5) Determine if a "STOP WORK" is required, if Yes then broadcast over radio:

Yes ______ No______ Time Stop Work Broadcasted: _______________

6) Assign a competent person(s) to verify that the fresh air raise stench system discharged and the pressure gauge inside the panel is at 0 psi.

Name Assigned: ______________________, Time: ___________________

7) Broadcast over the radio underground channel #20 **(EVERY 10 MINUTES)** that ***"stench gas has been release and that all underground personnel must report to the nearest refuge station or rescue tent immediately."***
Continue to broadcast until everyone is accounted for in Refuge Stations.

Name: ______________________, Time: ___________________

8) Assign a competent person(s) to be positioned at the wicket to call U/G refuge stations and rescue tents.

Person Calling Refuges: ______________________ Time: ___________________

9) Ensure that the tag board is manned. If any U/G employees come to the wicket, allow them to shower but hold them on surface in the huddle room. The Incident Command Group will initiate the All Clear once the emergency is over.

Tag Board Manned By: ______________________ Time: ___________________

2

10) Total Number of People tagged in on the tag board: ______.

Number of People accounted for in Refuge Stations ______. Time: ____________

Number of People Unaccounted for: ______.

Last known working location of unaccounted for personnel:

____

____

____

____

____

11) Appoint a competent person(s) to control access at the portal (vehicle & radio required). Anyone that exits the portal must report immediately to the Incident Command Group.

Name Assigned: ______________________, Time: ___________________

12) Assign a competent person to be positioned at the Fresh Air Raise to ensure the main ventilation fans remain operational, and to account for personnel that may use the emergency manway to surface.

Name Assigned: ______________________ Time: ___________________

13) Assign a competent person to be positioned at the DCO Exhaust Raise to account for personnel that may use the emergency manway to surface.

Name Assigned: ______________________ Time: ___________________

14) Appoint a Briefing Officer for the first Mine Rescue Team.

Name Assigned: ______________________, Time: ___________________

15) Arrange for transportation for the Mine Rescue team. Vehicle should be taken to Mine Rescue room. Secure a seconded vehicle for team #2.

Name Assigned: ______________________, Time: ___________________

3

16) Designate someone to notify the maintenance shop, to start up the ambulance to ensure its emergency ready and on stand-by (ext. 130), or call maintenance shop on radio Channel #8. (If Required) Then have the fire truck delivered to mine rescue room.

Person Contacted: ______________________ Time: ___________________

17) Ensure an Engineer / Vent Tech. is available to assist in determining ventilation installations and ensure level plans are available for the Incident Command Group and Mine Rescue Teams (**3 Complete Sets of Prints**).

Name Assigned: ______________________, Time: ___________________

18) Ensure a Mechanical/Electrical person is available for information on equipment and electrical installations and to check surface ventilation fans ensuring their operation.

Name Assigned: ______________________, Time: ___________________

19) Document the number of ERT members that have assembled in the Mine Rescue room.

Number of MR Personnel	Time
____________________________	_________
____________________________	_________
____________________________	_________

20) Contact neighboring mines and advise that Mine Rescue mutual aid assistance is required if we do not have 15 mine rescue personnel onsite. (Refer to Mutual Aid Contact List)

Name & Site Contacted: ____

Time: ___________________

21) Once you have sufficient information to develop a plan of rescue and recovery, call the Mine Rescue room and ask the ERT Coordinator/Briefing Officer to come to the Incident Command Center for briefing.

Name Assigned: ______________________ Time: ___________________

22) Arrange for additional stench to be injected into the fresh air raise if U/G employees are not responding to the stench. **(Under the direction of the Official in Charge or designate ONLY).**

Required ____________ Not Required _______________

Name Assigned: ______________________ Time: __________________

23) Notify Corporate Officials and General Manager/Assistant General Manager if offsite.

Norman Ladouceur: **1-819-860-6258** Time: __________________

Gerald MacDonald: **1-819-856-0535** Time: __________________

Patrice Gilbert: **1-647-281-1193** Time: __________________

24) Designate someone to notify the medic, to ensure they are emergency ready and on stand-by. (If Required)

Person Assigned: ______________________ Time: __________________

25) Appoint someone to call the WSCC Inspector; (1-800-661-0792)

Person Assigned: ______________________ Time: __________________

WSCC Person Contacted: ______________________ Time: __________________

Ensure notice in writing of the occurrence is provided to the WSCC within 72 hours.

26) Once the emergency is over then confirm with the Briefing Officer(s) that all Mine Rescue Personnel are cleared from underground.

Time: __________________

27) Advise the Electricians or surface Mechanics to release Winter Green into the fresh air system (Follow Procedure VII-0005 Underground Stench Gas Procedure). Then reload the surface fresh air system with stench.

Name Contacted: ______________________ Time: __________________

Time Fresh Air System Recharge: __________________

28) Advise the Electricians to release Anti-Stench into the compressed air system (Follow Procedure VII-0005 Underground Stench Gas Procedure). Then reload the underground compressed air system with stench.

Name Contacted: ____________________ Time: _________________

Time Compressed Air System Recharge: _________________

29) In the event this was a drill, instruct personnel in Refuge Stations to return to their heading to blow the air headers for a few moments and then to proceed to surface.

In the event this was a real fire, instruct personnel in Refuge Stations to proceed to surface.

Person Informing Workers: ____________________ Time: _________________

If this was a real fire and it is deemed necessary by the Incident Control Group, Mine Rescue personnel could be assigned to blow air lines after stench has been dumped to help clear stench from the system. This can be done at the same time people are being evacuated from Refuge Stations and making their way to surface.

30) Broadcast the **ALL CLEAR** once the emergency is over! If a Stop Work was ordered then broadcast over the radio system for all site personnel to Stand Down and resume normal duties.

Time: ____________________________

Notify the Control Room Operator of the all clear and to resume normal operations!

31) **Time the Tag Board is cleared and all personnel are on surface.**

Time: _________________

32) Leave instructions in the Shift log for the oncoming shift to be notified of the stench that was dumped as well as the wintergreen, as well as any headings that may have compressed air blowing. Crews will be instructed to open their air header in their heading to clear any stench residue from the lines.

Instructions Left By: ________________ Time: _________________

Note:
Incident Command to determine if site WIFI capabilities to be suspended to limit the chance of social media information leaving site (i.e. facebook, text etc)

Now

GO THROUGH STEPS 1 – 29 ABOVE INFORMING ALL APPROPRIATE PEOPLE THAT THE "ALL CLEAR" HAS BEEN GIVEN.

Time: __________________

Names of Incident Command Group Members:

__________________ ____________________ __________________ _________________

__________________ ____________________ __________________ _________________

__________________ ____________________ __________________ _________________

Sign: _______________________ Date: ____________________ Time: ____________

*****Forward this form to the Safety Department*****

In the event that there is a need to organize Critical Incident Stress Debriefing sessions, contact the Manager of Human Resources so that they can make the arrangements through our EAP provider VCARS.

Sandra Marseille
Cell: (819-860-3723)
Office (819-759-3555 ext. 4608040)

Person Assigned to contact Human Resources: _____________________

Date and Time that HR was contacted: _____________________

W:\Safety\Emergency Response\Emergency Checksheets\Incident Command Group Duties Underground Emergency

7

HOPE BAY EMERGENCY RESPONSE PLAN

HOPE BAY, NUNAVUT

Appendix J: Confined Space Entry Procedure

HOPE BAY SAFE WORKING PROCEDURES			
Division:	Operations		
Section:	IV-0003		
Subject:	Confined Space Entry & Work		
Owner:	Safety Manager	Effective Date:	July 2019
Revision:	B	Replaces:	March 2018

1 OBJECTIVE

1.01 To provide a safe working procedure, equipment, monitoring and training to ensure all employees are safeguarded against the hazards associated with Confined Space Entry.

2 SCOPE

2.01 N/A

3 INTRODUCTION

3.01 NWT and NU Mine Health and Safety Act and Regulations: require all personnel be adequately trained to do their jobs safely, inspect their worksite or machinery and understand the lock out procedure and fire prevention apparatus and use.

4 RESPONSIBILITY

4.01 See procedure.

5 DEFINITIONS

5.01 **Acceptable Environmental Conditions**: The conditions which must exist from the employee to safely enter and perform work within a confined space.

5.02 **ACGIH**: American Conference of Governmental Industrial Hygienists devoted to the administrative and technical aspects of occupational and environmental health.

5.03 **Air Quality Tester**: A trained person that performs the requisite pre-entry and ongoing atmospheric testing and monitoring for safe confined space entries.

5.04 **Asphyxiation**: Suffocation from insufficient oxygen in the air, airway obstruction, or loss of pulmonary functions.

5.05 **Atmosphere**: Refers to the gases, vapors, mists, fumes and dusts within a confined space.

5.06 **Atmospheric Testing**: Pre-entry testing by a competent person using a calibrated direct-reading instrument to measure (in sequence) oxygen content, flammable gases and vapors, and toxic air components. As contaminants can stratify at different levels, the entire confined space must be evaluated remotely. If measurements indicate that the atmosphere is within acceptable limits, the entry may proceed. If not, ventilation or respiratory protective equipment must be provided, or entry is prohibited.

5.10 **Atmospheric Monitoring**: Continuous using a calibrated direct-reading instrument to verify acceptable atmospheric conditions for entrants. Alarm conditions pre-empt an entry. Re-entry is not permitted until the cause of the alarm is identified and corrected, and the confined space has been re-evaluated and the entry permit is re-issued.

5.11 **Available Rescue**: The emergency services team for rescue assistance which is available to respond immediately upon request.

5.12 **Blanking**: The absolute closure of adjacent piping by fastening across its bore, a solid plate or cap that completely covers the bore and that is capable of withstanding the maximum pressure of the adjacent piping.

HOPE BAY SAFE WORKING PROCEDURES			
Division:	Operations		
Section:	IV-0003		
Subject:	Confined Space Entry & Work		
Owner:	Safety Manager	Effective Date:	July 2019
Revision:	B	Replaces:	March 2018

5.13 **CS Attendant**: A worker trained and competent in the recognition of confined space hazards and exposure symptoms. Stationed at the entrance of the confined space to monitor and record the entry and exit of permitted workers, and initiate the emergency response when required.

5.14 **Cold Work**: Work that cannot produce a source of ignition. Examples of cold work include valve adjustment and brush painting. Cold work may be performed provided the atmospheric concentration of flammable gases and vapor is less than 10% of the lower explosive limit (LEL).

5.15 **Confined Space**: Any tank, process vessel, underground vault, tunnel or other enclosure that is not designed or intended for human occupancy and that a person would only enter if there were work to be done. It may contain potential or known hazards including oxygen deficiency/enrichments and toxins such as carbon monoxide, hydrogen sulfide.

5.16 **Contaminant**: Toxic material found as a residue in or on a person, or on an object where it is not wanted.

5.17 **Emergency Plan**: A plan that establishes guidelines for handling foreseeable confined space incidents or accidents; a prerequisite for safe confined space entry.

5.18 **Engulfment**: The surrounding and effective capture of a person by liquid or finely divided solid which could be aspirated to cause death by filing or plugging the respiratory system or which could exert enough force on the body to cause death by strangulation, constriction or crushing.

5.19 **Entrant**: A trained person authorized by the Supervisor of confined space to enter a confined space.

5.20 **Entry**: A confined space that is deemed to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.

5.21 **Entry Permit**: The written authorization from an entry supervisor for entry into a confined space for a stated purpose during a given time, which certifies that all potential hazards have been evaluated and are controlled. The Supervisor and the entrants shall review and sign the entry permit prior to the confined space entry. A competent person who performs atmospheric testing shall also sign the entry permit.

5.22 **General Ventilation**: A system that introduces fresh air into a confined space and relies on its movement to mix with, dilute, and displace air contaminants.

5.23 **Hazardous Atmosphere**: An atmosphere presenting a potential for death, disablement, injury or acute illness from one or more of the following:

a. The presence of less than 19.5% or more than 23% oxygen by volume.
b. The presences of a flammable gas, vapor, and/or mist in excess of 10% of its lower explosive limit (LEL).
c. A concentration of airborne combustible dust that obscures vision at a distance of 5 feet or less.
d. A concentration of any, corrosive, or asphyxiate substance above the permissible exposure limit (PEL) or above the numerical limit given for the substance in the current ACGIH TLV booklet.
e. Any condition that is known to present a safety or acute health hazard or is immediately dangerous life or health (IDLH).

5.24 **Hot Work**: Welding, oxy-fuel gas cutting, burning, heating, grinding, or the use of live electrical devices or operations involving actions or materials that can provide a source of ignition in a

HOPE BAY SAFE WORKING PROCEDURES			
Division:	Operations		
Section:	IV-0003		
Subject:	Confined Space Entry & Work		
Owner:	Safety Manager	Effective Date:	July 2019
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confined space. Hot work shall proceed only under acceptable environmental conditions (i.e. 0 % LEL) and competition of hot work permit.

5.25 **Inerting**: Rendering an atmosphere in a confined space non-flammable, non-explosive or otherwise chemically non-reactive by displacing or diluting the original atmosphere with an inter gas such as argon or nitrogen.

5.26 **Isolation**: A process whereby a confined space is removed from service and completely protected from inadvertent release of material or startup of any power source.

5.27 **Lower Explosive Limit**: The lowest concentration of a flammable gas or vapor which will ignite and burn in the presence of an ignition source.

5.28 **Purging**: A method by which gases, vapors or other air contaminants are displaced from a confine space.

5.29 **Rescue**: Moving an incapacitated person from a location inside the confined space to a safe location outside the confined space.

5.30 **Rescue Team**: Rescue professionals or a designated team of employees who have current qualifications in standard first aid, CPR, the use of SCBA's and are trained and equipped to perform external and internal confined space rescue work.

5.31 **SCBA**: Positive pressure supplied air respiratory protection required for entry into atmospheres that are immediately dangerous to life (IDLH). Positive pressure SCBA's provide the highest level of protection against airborne contaminants and oxygen deficiency.

5.32 **Threshold Limit Value (TLV)**: refers to airborne concentrations of chemical substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, over a working lifetime, without adverse health effects.

5.33 **Toxic Atmosphere**: Any atmosphere where the level of air contaminants exceeds OHSA permissible exposure limits (PEL) ACGIH threshold limit values (TLV) or NIOSH recommended exposure limits.

6 REFERENCES AND RELATED DOCUMENTS

6.01 NWT Safety Act and Regulations:

6.02 Hope Bay Contracting Safe Welding, Burning and Cutting procedure

6.03 Hope Bay Lock-Out Removal procedure

6.04 Hope Bay Managing Control of Hazardous Energy Lock-Out Program

6.05 Hope Bay Respiratory Protection Program

6.06 Hope Bay Working Alone procedure

7 PREPARATION

7.01 **TOOLS**: PPE, Rescue Equipment, Communications Equipment, Gas Tester, Oxygen Tester

7.02 **HAZARDS**: Injury, Fatality, Slips, Trips, Falls.

7.03 **REQUIREMENTS**: THA Training, Safe Working Procedure, Confined Space Permit, Atmospheric Testing

AGNICO EAGLE HOPE BAY	HOPE BAY SAFE WORKING PROCEDURES		
Division:	Operations		
Section:	IV-0003		
Subject:	Confined Space Entry & Work		
Owner:	Safety Manager	Effective Date:	July 2019
Revision:	B	Replaces:	March 2018

8 PROCEDURE

8.01 General

- Confined space entry is not permitted until the confined space permit has been completed and posted at the work site.
- Prior to allowing any work or entry into a confined space air quality in the confined space must be tested by a qualified person. Results of these tests will be recorded on the **Confined Space Permit**. The result will be reviewed with all employees involved and the supervisor in charge.
- Testing will include, but not be limited to, tests for harmful vapors, gases, fumes, dusts and oxygen content. Evaluations for heat stress potential will be performed when required.
- No entry into any Confined Space is permitted until:
    - A Confined Space Permit is completed.
    - All Employees have reviewed all the hazards associated with the particular task.
    - All atmospheric testing has been completed.
    - Ventilation is in place when required.
    - The flammable limit does not exceed 20% of the lower flammable limit.
    - All ignition sources have been eliminated where necessary.
    - All protective equipment is available and being worn by workers.
    - The permit is posted at the job sit.

8.02 The Health and Safety Manager Shall Ensure That:

- All confined spaces are identified.
- All employees use lifelines and safety belts for all work performed in a confined space that are IDLH (immediately dangerous to life and health).
- Guards / safety watch are positioned outside the confined space as required.
- Where the use of lifelines is not feasible, two guards will be positioned and be fully equipped with self-contained breathing apparatus or an air supplied system equipped with an emergency escape air bottle.
- Effective means of communications/contact between workers is made available.
- All pipes are blanked, sealed or secured in such a way as to prevent any harmful substances from entering the confined space.
- All relevant electrical equipment has been properly locked out.
- All employees are fully trained in confined space work and fully competent for the tasks at hand.
- Appropriate SCBA's and persons trained in use of the equipment must be available for when persons are working in a confined space.

8.03 Prerequisites

- All personnel, workers and contractors must be familiar with all chemical safety information associated with completion of this procedure.
- Must have proper and adequate training for entry into confined spaces

Note: Additional chemical information may be found in the MSDS.

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8.04 **Precautions**

- All personnel, workers and contractors are cautioned that at no time should they proceed with or continue a confined space entry if they believe that any unsafe condition exists.
- Air ventilation, forced-air ventilation used to control hazardous atmosphere may actually create an explosive atmosphere by changing the air-to-fuel ration.
- Entry into a confined space occurs when any part of a person's body breaks the plane of the opening into the confined space.
- All access points to confined spaced shall be posted with signage that states "Danger Permit Required Confined Space Do Not Enter".
- Unauthorized entry into any confined space is prohibited. Prevention of unauthorized entry will be made through training and posting of signs. Any person observing unauthorized entry or unsafe work in or around a confined space shall warn the workers performing the work of the perceived hazards and immediately notify their supervisor.
- In the event of a main power failure. All entrants must evacuate the confined space until alternate power is provided, or the main power is restored.

8.05 **Hazardous Atmosphere**

- To reflect the relative hazards, and to ensure a consistent approach, confined space entries have been classified into Class A, B and C. The classifications of the entry shall be based on the conditions present at the time of entry with consideration for potential changes of conditions ad identified in the hazard assessment.

Note: As per OH & S Code, a person must not enter or work at a work area if more than twenty (20) percent of the lower explosive limit of a flammable or explosive substance is present in the atmosphere.

<u>Class A (High Hazard)</u>

- A confined space will be considered Class A if the hazards in the confined space or in its proximity are either not known or have not been determined.
- The hazards in the confined space included on or all of the following:
  - Oxygen concentration is less than 19.5% or more than 23% by volume,
  - Explosive or flammable atmosphere between 10% and 20% Lower Explosives Limit (LEL), and
  - The area atmosphere exceeds the protective limits of air purifier respiratory equipment.
- The following controls must be put in place for a Class A classified area:
  - All entrants and monitors must be trained in the use of supplied breathing air equipment,
  - Supplied breathing air available and worn,
  - A confined space attendant in attendance at all times,
  - Two persons shall be stationed outside the confined space and visually check on those persons inside the confined space at frequent intervals, and shall be equipped for and capable of performing a rescue.
  - A specific rescue plan which has been reviewed and approved,
  - A valid confined space entry permit, and
  - An evacuation plan.

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<u>Class B (Medium Hazard)</u>

- A confined space will be considered Class B if all hazards are controlled and the oxygen concentrations are between 19.5% and 23% volume.
- Either of the following exists or is likely to exist:
  - Explosive or flammable atmosphere, less than 1% of the Lower Explosive Limit (of 10% LEL), or
  - The concentration of toxic substances exceeds 50% of the Occupational Exposure Limit (OEL)
- The following controls must be put in place for a Class B classified area:
  - An approved hazards assessment
  - A confined space attendant in attendance at all times
  - Two persons shall be stationed outside the confined space and visually check on those persons inside the confined space at frequent intervals, and shall be equipped for and capable of performing a rescue.
  - A valid confined space entry permit
  - An evacuation procedure, and
  - A valid rescue plan

<u>Class C (Low Hazard)</u>

- A confined space will be considered Class C if all identified hazards if all identified hazards are controlled, the potential for change is unlikely, and all of the following apply:
  - Oxygen concentration is between 19.5% and 23% by volume.
  - Concentration of explosive gases are 0% LEL.
  - Airborne concentrations of toxic substances are less than 50% of OEL.
- The following controls must be put in place for a Class C classified area:
  - Will require an approved hazard assessment,
  - A confined space attendant may be required,
  - A valid confined space entry permit, and
  - An evacuation procedure, and
  - A valid rescue plan.

8.06 **Forced Air Ventilation**

- If feasible, continuous forced air ventilation shall be used to inert or eliminate the hazardous atmosphere in the confined space during occupancy, until all personnel have vacated the confined space.
- The air supply for the forced air ventilation shall be from a clean source equivalent to clean breathable air. Clean breathable air is equivalent to clean outdoor air and contains 20.9% oxygen, 0% LEL or LFL and air contaminants if present is less than 10% of the regulatory occupational exposure limits.

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8.07 **Atmospheric Testing**

- Atmospheric testing shall be performed only be personnel trained in the use of testing equipment.
- The entrant(s) or representatives must be allowed to observe the testing if requested.
- Testing equipment shall be direct-reading and calibrated according to manufacturer's recommendation.
- Testing equipment shall be fresh-air tested prior to use.
- When monitoring for entries involving a descent into atmospheres that may be stratified, the atmospheric envelope should be tested a distance of approximately 4 feet in the direction of travel and to each side.
- If sampling probes are used, the entrant's rate of progress should be slowed to accommodate the sampling speed detector response.
- Pre-entry testing shall be conducted no longer than 20 minutes before initial entry, and when confined space has been vacated longer than 20 minutes.
- If a confined space is known, or shown by pre-entry testing to contain other than clean breathable air, the hazard must be controlled by cleaning, purging, or venting the space and the atmosphere must be retested before a worker enters the space.
- During occupancy of the confined space, testing shall be repeated periodically where there is potential for accumulation of the hazardous atmosphere. Testing frequency shall be determined by the CS team.
- Pre-entry testing is not required in "low hazard atmospheres" when the location and the control of the space ensure that a more hazardous atmosphere could not in-advertently develop.

8.08 **Confined Space Entry**

- Prior to into a confined space, a CS permit must be prepared for that confined space and reviewed by the CS team assembled for that entry.
- All of the items contained in the CS entry permit will be fulfilled; the written permit completed and signed by the appropriate personnel prior to any entry.
- After the confined space entrance covers are removed, the opening shall be promptly guarded by railing, temporary cover or other barriers to prevent accidental fall through the opening.
- The confined space is prepared as per requirements of the permit (prepared by the confined space team for the job).
- The confined space is prepared as per requirements of the permit (prepared by the confined space team for the job).
- The confined space atmosphere is pre-tested and re-tested as pre the previous section.

8.09 **Restrictions**

- No entry is permitted into a confined space with LEL more than 20 % per volume of air (refer to part 8.05 Hazardous Atmospheres.
- Entry into Immediately Dangerous to Life and Health (IDLH) atmosphere is prohibited unless approved by the Project Manager or their designate. Authorized personnel, workers and contractors must be properly trained, certified and deemed competent working in IDLH atmospheres.

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- If hazardous atmosphere is detected during occupancy, the confined space must be evacuated immediately, the source of the hazard identified and measures implemented to protect personnel, workers and contractors before any subsequent re-entry.
- A new permit will be required if the entry purpose changes or entry duration is exceeded.
- The completed Confined Space Entry Permit shall be made available to all entrants and posted at the entry point. Once work is completed, the confined space will be vacated, sealed and the lock out will be removed, the confined space team will initial the permit and return it to the Supervisor to keep in the office for a minimum of two years.

8.10 Lock-Out and Isolation

- Before a worker enters a confined space, any material conveyance equipment that transports material to or from the space must be free of material if the materials could present a hazard.
- Before a workers enters a confined space, adjacent piping which contains or has contained a harmful substance must be controlled by the following means:
  - Disconnecting, blanking, blinding or equivalent engineering system,
  - If the adjacent piping contains a harmful substances that is not gas or a vapor, nor a liquid of sufficient volatility to produce a hazardous concentration of an air contaminant in the discharge of the piping, double block and bleed system is needed.
  - If the adjacent piping contains or has contained a substance that is hazardous only because of its pressure, temperature or quantity, before a worker enters the space, the pressure must be controlled by de-energizing and locking out the pressure source and depressurizing the line.
  - Isolation of a confined space from gases found in a gravity-flow municipal or domestic sanitary or storm sewer system may be accomplished by a p-trap provided that the integrity of the trap is ensure immediately upon entry and the atmosphere is continuously monitored and shown to contain clean breathable air.

8.11 Training

- Confined space training shall address the following:
  - The Confined Space Entry course including responsibilities of all involved with the confined space entry.
  - Confined Space Identification and Hazards Recognition.
  - Atmospheric Testing.
  - Communication, including the use of equipment available at the site.
  - Permit System, Confined Space Permit, Equipment Isolation, Hot Work Permit, etc.
  - PPE, including respiratory protection.
  - Equipment Isolation Standard.
  - Rescue Awareness.
- Confined Space Rescue training shall consist of the following:
  - Understanding of rescue duties and entrant duties.
  - Proper use of rescue equipment.
  - First Aid and CPR.
  - Rescue personnel shall practice rescue at least once every twelve (12) months.

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8.12 **Rescue and Emergency Services**

- The employer must provide for the services of rescue persons when a worker enters a confined space. If these rescue persons are employees of another firm, or an agency such as a fire department, there must be a written agreement detailing the services that are to be provided.
- Before a worker enters a confined space, the Supervisor of confined space of the confined space or the CS Attendant must notify the safety department of work in the space.
- The Supervisor of confined space of the CS Attendant must notify rescue personnel when all workers have completed their work and exited from the space.
- The employer must ensure rescue personnel monitor the signaling system that will be used to summon the rescue persons in the event of an emergency whenever they have been informed by the Supervisor of confined space or CS Attendants that a confined space entry is in progress.
- Rescue or evacuation from a confined space must be directed by a supervisor who is adequately trained in such procedures or a qualified rescue person.
- If an equipment isolation permit is used in conjunction with a confined space permit, the rescue team shall place their locks on the lock box or the individual isolation per the equipment isolation procedure. The team must survey the scene to determine what hazards are present and take all necessary precautions to render the confined space prior to entry.
- Effective voice communication must be maintained at all times between workers engaged in the rescue of the evacuation and the persons directing the rescue persons.
- A rescue worker must not enter a confined space unless there is at least 1 additional worker located outside to render assistance.
- A self-contained breathing apparatus (SCBA) or air supplied respirator with escape bottle must be used during rescue operations in an unknown IDLH atmosphere.

8.11 **Non-Entry Rescue**

- Non-entry rescue by means of retrieval shall be used whenever an authorized entrant enters a confined space, unless the retrieval equipment would increase the overall risk of entry, and there is possibility that the retrieval line may become entangled or broken in the course of rescue.
- Retrieval system shall meet the following requirements:
  - Each authorized entrant shall use a full body harness, with a retrieval line attached at the center of the entrant's back near shoulder lever, above the entrants head, or at another point which presents a profile small enough for removal.
  - The other end of the retrieval line shall be attached to a mechanical device or fixed point outside the confined space.
  - A mechanical device shall be available to retrieve personnel, workers and contractors from a vertical type confined spaces more than 5 feet deep.
  - Rescue procedures shall comply will all Work Safe Fall Protection Standards, HRN Standards and Provincial/Territorial Standards.

Note: Rescue procedures must apply every possible effort to eliminate, control or reduce the risk to emergency personnel responding to emergency situations including the use of mechanical ventilation.

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9 ATTACHMENTS

CONFINED SPACE PERMIT SIGN-IN/OUT SHEET FOR EMERGENCY RESPONSE

ATTACH TO THE CONFINED SPACE PERMIT

By my signature, I verify that I understand and will comply with the practices, procedures, and requirements of the Confined Space Program.

Date	Name (Printed)	Signature	Time In	Time Out

The purpose of this for is to provide a standardized method for maintaining an accurate, real time tracking of entrants in a confined space. Maintaining an accurate log will enable emergency response/rescue personnel to know precisely who and how many entrants are in a confined space at a given time. The use of this form only becomes necessary when different entrants other than those initially identified on the permit are involved at the entry activity.

HOPE BAY EMERGENCY RESPONSE PLAN

HOPE BAY, NUNAVUT

Appendix K: Severe Weather Conditions Procedure

HOPE BAY STANDARD OPERATING PROCEDURE			
Title:	Severe Weather Conditions Procedure		
Document #:	III-0009		
Owner:	Health and Safety Manager	Effective Date:	November 25, 2018
Revision:	A	Replaces:	February 4, 2018

1. PURPOSE

Ensuring the safety of all employees and contractors by limiting or curtailing employee movement and activity during extreme weather conditions.

2. INTRODUCTION

This procedure was created to ensure the safety of all employees and contractors during periods of extreme weather conditions.

3. SCOPE

This procedure applies to all activities, facilities, equipment, processes, employees, contractors, and vendors at the Hope Bay site. As weather conditions change, it is the responsibility of all employees to be aware, monitor these changes, and report the conditions to their direct supervisor. When the General Manager or Designate deems conditions unsafe, a "White-Out" will be declared.

4. RESPONSIBILITIES

Mine General Manager:

a. Ensures the requirements of this procedure are applied and maintained.

Department Managers, Superintendents and Supervisors:

a. Ensure their employees are familiarized with this procedure.
b. Ensure that all mobile equipment traveling between the accommodation complex and the work locations are equipped with radio communications compatible with the site receivers/transmitters.
c. Install compatible base-radio communication at each work site,
d. Supply food and water rations to sustain each crew for a forty-eight (48) hour period at camp.
e. Provide sufficient fuel to maintain heat for personnel and run auxiliary equipment for a forty-eight (48) hour period at camp.
f. Install survival packs in all mobile equipment.
g. Install survival packs at remote work sites.
h. Providing equipment and manpower to assist on the rescue or movement of personnel when required

Employees (including Contractors):

a. Understand and practice this procedure; and

b. Ask their supervisor for clarification if they are unsure of any aspect of this procedure.

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Joint Occupational Health and Safety Committee (JOHSC) provides input during the periodic review of this procedure.

5. DEFINITIONS

5.1 **White-Out**: A weather condition in which the features of snow-covered land are indistinguishable due to uniform light diffusion. An atmospheric condition in which clouds over snow produce a uniform whiteness reducing the visibilities to near zero.

5.2 **FWO (Flight Weather Outage)**: Where weather conditions are below established flight standards.

5.3 **GWO (Ground Weather Outage):** Where weather conditions are of a nature that reduces visibility (elevated winds, fog, blowing snow, blizzard conditions). Decreasing temperatures that compromise equipment effectiveness, and expose field workers to extreme cold temperatures (example: <-50°C).

5.4 **SWO (Site Weather Outage)**: To be called when weather extremes prevent the ability to Safety manage a medevac event (example: aircraft unable to land or take off).

5.5 **GWA (Ground Weather Advisory) Level 1**: A weather advisory where visibility is less than 100 feet (30 meters) and/or decreasing ambient temperatures are being observed. Proceed with normal work with extreme caution.

5.6 **GWA (Ground Weather Advisory) Level 2**: A weather advisory where visibility is less than 50 feet (15 meters) and/or decreasing ambient temperatures are being observed. Proceed with **ESSENTIAL** work with extreme caution.

5.7 **GWA (Ground Weather Advisory) Level 3**: A weather advisory where visibility is less than 10 feet (3 meters) and/or outside ambient temperatures may compromise equipment effectiveness and unnecessarily expose field workers to extreme temperatures. All outside work is suspended and essential services work to proceed under a plan review by the site weather advisory team. Underground operations proceed with caution.

5.8 **Blizzard:** Blizzard is a weather condition characterized by low temperatures and strong winds bearing large amounts of dry snow particles, which can reduce visibility to only a few meters. Storm systems powerful enough to cause blizzards usually form when the jet stream dips far to the south, allowing cold air from the north to clash with warm air from the south.

5.9 **Freezing Rain:** Freezing rain occurs when rain droplets fall into an above freezing layer of atmosphere and then into a shallow layer of cold air near the earth's surface. Upon striking a cold object, these super cooled droplets form a thin layer of ice. Lower elevations are more vulnerable to damaging accumulation of ice since cold air naturally settles into them. Freezing rain has the potential of causing hazardous weather conditions for travelers. Rain can freeze on any object it contacts, that is below freezing (example: rocks, aircraft, walkways etc.)

5.10 **Fog**: Fog is simply a cloud that touches the ground. A cloud is composed of millions of tiny, liquid water droplets. In order for fog to form, there has to be the presence of a moist air mass, a cooling process, and light winds. Fog is usually associated with fair and calm weather, but the reduced visibility may prevent flights from arriving or departing from site. Meteorologists report thick fog when the visibility is less than one kilometer.

5.11 **Snow Squalls:** Snow squalls or Lake effect snow is the result of cold air blowing over a relatively warm body of water. As the air moves over the water, it picks up heat and moisture. When it gets to the colder land, it is forced to drop this moisture in the form of snow. The

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squalls can carry strong winds and produce significant accumulations of snow, reducing visibility and making roads slippery.

5.12 **Coastal Fog:** Fog will be expected to form near the shoreline, and may cause reduced visibility on/near the shore.

5.13 **Visibility Parameters:** The distance at which a given object can be seen and identified with the unaided eye in certain conditions (heavy precipitation, fog, blowing snow, etc.).

6. REFERENCES AND RELATED DOCUMENTS

6.1. NWT Safety Act and Regulations

7. PREPARATION

7.1. **TOOLS:** PPE, Radio, Survival Kit

7.2. **HAZARDS:** Cold Stress, Collision, Frost Bite, Slips, Trips, Falls, Death

7.3 **REQUIREMENTS:** Proper Extreme Weather Training

8. PROCEDURE

8.1 When the employees observe weather conditions to be changing, they will report the condition to their supervisor.

8.2 The supervisor will relay the information of the employee concerns of deteriorating weather conditions to the Site Services Supervisor who will assess the situation and provide feedback to the employees.

8.3 The Site Services Supervisor will inform the General Manager or Designate of the deteriorating weather conditions that it is unsafe to continue working or traveling, the General Manager or Designate will determine the declaration of a "White-Out".

8.4 The Site Services Supervisor will broadcast the "White-Out" on all radio channels.

8.5 All movement of mobile equipment or people during the "White-Out" condition must be approved by the Site Services Supervisor.

8.6 All camps, worksites, vehicles and stranded mobile equipment operators must report to their supervisor if they are unable to muster to a safe location during the white out event.

8.7 A logbook will be kept by the Health and Safety Department recording the dates and times of all "White-Outs", and record any events, situations or remedial actions taken.

8.8 The General Manager or Designate will be responsible for organizing manpower and support vehicles, which may be required during the "White-Out" period.

8.9 As time passes, employees will keep the Site Services Supervisor informed and he/she will give updates to the General Manager or Designate every hour as well as broadcast the updates on all radio channels.

8.10 When the white out conditions have ceased the Site Services Supervisor will broadcast a message to all channels indicating that "White-Out" conditions have ceased.

HOPE BAY EMERGENCY RESPONSE PLAN

HOPE BAY, NUNAVUT

Appendix L: Hope Bay Emergency Response Team Standard

Emergency Response Team Standard

February 5, 2021

Agnico Eagle Hope Bay in an effort to ensure the health and safety of all personnel on site, has set the following standards that shall be in effect before an individual will be considered for acceptance into the Hope Bay Emergency Response Team (ERT) Membership. Adherence to this standard will provide a concrete framework that ensure consistent methods and requirements for emergency response, training and membership.

MEMBERSHIP REQUIREMENTS

All individuals seeking membership whether through introductory training or inter-provincial/territorial transfer shall have been in continuous employment with Agnico Eagle, or KCMD no less than 90 days.

Candidates must have the potential for developing into a competent member of a mine rescue team and have both the mental and physical qualifications. Members of mine rescue teams should be:

- not younger than 18 years of age;
- in good health and physically fit;
- clean-shaven daily, with no facial hair to interfere with the facemask seal;
- calm and self-controlled in emergency and danger;
- of good judgement and initiative;
- capable of performing long and arduous physical labour;
- familiar with working environment;
- a holder of a valid Standard First Aid Certificate from a recognized training provider;
- able to follow directions and communicate in the language of the operation.

All individuals seeking membership whether through introductory training or inter-provincial/territorial transfer shall have completed a Medical Assessment by the Hope Bay Physician Assistant within 90 days of registration or transfer.

All individuals seeking membership through inter-provincial/territorial transfer that possess a current Northwest Territories Surface or Underground Mine Rescue Certificate with no more than one (1) year between training periods, a current Standard First Aid Certificate and has completed a Hope Bay Medical Assessment may attend regular scheduled ERT training.

All individuals seeking membership through inter-provincial/territorial transfer that possess a current Surface or Underground Mine Rescue Certificate with no more than one (1) year between training periods. May apply to take the Nunavut Surface / Underground Mine Rescue Exam. After successful completion of the Nunavut Surface / Underground Mine Rescue Exam. The Individual will be issued a Nunavut Surface / Underground Mine Rescue Certificate.

All individuals seeking membership through inter-provincial/territorial transfer that possess an expired Surface or Underground Mine Rescue Certificate with more than five (5) years between training periods. Must apply for retraining through the Hope Bay Introductory

Nunavut Surface / Underground Mine Rescue Training Program. After successful completion the individual will be issued a Nunavut Mine Rescue Certificate.

TRAINING STANDARDS

ERT training session will consist of either an eleven (11) hour training sessions or two (5.5) hour training sessions. The Emergency Response (ERT) Coordinator with the approval of the Health & Safety Manager or designate may modify this schedule based on site or team needs.

All ERT members must complete a minimum of fifty-five (55) training hours annually to maintain active membership. If an ERT member receives less than fifty-five (55) training hours annually the ERT member will be removed from Active Status and moved to Current Status as per the WSCC Mine Rescue Training Standards.

All individuals attending ERT training shall be clean shaven. Any exceptions must be approved by the Physician Assistant and ERT Coordinator.

All ERT members must complete the following training that is not included in regularly scheduled mine rescue training.

- Annual Medical Assessment
- Basic / Introductory Mine Rescue Training
- Mill Orientation
- U/G Orientation
- Respirator/Facepiece Fit Testing
- WHIMIS
- Fall Protection Training (Every Two Years)
- Confined Space Training (Every Two Years
- Site Driver's Training
- Annual Audiometric Testing
- First Aid Training (Every Three Years)
- Lock-out Tag-out (LOTO) Training

Specialty training that may occur for some ERT members will not be included as regular training hours.

- Firefighter 1
- Firefighter 2
- Spill Response
- Hazmat
- Ice Water Rescue
- Nunavut/NWT Mine Rescue Competition

REGULAR SESSION SCHEDULING

Regular mine rescue training shall be scheduled quarterly. Each ninety (90) day schedule shall be posted in advance of the first scheduled training date. The ERT Coordinator shall be responsible to ensure the accuracy of the training schedule taking into account member rotations, shifts, vacation and external training.

Each quarterly schedule shall be approved by each department manager or designate. Once approved, any personnel changes to the schedule must be made in advance via the Training Exemption Form and a suitable replacement must be provided to take the vacant trainee's place.

Each ERT member shall receive a copy of the quarterly training schedule for their reference If an ERT member wishes to change the date of their regular training, it is the responsibility of the ERT member to find an alternate trainee to switch training dates with.

ERT MEMBER RESPONSIBILITES

Each ERT member shall be responsible to attend the training date which they have been scheduled.

Each ERT member is responsible to tag-in on the ERT board in the main hallway at the start of each rotation, and tag-out on the last day of each rotation.

Each ERT member shall maintain and have access to the required PPE for both an underground and surface emergency response. If PPE is not available then the ERT Coordinator shall be notified to provide assistance in obtaining the appropriate PPE.

Each ERT member shall be responsible for the monitoring and maintenance of their personal emergency pager. Including the following;

- charge of the battery;
- physical condition/cleanliness;
- reporting of damage or malfunction to the ERT Coordinator in a timely manner;
- Monitoring at all time as is practical for the initiation of emergency codes;
- Responding to emergency codes in a responsible and timely manner.

Each ERT member shall respond to the following code as descried.

- 911 - Site emergency, report to the Mine Rescue Room.
- 111 - Test page, no additional response is required.
- 103 - Test page, call phone ext. #103 to confirm that the test page was received.
- 222 – Test page, this is a timed drill. Respond to the mine rescue room and prepare emergency equipment as directed by the ERT Coordinator.

When an ERT member is unable to perform their responsibilities they must communicate with the ERT Coordinator that they require assistance in the application, understanding or interpretation of their responsibilities.

ON SITE ERT REQUIRMENTS

Hope Bay management shall maintain a minimum of ten (10) ERT personnel on site to respond to a site emergency at all times. With the ability to provide additional mine rescue teams through a mutual aid agreement with neighbouring mines.

HOPE BAY EMERGENCY RESPONSE PLAN

HOPE BAY, NUNAVUT

Appendix M: WSCC Mine Rescue Training Standards

WSCC Workers' Safety & Compensation Commission

Mine Rescue Training Standards

Every mine has to maintain a mine rescue team to help ensure the safety of workers and property on mine sites. The objectives of mine rescue are to find and rescue trapped miners, find and extinguish fires and examine mines for noxious gases.

This standard applies to all mines where employees are expected to conduct work and includes areas where mining is to take place including exploration drilling/sampling activities, open pit operations, tunnels, adits, ramps and shafts as well as structures at remote areas.

This standard is based on the legislative authority of the *Mine Health and Safety Act and Regulations for the Northwest Territories/ Nunavut (NT/NU).*

PART 5 MINE EMERGENCIES

Mine Rescue Stations and Equipment

8.52. Mine rescue stations shall be established, equipped, operated and maintained at every operating mine as directed by the chief inspector.

8.53. (1) The manager shall appoint a person who is qualified in mine rescue instruction to be responsible to maintain the mine rescue equipment in good and serviceable condition at all times and to train mine rescue teams.

(2) The manager shall appoint a person under subsection (1) who holds a valid mine rescue instructor's certificate issued by the chief inspector.

8.56. The manager shall ensure that

(a) a sufficient number of qualified persons are trained as mine rescue team members;

(b) a sufficient number of qualified persons who are trained as mine rescue team members are readily available at the mine when persons are normally at work in the mine; and

(c) at least two teams, or such other number of teams as may be required by the chief inspector, are readily available to get to the mine when persons are normally at work in the mine.

Survival Rescue Procedures

8.73. The manager shall ensure that all persons who are required to work underground are

(a) trained in survival rescue procedures, including the use of self-rescue apparatus acceptable to the chief inspector; and

(b) retrained annually.

Instructor Emergency Procedures

8.74. The manager of an open pit mine shall appoint a qualified person to instruct and train personnel in emergency rescue techniques.

Surface Emergency Situations

8.75. The manager of a surface mine shall ensure that properly maintained equipment and trained personnel are available to respond to a fire, explosion, or dangerous incident while the mine is in operation.

PART XII FIRE PROTECTION

Fire Fighting

12.01. (1) The manager shall ensure that a fire risk assessment is carried out not later than March 31 in each calendar year for all parts of the mine, both underground and surface, and the assessment shall

(c) identify the need for fire protection and the type of fire protection that should be provided; and

(d) set out measures to be taken to reduce the hazard from fire, including

(i) equipment design,
(ii) adequate maintenance of equipment,
(iii) proper training,
(iv) evacuation procedures,
(v) use of detection and early fire warning devices,
(vi) type of fire suppression equipment, and
(vii) means of egress from a worksite.

12.03. (1) The manager shall ensure that the following training in firefighting is carried out under the direction of a qualified person:

(a) all persons newly employed at a mine shall be given instruction in the use of firefighting equipment during the first week of employment;

(b) all persons regularly employed underground shall receive a refresher course in the use of firefighting equipment;

(c) the manager shall ensure that a suitable number of employees are trained in firefighting techniques and those employees shall attend at least 20 hours of training annually.

(2) The qualified person appointed by the manager to carry out the training required under subsection (1) shall record all drills and practices and the name of each person in attendance.

PART XV EXPLORATION

15.02. (1) Before any exploration activity is commenced, the owner shall submit to the chief inspector

(b) a safety program concerning the health and safety of persons employed in the exploration activities that includes

(ii) procedures for first aid and prevention of hypothermia,
(iii) procedures for dealing with fire hazards,

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Minimum Standards

There are incidents and emergencies where Mine Rescue teams must respond. This may include rescue of trapped miners, extinguishment of fires, examination of mines for noxious gases, electrical fires, gas leaks, avalanches, and motor vehicle accidents. Mine Rescue can be dangerous work, especially if it is not performed properly. Some responses will require that Emergency Response Teams attend to casualties in need of assistance however; the rescuer's first responsibility is for personal safety and the safety of their team.

The minimum standards for Mine Rescue Certification Training which mining operations must meet are:

1. Mine Managers will have qualified trainers that are certified to deliver Mine Rescue Certification Training.
2. Mine Managers will ensure the delivery of Mine Rescue Training meets the Standard for Mine Rescue Certification Training.
3. Mine Managers are responsible for the testing of trainee competencies and maintenance of training records after all components of training are completed. These records must be maintained on site for as long as the workers are employed.
4. The WSCC will issue certificates of competency to each person successfully completing an approved course in the use and maintenance of mine rescue equipment delivered by qualified trainers.
5. Mine Managers shall ensure that required Mine Rescue Training is provided.
6. The WSCC will conduct audits periodically to ensure the Mine Rescue Training Standard for Mine Rescue is being followed. The audit will include the equipment and maintenance of mine rescue equipment at the site.
7. Mine Managers for underground mines will ensure as a minimum, three fully-outfitted, five-person teams (15 people) for each property. There must be a minimum of 10 trained mine rescue people on surface when a team is underground.
8. Mine Managers for surface mines will ensure a minimum of 10 trained mine rescue people for response on surface at all times.
9. Mine Managers will ensure that arrangements are made with other established mining operations for mine rescue mutual aid.
10. The Chief Inspector must be notified of the arrangements for mutual aid.

General Requirements for Mine Rescue Certification Training

The medical and psychological fitness of a worker should be evaluated prior to training for mine rescue. Workers and supervisors to be trained in the use and maintenance of mine rescue equipment must meet the following criteria:

1. Complete the baseline examination for medical requirements following the current CSA standard "Selection, Use and Care of Respirator". Applicants must be examined by a medical professional and certified fit for mine rescue training and if accepted, annually while they remain in active training.
2. Candidates must have the potential for developing into a competent member of a mine rescue team and have both the mental and physical qualifications. Members of mine rescue teams should be:
    a. not younger than 18 years of age;
    b. in good health and physically fit;
    c. clean-shaven, with no facial hair to interfere with the facemask seal.
    d. calm and self-controlled in emergency and danger;
    e. of good judgement and initiative;
    f. capable of performing long and arduous physical labour;
    g. familiar with working environment;
    h. a holder of a valid Standard First Aid Certificate from a recognized training provider;
    i. able to follow directions and communicate in the language of the operation

Introductory Mine Rescue Certification Training Requirements

Introductory mine rescue certification is considered to be entry-level mine rescue training. In addition to the general requirements, potential candidates must successfully complete Basic Mine Rescue Training delivered by qualified mine rescue instructors certified by the Workers Safety and Compensation Commission (WSCC).

Introductory mine rescue training will consist of a minimum of 40 hours of training. Classroom instruction combined with practical evolutions on surface or underground is used to test candidates on theory and application of knowledge in the following areas:

1. Mine rescue organization
2. Care and use of respiratory protective equipment
3. The properties of normal air and gases encountered in a contaminated mine atmosphere
4. Oxygen therapy
5. Gas detection methods and use of gas detection equipment
6. Rope rescue
7. Environmental conditions
8. Electrical hazards
9. Rescue tools
10. Fire
11. Mine operations
12. Operation skills

The body of knowledge for reference will include The *Western Canada Mine Rescue Manual* and manufacturers' guidelines for operation of equipment, apparatus and instruments in use. To qualify for certification, participants must demonstrate a satisfactory degree of knowledge, skill; competency and proficiency in the use of mine rescue equipment and must attain a minimum of seventy percent on a written exam set by the instructor.

Maintenance of Mine Rescue Certification

Active

All **active** members of mine rescue teams must receive regularly scheduled refresher training with at least five 11-hour training sessions annually (55 hours of training/year) covering all topics to maintain their active status.

Current

To remain **current** with a mine rescue certificate, members must participate in at least 11-hours of training per year.

AGNICO EAGLE
HOPE BAY

Appendix

Medical Requirements

(From *CAN/CSA-Z94.4-11 Standard)*

Part 5: Respirator User's Health Conditions (check YES or NO box only. Do not specify)
(a) Some conditions can seriously affect your ability to safely use a respirator. Do you have or do you experience any of the following, or another condition that may affect respirator use? ❑ YES ❑ NO

Shortness of breath	Breathing difficulties	Chronic bronchitis	Emphysema
Lung disease	Chest pain on exertion	Heart problems	Allergies
Hypertension	Cardiovascular disease	Thyroid problems	Diabetes
Neuromuscular disease	Fainting spells	Dizziness/nausea	Seizures
Temperature susceptibility	Claustrophobia/fear of heights	Hearing impairment	Dentures
Panic attacks	Colour blindness	Asthma	Pacemaker
Vision impairment	Reduced sense of smell	Reduced sense of taste	
Back/neck problems	Facial features/skin conditions		

Prescription medication to control a condition
Other condition(s) affecting respirator use:
Δ (b) Have you had previous difficulty while using a respirator? ❑ YES ❑ NO
Δ (c) Do you have any concerns about your future ability to use a respirator safely? ❑ YES ❑NO
A "YES" answer to "a" "b" or "c" indicates further assessment by a health care professional is required prior to respirator use. NOTE: Medical information is NOT to be offered on this form.
Signature of Respirator User: Supervisor's Initials:
Date:

Part 6: Health Care Professional Primary Assessment (if required)
Assessment date:
Respirator use permitted?: ❑ YES ❑ NO ❑ UNCERTAIN
Referred to medical assessment: ❑ YES ❑ NO
Comments:

Reassessment date:

Name of Health Care Professional: Title: Signature of HCP:

Part 7: Medical Assessment (if required)
Assessment Date:

❑ Class 1. NO restrictions

❑ Class 2. Some specific restrictions apply: ______________________

❑ Class 3. Respirator use is NOT permitted.

Name of Physician: Signature of Physician:

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References

Western Canada Mine Rescue Manual

HOPE BAY EMERGENCY RESPONSE PLAN

HOPE BAY, NUNAVUT

Appendix N: Mine Rescue Mutual Aid Agreement

Mine Rescue Mutual Aid Agreement

Preamble:

The operators of the **Dominion Diamond Mines ULC, Diavik Diamond Mines (2012) Inc., De Beers Canada, Agnico Eagle Mines Ltd., TMAC Resources Inc.**, and the **Giant Mine Remediation Project** are committed to safety as a fundamental value. They each recognize that having Crisis and Emergency Response capability is essential in the event that extraordinary circumstances put human life, operational infrastructure or the environment in extreme danger. To that end each party has created a fully equipped Crisis and Emergency response capability supported by documented response procedures, highly trained personnel, and appropriate equipment and infrastructure to respond to the variety of emergencies that may occur from time to time on their respective sites.

Each Operator also recognizes that, at times, the scale of an emergency or crisis may overwhelm their individual resources; and believe that – given their geographic distance from the usual First Responders and the physical proximity of their respective sites – it is both desirable and prudent to establish terms for a combined response should such circumstances arise at one mine site or the other.

A Shared Commitment:

1. We each recognize the need to have and to maintain a strong, independent, self-contained emergency response capability.
2. We each recognize our shared commitment to the safety and preservation of life and the environment.
3. We each promise to use best efforts to respond to reasonable requests from the others to share emergency response capability when resources on the impacted site are determined to be insufficient to meet the magnitude of the emergency.
4. We each reserve the right, acting reasonably, to decline a request for such assistance if it would in any way compromise the safety and security of the people or the environment at our own site or the safety of our emergency responders.
5. We each acknowledge that assistance provided under this Agreement is voluntary and exempt from legal liability, save and except when provided in a reckless or grossly negligent manner.
6. We each accept that it is fair and proper for the responding party hereunder to be reimbursed for all reasonable costs incurred by in providing such assistance.

This Agreement is an expression of shared intent only and does not constitute a binding agreement between the parties. Signed by each party into effect on January 1, 2018.

Chantal Lavoie
Chief Operating Officer
Dominion Diamond Mines ULC

Patrick Boitumelo
President & Chief Operating Officer
Diavik Diamond Mines (2012) Inc.

Digitally signed by Rodel, Allan
DN: cn=Rodel, Allan
Date:2017.12.13 16:11:23 -07'00'

Allan Rodel
Gahcho Kué Mine General Manager
De Beers Canada

Dominique Girard
Vice President Nunavut, Operations
Agnico Eagle Mines Ltd.

Dan Gagnon
Mine General Manager
TMAC Resources Inc.

Mark Schmalz
Giant Mine Manager

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HOPE BAY EMERGENCY RESPONSE PLAN

HOPE BAY, NUNAVUT

Appendix O: Telephone Call Record Sheet

Telephone Call Record Sheet

Use one page per call

Call Taken / Made by:		Ext. No.		Date:		Time:	

Call Source: Government ☐ Media ☐ Assistance Offer ☐ Other ☐	Employee ☐ Employee: Family ☐ Public ☐

Caller Details:			
Name:			
Title / Relationship			
Organization / Department			
Phone Number:		Fax Number	
Message For:		Return call by: (Time)	

Message Information Request:

Action Required	Call Back: ☐	Send Fax: ☐	Wants Meeting: ☐	Will Call You ☐	
Actioned By:		Date:		Time:	

OPERATIONS, MAINTENANCE AND SURVEILLANCE MANUAL: HOPE BAY DORIS TAILINGS IMPOUNDMENT AREA

HOPE BAY, NUNAVUT

Appendix F – Dam Emergency Plan

Operations, Maintenance and Surveillance Manual: Hope Bay Doris Tailings Impoundment Area

Hope Bay, Nunavut

Appendix G – Trigger Action Response Plan (TARP)

								High level actions and response			
Component	**Sub-component**	**Function**	**Monitoring method**	**Parameter**	**Attribute**	**Value**	**ERP**	**Hope Bay Actions**	**Hope Bay Response**	**SRK Actions**	**SRK Response**
North Dam	Dam Structure	Containment	Inclinometer	Deformation - Displacement	0 - Normal Operating Condition	Within typical maximum of past 24 months	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
North Dam	Dam Structure	Containment	Inclinometer	Deformation - Displacement	1 - Early Warning Condition	Displacement exceeds typical maximum range of past 24 months	NO	Regular Monitoring	TNP and Work with EoR to review	data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
North Dam	Dam Structure	Containment	Inclinometer	Deformation - Displacement	2 - Corrective Action Condition	Displacement of 0.1 m per month over two survey periods (0.2 m) or greater than 0.5m total, with a credible trend	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	Inclinometer	Deformation - Displacement	3 - Critical Condition	Displacement of 0.15 m per month over four survey periods (0.6m) or greater than 1.0m total, or if strain is greater than 10% in any area, with a credible and continuous or accelerating trend. 3 or more surrounding instruments must support this.	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	Survey Monitoring	Deformation (SSP) - Displacement	0 - Normal Operating Condition	Total displacement within typical maximum range of past 24 months	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
North Dam	Dam Structure	Containment	Survey Monitoring	Deformation (SSP) - Displacement	1 - Early Warning Condition	Total displacement exceeds typical maximum range of past 24 months	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
North Dam	Dam Structure	Containment	Survey Monitoring	Deformation (SSP) - Displacement	2 - Corrective Action Condition	Vertical, horizontal or total displacement of 0.1 m per month over two survey periods (0.2 m) or greater than 0.5 m total, with a credible trend.	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	Survey Monitoring	Deformation (SSP) - Displacement	3 - Critical Condition	Vertical, horizontal or total displacement of 0.15 m per month over four survey periods (4 months) or greater than 1.0 m total with a credible and continuous or accelerating trend. 3 or more surrounding instruments must support this.	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	Survey Monitoring	Deformation (CSP) - Displacement	0 - Normal Operating Condition	Total displacement within typical maximum range of past 24 months	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
North Dam	Dam Structure	Containment	Survey Monitoring	Deformation (CSP) - Displacement	1 - Early Warning Condition	Total displacement exceeds typical maximum range of past 24 months	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
North Dam	Dam Structure	Containment	Survey Monitoring	Deformation (CSP) - Displacement	2 - Corrective Action Condition	Vertical, horizontal or total displacement of 0.1 m per month over two survey periods (0.2 m) or greater than 0.5 m total, with a credible trend.	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	Survey Monitoring	Deformation (CSP) - Displacement	3 - Critical Condition	Vertical, horizontal or total displacement of 0.15 m per month over four survey periods (4 months) or greater than 1.0 m total with a credible and continuous or accelerating trend. 3 or more surrounding instruments must support this.	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	Survey Monitoring	Deformation (DSP) - Displacement	0 - Normal Operating Condition	Total displacement within typical maximum range of past 24 months	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
North Dam	Dam Structure	Containment	Survey Monitoring	Deformation (DSP) - Displacement	1 - Early Warning Condition	Total displacement exceeds typical maximum range of past 24 months	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
North Dam	Dam Structure	Containment	Survey Monitoring	Deformation (DSP) - Displacement	2 - Corrective Action Condition	Vertical, horizontal or total displacement of 0.1 m per month over two survey periods (0.2 m) or greater than 0.5 m total, with a credible trend.	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	Survey Monitoring	Deformation (DSP) - Displacement	3 - Critical Condition	Vertical, horizontal or total displacement of 0.15 m per month over four survey periods (4 months) or greater than 1.0 m total with a credible and continuous or accelerating trend. 3 or more surrounding instruments must support this.	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	Visual inspection	Overall condition	0 - Normal Operating Condition	No change observed from previous inspection, no ongoing issues.	YES	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
North Dam	Dam Structure	Containment	Visual inspection	Overall condition	1 - Early Warning Condition	New or continued issues observed, runoff observed at the toe	YES	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
North Dam	Dam Structure	Containment	Visual inspection	Overall condition	2 - Corrective Action Condition	New or continued issues observed and progressing at a notable rate (issue specific)	YES	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	Visual inspection	Overall condition	3 - Critical Condition	Any observed issues clearly detrimental to the dam stability	YES	Regular monitoring, implement TPP	Implement TPP tasks, TNP, ERP	Review Monitoring data	Support implementation of TPP, TNP, ERP
North Dam	Dam Structure	Containment	Visual inspection	Cracking	0 - Normal Operating Condition	None	YES	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
North Dam	Dam Structure	Containment	Visual inspection	Cracking	1 - Early Warning Condition	Newly observed cracking, less than 5 cm wide, less than 10m long	YES	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
North Dam	Dam Structure	Containment	Visual inspection	Cracking	2 - Corrective Action Condition	New or expanding cracking 5 - 10 cm wide, 10-30m long but not in a clear orientation that would suggest a failure mechanism (semicircular, perpendicular or parallel to crest) but potential to propagate. Multiple aligned smaller cracks could be considered one larger crack.	YES	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	Visual inspection	Cracking	3 - Critical Condition	New or expanding cracking >10 cm wide or >30m long, clear failure mechanism or propagation potential. Typically a semi-circular shape or across the dam structure (longitudinal or transverse)	YES	Regular monitoring, implement TPP	Implement TPP tasks, TNP, ERP	Review Monitoring data	Support implementation of TPP, TNP, ERP
North Dam	Dam Structure	Containment	Visual inspection	Depressions/settlement/erosion	0 - Normal Operating Condition	Minor depressions or settlement observed in the fill, less than 10 cm deep, limited extents (less than 10m2). Historically observed on the North Dam, typically observed within a few years of fill placement)	YES	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
North Dam	Dam Structure	Containment	Visual inspection	Depressions/settlement/erosion	1 - Early Warning Condition	New depressions or settlement observed (10-50 cm deep and 10-20 m2 in area or deeper in an area smaller than 10m2)	YES	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
North Dam	Dam Structure	Containment	Visual inspection	Depressions/settlement/erosion	2 - Corrective Action Condition	New or progressing depressions, settlement or erosion observed (greater than 50 cm deep and greater than 20 m2 in area, or potentially deeper in a smaller area (like a sink hole))	YES	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	Visual inspection	Depressions/settlement/erosion	3 - Critical Condition	Progression of previously observed depressions, settlement or erosion (greater than 1m deep and greater than 20 m2 in area, expanded since previous inspection or supported by similar trends in nearby instrumentation).	YES	Regular monitoring, implement TPP	Implement TPP tasks, TNP, ERP	Review Monitoring data	Support implementation of TPP, TNP, ERP
North Dam	Dam Structure	Containment	Visual inspection	Lateral displacement, typically associated with crac	0 - Normal Operating Condition	None	YES	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
North Dam	Dam Structure	Containment	Visual inspection	Lateral displacement, typically associated with crac	1 - Early Warning Condition	Newly observed displacement, typically associated with cracking, (10-20 cm deep or 10-20 m2 in area)	YES	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
North Dam	Dam Structure	Containment	Visual inspection	Lateral displacement, typically associated with crac	2 - Corrective Action Condition	New or progressing displacement observed (greater than 20 cm deep or greater than 20 m2 in area)	YES	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	Visual inspection	Lateral displacement, typically associated with crac	3 - Critical Condition	Progression of previously observed displacement (greater than 20 cm deep or greater than 20 m2 in area, expanded since previous inspection or supported by similar trends in nearby instrumentation)	YES	Regular monitoring, implement TPP	Implement TPP tasks, TNP, ERP	Review Monitoring data	Support implementation of TPP, TNP, ERP
North Dam	Dam Structure	Containment	Visual inspection /Seepage	Seepage water quantity and quality	0 - Normal Operating Condition	None	YES	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
North Dam	Dam Structure	Containment	Visual inspection /Seepage	Seepage water quantity and quality	1 - Early Warning Condition	Run-off or seepage flow noted at toe during inspection, similar to historically low flow rates (~2-5L/s). No tailings signature in the field water chemistry	YES	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation

								High level actions and response			
Component	Sub-component	Function	Monitoring method	Parameter	Attribute	Value	ERP	Hope Bay Actions	Hope Bay Response	SRK Actions	SRK Response
North Dam	Dam Structure	Containment	Visual inspection /Seepage	Seepage water quantity and quality	2 - Corrective Action Condition	Run-off flow noted at toe during inspection, notably higher flow rate than in past seasons. Water quality is visibly clear without a tailings signature or a low flow rate with tailings signature identified.	YES	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	Visual inspection /Seepage	Seepage water quantity and quality	3 - Critical Condition	Seepage water flow noted at toe during inspection, notably higher flow rate than in past seasons (typically a small stream of water during freshet) with high TSS (visibly sediment laden) and a tailings signature noted, or flow rate high enough that sampling cannot occur for safety reasons.	YES	Regular monitoring, implement TPP	Implement TPP tasks, TNP, ERP	Review Monitoring data	Support implementation of TPP, TNP, ERP
North Dam	Dam Structure	Containment	GTC	Critical Zone - Core Temperature	0 - Normal Operating Condition	Below typical maximum of past 24 months	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
North Dam	Dam Structure	Containment	GTC	Critical Zone - Core Temperature	1 - Early Warning Condition	Exceed typical maximum of past 24 months	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
North Dam	Dam Structure	Containment	GTC	Critical Zone - Core Temperature	2 - Corrective Action Condition	Temperature exceeding design criteria of -2°C, for multiple beads, with credible trend	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	GTC	Critical Zone - Core Temperature	3 - Critical Condition	Temperature exceeding design criteria of 0°C, for multiple beads, with credible warming trend	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	GTC	Critical Zone - Foundation Temperature	0 - Normal Operating Condition	Below typical maximum of past 24 months	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
North Dam	Dam Structure	Containment	GTC	Critical Zone - Foundation Temperature	1 - Early Warning Condition	Exceed typical maximum of past 24 months	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
North Dam	Dam Structure	Containment	GTC	Critical Zone - Foundation Temperature	2 - Corrective Action Condition	Temperature exceeding thermal design criteria of -8°C, for multiple beads, with credible trend	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	GTC	Critical Zone - Foundation Temperature	3 - Critical Condition	Temperature exceeding design criteria of -2°C, for multiple beads, with credible warming trend	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	GTC	Non-critical Zone - Foundation Temperature	0 - Normal Operating Condition	Below typical maximum of past 24 months	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
North Dam	Dam Structure	Containment	GTC	Non-critical Zone - Foundation Temperature	1 - Early Warning Condition	Exceed typical maximum of past 24 months	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
North Dam	Dam Structure	Containment	GTC	Non-critical Zone - Foundation Temperature	2 - Corrective Action Condition	Temperature exceeding freezing point depression threshold -2°C, for multiple beads, with credible trend	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	GTC	Non-critical Zone - Foundation Temperature	3 - Critical Condition	Temperature exceeding design criteria of 0°C, for multiple beads, with credible warming trend	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Dam Structure	Containment	GTC	Excluded beads - Temperature	0 - Normal Operating Condition	Below typical maximum of past 24 months	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
North Dam	Dam Structure	Containment	GTC	Excluded beads - Temperature	1 - Early Warning Condition	Exceed typical maximum of past 24 months	NO	Regular Monitoring	Work with EoR to review and inve	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
North Dam	Dam Structure	Containment	GTC	Excluded beads - Temperature	2 - Corrective Action Condition	Exceed historical maximum since installation	NO	Regular Monitoring	TNP	Review Monitoring data	None
North Dam	Dam Structure	Containment	GTC	Excluded beads - Temperature	3 - Critical Condition	None - Used to support thermal assessment of other zones	NO	None	TNP	Review Monitoring data	None
North Dam	Thermosyphons	Passive Cooling	GTC	Thermal	0 - Normal Operating Condition	Operational Cooling during winter	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
North Dam	Thermosyphons	Passive Cooling	GTC	Thermal	1 - Early Warning Condition	Impeded cooling during winter	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
North Dam	Thermosyphons	Passive Cooling	GTC	Thermal	2 - Corrective Action Condition	Dormant during winter (Exception for North 2)	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Thermosyphons	Passive Cooling	GTC	Thermal	3 - Critical Condition	Multiple thermosyphons not functioning correctly during winter (typically cooling November - April)	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Thermosyphons	Passive Cooling	Visual inspection	Overall and cracks	0 - Normal Operating Condition	No issues or minor surface rust	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
North Dam	Thermosyphons	Passive Cooling	Visual inspection	Overall and cracks	1 - Early Warning Condition	Deeper rust or other damage not limiting function	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
North Dam	Thermosyphons	Passive Cooling	Visual inspection	Overall and cracks	2 - Corrective Action Condition	Deeper rust or other damage limiting function	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
North Dam	Thermosyphons	Passive Cooling	Visual inspection	Overall and cracks	3 - Critical Condition	Multiple thermosyphons not functioning correctly during winter (typically cooling November - April)	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	Survey Monitoring	Deformation (SSP)	0 - Normal Operating Condition	Total displacement within typical maximum range of past 24 months	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Dam Structure	Containment	Survey Monitoring	Deformation (SSP)	1 - Early Warning Condition	Total displacement exceeds typical maximum range of past 24 months	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
South Dam	Dam Structure	Containment	Survey Monitoring	Deformation (SSP)	2 - Corrective Action Condition	Vertical, horizontal or total displacement of 0.1 m per month over two survey periods (0.2 m) or greater than 0.5 m total, with a credible trend.	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	Survey Monitoring	Deformation (SSP)	3 - Critical Condition	Vertical, horizontal or total displacement of 0.15 m per month over four survey periods (4 months) or greater than 1.0 m total with a credible and continuous or accelerating trend. 3 or more surrounding instruments must support this.	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	Survey Monitoring	Deformation (CSP)	0 - Normal Operating Condition	Total displacement within typical maximum range of past 24 months	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Dam Structure	Containment	Survey Monitoring	Deformation (CSP)	1 - Early Warning Condition	Total displacement exceeds typical maximum range of past 24 months	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
South Dam	Dam Structure	Containment	Survey Monitoring	Deformation (CSP)	2 - Corrective Action Condition	Vertical, horizontal or total displacement of 0.1 m per month over two survey periods (0.2 m) or greater than 0.5 m total, with a credible trend.	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	Survey Monitoring	Deformation (CSP)	3 - Critical Condition	Vertical, horizontal or total displacement of 0.15 m per month over four survey periods (4 months) or greater than 1.0 m total with a credible and continuous or accelerating trend. 3 or more surrounding instruments must support this.	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	Survey Monitoring	Deformation (DSP)	0 - Normal Operating Condition	Total displacement within typical maximum range of past 24 months	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Dam Structure	Containment	Survey Monitoring	Deformation (DSP)	1 - Early Warning Condition	Total displacement exceeds typical maximum range of past 24 months	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
South Dam	Dam Structure	Containment	Survey Monitoring	Deformation (DSP)	2 - Corrective Action Condition	Vertical, horizontal or total displacement of 0.1 m per month over two survey periods (0.2 m) or greater than 0.5 m total, with a credible trend.	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	Survey Monitoring	Deformation (DSP)	3 - Critical Condition	Vertical, horizontal or total displacement of 0.15 m per month over four survey periods (4 months) or greater than 1.0 m total with a credible and continuous or accelerating trend. 3 or more surrounding instruments must support this.	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	Visual inspection	Overall condition	0 - Normal Operating Condition	No change observed from previous inspection, no ongoing issues.	YES	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Dam Structure	Containment	Visual inspection	Overall condition	1 - Early Warning Condition	New or continued issues observed, runoff observed at the toe	YES	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation

								High level actions and response			
Component	**Sub-component**	**Function**	**Monitoring method**	**Parameter**	**Attribute**	**Value**	**ERP**	**Hope Bay Actions**	**Hope Bay Response**	**SRK Actions**	**SRK Response**
South Dam	Dam Structure	Containment	Visual inspection	Overall condition	2 - Corrective Action Condition	New or continued issues observed and progressing at a notable rate (issue specific)	YES	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	Visual inspection	Overall condition	3 - Critical Condition	Any observed issues clearly detrimental to the dam stability	YES	Regular monitoring, implement TPP	Implement TPP tasks, TNP, ERP	Review Monitoring data	Support implementation of TPP, TNP, ERP
South Dam	Dam Structure	Containment	Visual inspection	Cracking	0 - Normal Operating Condition	None	YES	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Dam Structure	Containment	Visual inspection	Cracking	1 - Early Warning Condition	Newly observed cracking, less than 5 cm wide, less than 10m long	YES	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
South Dam	Dam Structure	Containment	Visual inspection	Cracking	2 - Corrective Action Condition	New or expanding cracking 5 - 10 cm wide, 10-30m long but not in a clear orientation that would suggest a failure mechanism (semicircular, perpendicular or parallel to crest) but potential to propagate. Multiple aligned smaller cracks could be considered one larger crack.	YES	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	Visual inspection	Cracking	3 - Critical Condition	New or expanding cracking >10 cm wide or >30m long, clear failure mechanism or propagation potential. Typically a semi-circular shape or across the dam structure (longitudinal or transverse)	YES	Regular monitoring, implement TPP	Implement TPP tasks, TNP, ERP	Review Monitoring data	Support implementation of TPP, TNP, ERP
South Dam	Dam Structure	Containment	Visual inspection	Depressions/settlement/erosion	0 - Normal Operating Condition	Minor depressions or settlement observed in the fill, less than 10 cm deep, limited extents (less than 10m2). Historically observed on the North Dam, typically observed within a few years of fill placement)	YES	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Dam Structure	Containment	Visual inspection	Depressions/settlement/erosion	1 - Early Warning Condition	New depressions or settlement observed (10-50 cm deep and 10-20 m2 in area or deeper in an area smaller than 10m2)	YES	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
South Dam	Dam Structure	Containment	Visual inspection	Depressions/settlement/erosion	2 - Corrective Action Condition	New or progressing depressions, settlement or erosion observed (greater than 50 cm deep and greater than 20 m2 in area, or potentially deeper in a smaller area (like a sink hole))	YES	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP

							High level actions and response				
Component	Sub-component	Function	Monitoring method	Parameter	Attribute	Value	ERP	Hope Bay Actions	Hope Bay Response	SRK Actions	SRK Response
South Dam	Dam Structure	Containment	Visual inspection	Depressions/settlement/erosion	3 - Critical Condition	Progression of previously observed depressions, settlement or erosion (greater than 1m deep and greater than 20 m2 in area, expanded since previous inspection or supported by similar trends in nearby instrumentation).	YES	Regular monitoring, implement TPP	Implement TPP tasks, TNP, ERP	Review Monitoring data	Support implementation of TPP, TNP, ERP
South Dam	Dam Structure	Containment	Visual inspection	Lateral displacement, typically associated with crac	0 - Normal Operating Condition	None	YES	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Dam Structure	Containment	Visual inspection	Lateral displacement, typically associated with crac	1 - Early Warning Condition	Newly observed displacement, typically associated with cracking, (10-20 cm deep or 10-20 m2 in area)	YES	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
South Dam	Dam Structure	Containment	Visual inspection	Lateral displacement, typically associated with crac	2 - Corrective Action Condition	New or progressing displacement observed (greater than 20 cm deep or greater than 20 m2 in area)	YES	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	Visual inspection	Lateral displacement, typically associated with crac	3 - Critical Condition	Progression of previously observed displacement (greater than 20 cm deep or greater than 20 m2 in area, expanded since previous inspection or supported by similar trends in nearby instrumentation)	YES	Regular monitoring, implement TPP	Implement TPP tasks, TNP, ERP	Review Monitoring data	Support implementation of TPP, TNP, ERP
South Dam	Dam Structure	Containment	Visual inspection /Seepage	Seepage or piping	0 - Normal Operating Condition	None	YES	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Dam Structure	Containment	Visual inspection /Seepage	Seepage or piping	1 - Early Warning Condition	Run-off or seepage flow noted at toe during inspection, similar to historically low flow rates (~less than 2L/s). No tailings signature in the field water chemistry	YES	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
South Dam	Dam Structure	Containment	Visual inspection /Seepage	Seepage or piping	2 - Corrective Action Condition	Run-off flow noted at toe during inspection, notably higher flow rate than in past seasons. Water quality is visibly clear without a tailings signature or a low flow rate with tailings signature identified. Tailings deposited on the downstream side of the dam (not wind deposited)	YES	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	Visual inspection /Seepage	Seepage or piping	3 - Critical Condition	Seepage water flow noted at toe during inspection, notably higher flow rate than in past seasons (typically a small stream of water during freshet) with high TSS (visibly sediment laden or containing tailings solids) and a tailings signature noted, or flow rate high enough that sampling cannot occur for safety reasons.	YES	Regular monitoring, implement TPP	Implement TPP tasks, TNP, ERP	Review Monitoring data	Support implementation of TPP, TNP, ERP
South Dam	Dam Structure	Containment	Visual inspection	Ponded water downstream (Visual estimate)	0 - Normal Operating Condition	Small ponds near DS toe of dam	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Dam Structure	Containment	Visual inspection	Ponded water downstream (Visual estimate)	1 - Early Warning Condition	Ponded water against toe of dam (0 to 1.0m, no RCP/Tailings signature)	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
South Dam	Dam Structure	Containment	Visual inspection	Ponded water downstream (Visual estimate)	2 - Corrective Action Condition	Ponded water against toe of dam (Less than 1.0m, with RCP/tailings signature)	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	Visual inspection	Ponded water downstream (Visual estimate)	3 - Critical Condition	Water greater than 1m ponded against toe (regardless or tailings signature)	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	GTC	Critical Zone - Foundation Temperature	0 - Normal Operating Condition	Below typical maximum of past 24 months	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Dam Structure	Containment	GTC	Critical Zone - Foundation Temperature	1 - Early Warning Condition	Exceed typical maximum of past 24 months	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
South Dam	Dam Structure	Containment	GTC	Critical Zone - Foundation Temperature	2 - Corrective Action Condition	Temperature exceeding design criteria of -2°C, for multiple beads, with credible trend	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	GTC	Critical Zone - Foundation Temperature	3 - Critical Condition	Temperature exceeding design criteria of 0°C, for multiple beads, with credible warming trend	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	GTC	Non-critical Zone - Foundation Temperature Downs	0 - Normal Operating Condition	Below typical maximum of past 24 months	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Dam Structure	Containment	GTC	Non-critical Zone - Foundation Temperature Downs	1 - Early Warning Condition	Exceed typical maximum of past 24 months	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
South Dam	Dam Structure	Containment	GTC	Non-critical Zone - Foundation Temperature Downs	2 - Corrective Action Condition	Temperature exceeding freezing point depression limit -2°C (below modelled -3°C isotherm)	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	GTC	Non-critical Zone - Foundation Temperature Downs	3 - Critical Condition	Rapid temperature increase exceeding -2°C, indicative of abnormal thaw event	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	GTC	Non-critical Zone - Key Trench Temperature	0 - Normal Operating Condition	Below typical maximum of past 24 months	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Dam Structure	Containment	GTC	Non-critical Zone - Key Trench Temperature	1 - Early Warning Condition	Exceed typical maximum of past 24 months	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
South Dam	Dam Structure	Containment	GTC	Non-critical Zone - Key Trench Temperature	2 - Corrective Action Condition	Temperature exceeding freezing point depression threshold -2°C, for multiple beads, with credible trend	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	GTC	Non-critical Zone - Key Trench Temperature	3 - Critical Condition	Temperature exceeding design criteria of 0°C, for multiple beads, with credible warming trend	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Dam Structure	Containment	GTC	Excluded beads - Temperature	0 - Normal Operating Condition	Below typical maximum of past 24 months	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Dam Structure	Containment	GTC	Excluded beads - Temperature	1 - Early Warning Condition	Exceed typical maximum of past 24 months	NO	Regular Monitoring	Work with EoR to review and inve	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Dam Structure	Containment	GTC	Excluded beads - Temperature	2 - Corrective Action Condition	Exceed historical maximum since installation	NO	Regular Monitoring	TNP	Review Monitoring data	None
South Dam	Dam Structure	Containment	GTC	Excluded beads - Temperature	3 - Critical Condition	None - Used to support thermal assessment of other zones	NO	None	TNP	None	None
South Dam	Tailings Beach	Pond control	Visual inspection	Beach length (Distance from dam face to full Reclai	0 - Normal Operating Condition	Beach length greater than 100 m	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Tailings Beach	Pond control	Visual inspection	Beach length (Distance from dam face to full Reclai	1 - Early Warning Condition	Beach length between 50 and 100 m	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
South Dam	Tailings Beach	Pond control	Visual inspection	Beach length (Distance from dam face to full Reclai	2 - Corrective Action Condition	Beach length of 10 - 50 m	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Tailings Beach	Pond control	Visual inspection	Beach length (Distance from dam face to full Reclai	3 - Critical Condition	Beach length less than 10 m or water against dam	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Tailings Beach	Pond control	Survey Monitoring	Tailings beach to pond elevation differential	0 - Normal Operating Condition	1.0 m	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Tailings Beach	Pond control	Survey Monitoring	Tailings beach to pond elevation differential	1 - Early Warning Condition	0.5-1.0 m	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
South Dam	Tailings Beach	Pond control	Survey Monitoring	Tailings beach to pond elevation differential	2 - Corrective Action Condition	0.1-0.5m	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Tailings Beach	Pond control	Survey Monitoring	Tailings beach to pond elevation differential	3 - Critical Condition	<0.1m	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Tailings Beach	Pond control	Visual inspection	Distance from South Dam face to smaller ponded w	0 - Normal Operating Condition	No ponding on tailings beach	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
South Dam	Tailings Beach	Pond control	Visual inspection	Distance from South Dam face to smaller ponded w	1 - Early Warning Condition	Pond smaller than 100m2 in area within 50 m of the dam face	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
South Dam	Tailings Beach	Pond control	Visual inspection	Distance from South Dam face to smaller ponded w	2 - Corrective Action Condition	Pond greater than 100m2 in area within 50 m of the dam face	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
South Dam	Tailings Beach	Pond control	Visual inspection	Distance from South Dam face to smaller ponded w	3 - Critical Condition	Pond greater than 100m2 against the dam face	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Access	Doris Creek Bridge	Access	Visual inspection	Unsafe to cross	0 - Normal Operating Condition	Access over Doris Creek available	YES	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
TIA Access	Doris Creek Bridge	Access	Visual inspection	Unsafe to cross	1 - Early Warning Condition	Access over Doris Creek available	YES	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation

High level actions and response

Component	Sub-component	Function	Monitoring method	Parameter	Attribute	Value	ERP	Hope Bay Actions	Hope Bay Response	SRK Actions	SRK Response
TIA Access	Doris Creek Bridge	Access	Visual inspection	Unsafe to cross	2 - Corrective Action Condition	Safe access over Doris Creek available but bridge condition deterioration noted	YES	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Access	Doris Creek Bridge	Access	Visual inspection	Unsafe to cross	3 - Critical Condition	Unsafe access over Doris Creek Bridge	YES	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Reclaim Pond	Process Water Source	Pressure transducer and wa	Water level thresholds	0 - Normal Operating Condition	Below 31.5 masl (with adequate supply for reclaim)	YES	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
TIA Overall	Reclaim Pond	Process Water Source	Pressure transducer and wa	Water level thresholds	1 - Early Warning Condition	31.5-32.5 masl	YES	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
TIA Overall	Reclaim Pond	Process Water Source	Pressure transducer and wa	Water level thresholds	2 - Corrective Action Condition	32.5-33.5 masl	YES	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Reclaim Pond	Process Water Source	Pressure transducer and wa	Water level thresholds	3 - Critical Condition	>33.5 masl	YES	Regular monitoring, implement TPP	Implement TPP tasks, TNP, ERP	Review Monitoring data	Support implementation of TPP, TNP, ERP
TIA Overall	Tailings Discharge Pipeline	Mine water discharge t	Mill Sampling	Mill Throughput	0 - Normal Operating Condition	At target tailings solids production rate (38% +/- 5%)	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
TIA Overall	Tailings Discharge Pipeline	Mine water discharge t	Mill Sampling	Mill Throughput	1 - Early Warning Condition	Tailings solids production rate varies >5% from target for greater than 1 week	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
TIA Overall	Tailings Discharge Pipeline	Mine water discharge t	Mill Sampling	Mill Throughput	2 - Corrective Action Condition	> 1 month of deposition at high or low production rate	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Tailings Discharge Pipeline	Mine water discharge t	Mill Sampling	Mill Throughput	3 - Critical Condition	> 2 months of deposition at high or low production rate	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Tailings Discharge Pipeline	Mine water discharge t	Mill Sampling	Tailings Solids ContentLow solids content (high wate	0 - Normal Operating Condition	At target solids content content (+/-5%)	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
TIA Overall	Tailings Discharge Pipeline	Mine water discharge t	Mill Sampling	Tailings Solids ContentLow solids content (high wate	1 - Early Warning Condition	Tailings solids content varies > 5% from target for greater than 1 week	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
TIA Overall	Tailings Discharge Pipeline	Mine water discharge t	Mill Sampling	Tailings Solids ContentLow solids content (high wate	2 - Corrective Action Condition	> 1 month of deposition at off-spec solids content	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Tailings Discharge Pipeline	Mine water discharge t	Mill Sampling	Tailings Solids ContentLow solids content (high wate	3 - Critical Condition	> 2 months of deposition at off-spec solids content	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Tailings Discharge Pipeline	Mine water discharge t	Tailings Salinity	Pump box tailings salinity (TL-5) when depositing of	0 - Normal Operating Condition	Salinity below FPD levels (quantify salinity +/- 5%)	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
TIA Overall	Tailings Discharge Pipeline	Mine water discharge t	Tailings Salinity	Pump box tailings salinity (TL-5) when depositing of	1 - Early Warning Condition	Elevated salinity recorded (in any sample)	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
TIA Overall	Tailings Discharge Pipeline	Mine water discharge t	Tailings Salinity	Pump box tailings salinity (TL-5) when depositing of	2 - Corrective Action Condition	> 1 week of deposition at off-spec salinity	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Tailings Discharge Pipeline	Mine water discharge t	Tailings Salinity	Pump box tailings salinity (TL-5) when depositing of	3 - Critical Condition	>1 month of deposition at off-spec salinity	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Tailings Discharge Pipeline	Mine water discharge t	Tailings Salinity	Pump box tailings salinity (TL-5) when depositing of	0 - Normal Operating Condition	Salinity below water quality requirement (quantify salinity +/- 5%)	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
TIA Overall	Tailings Discharge Pipeline	Mine water discharge t	Tailings Salinity	Pump box tailings salinity (TL-5) when depositing of	1 - Early Warning Condition	Elevated salinity recorded (in any sample)	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
TIA Overall	Tailings Discharge Pipeline	Mine water discharge t	Tailings Salinity	Pump box tailings salinity (TL-5) when depositing of	2 - Corrective Action Condition	> 1 week of deposition at off-spec salinity	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Tailings Discharge Pipeline	Mine water discharge t	Tailings Salinity	Pump box tailings salinity (TL-5) when depositing of	3 - Critical Condition	>1 month of deposition at off-spec salinity	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Tailings Discharge Pipeline	Tailings spigots	Visual inspection	Location and function	0 - Normal Operating Condition	Spigot in planned location, communicated on weekly visual survey	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
TIA Overall	Tailings Discharge Pipeline	Tailings spigots	Visual inspection	Location and function	1 - Early Warning Condition	Discharge from an unplanned spigot	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
TIA Overall	Tailings Discharge Pipeline	Tailings spigots	Visual inspection	Location and function	2 - Corrective Action Condition	Temporary deposition from east shore with the potential for inadequate beach development at the South Dam	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Tailings Discharge Pipeline	Tailings spigots	Visual inspection	Location and function	3 - Critical Condition	Extended period of deposition from east shore leading to inadequate beach development at the South Dam	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Tailings Discharge Pipeline	Tailings spigots	Visual inspection	Overall condition, cracks or leaks	0 - Normal Operating Condition	No apparent issues	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
TIA Overall	Tailings Discharge Pipeline	Tailings spigots	Visual inspection	Overall condition, cracks or leaks	1 - Early Warning Condition	Small leak observed below tee-joint. Repairable with limited downtime, can be remediated with little effort, also if conditions that	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
TIA Overall	Tailings Discharge Pipeline	Tailings spigots	Visual inspection	Overall condition, cracks or leaks	2 - Corrective Action Condition	Full break in the pipeline within deposition footprint (below the pipe tee-joint to each spigot).	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Tailings Discharge Pipeline	Tailings spigots	Visual inspection	Overall condition, cracks or leaks	3 - Critical Condition	Large leak or pipe break ongoing, reportable spill, significant unplanned discharge within the ultimate tailings footprint	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Reclaim Jetty pad	Reclaim Pumping	Survey monitoring	Deformation - Displacement	0 - Normal Operating Condition	Total displacement within typical maximum range of past 24 months	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
TIA Overall	Reclaim Jetty pad	Reclaim Pumping	Survey monitoring	Deformation - Displacement	1 - Early Warning Condition	Total displacement exceeds typical maximum range of past 24 months	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
TIA Overall	Reclaim Jetty pad	Reclaim Pumping	Survey monitoring	Deformation - Displacement	2 - Corrective Action Condition	Vertical, horizontal or total displacement of 0.2 m over two months (two survey periods), with a credible trend. (NEED TO REVISIT	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Reclaim Jetty pad	Reclaim Pumping	Survey monitoring	Deformation - Displacement	3 - Critical Condition	Vertical, horizontal or total displacement of 0.4 m over four months with continuous or accelerating credible trend for 2 or more nearby	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Reclaim Jetty pad	Reclaim Pumping	Visual inspection	Cracking	0 - Normal Operating Condition	None	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
TIA Overall	Reclaim Jetty pad	Reclaim Pumping	Visual inspection	Cracking	1 - Early Warning Condition	Newly observed cracking, less than 5 cm wide, less than 10m long	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
TIA Overall	Reclaim Jetty pad	Reclaim Pumping	Visual inspection	Cracking	2 - Corrective Action Condition	New or expanding cracking 5 - 10 cm wide, 10-30m long but not in a clear orientation that would suggest a failure mechanism	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Reclaim Jetty pad	Reclaim Pumping	Visual inspection	Cracking	3 - Critical Condition	New or expanding cracking >10 cm wide or >30m long, clear failure mechanism or propagation potential. Typically a semi-circular shape or	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Mine Water Intake/Dischar	Discharge water to RCP	Visual inspection	Overall condition, cracks or leaks, tundra damage	0 - Normal Operating Condition	No apparent issues	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
TIA Overall	Mine Water Intake/Dischar	Discharge water to RCP	Visual inspection	Overall condition, cracks or leaks, tundra damage	1 - Early Warning Condition	No leaks but located on tundra (or in unplanned location leading to potential adverse impacts)	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
TIA Overall	Mine Water Intake/Dischar	Discharge water to RCP	Visual inspection	Overall condition, cracks or leaks, tundra damage	2 - Corrective Action Condition	Small leak observed (repairable with limited downtime, can be remediated with little effort) or conditions that could lead to	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Mine Water Intake/Dischar	Discharge water to RCP	Visual inspection	Overall condition, cracks or leaks, tundra damage	3 - Critical Condition	Large leak or pipe break ongoing, reportable spill, significant unplanned discharge outside the ultimate tailings footprint	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Mine Water Intake/Dischar	Water from RCP to WTI	Visual inspection	Overall condition, cracks or leaks, tundra damage	0 - Normal Operating Condition	No apparent issues	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
TIA Overall	Mine Water Intake/Dischar	Water from RCP to WTI	Visual inspection	Overall condition, cracks or leaks, tundra damage	1 - Early Warning Condition	No leaks but located on tundra (or in unplanned location leading to potential adverse impacts)	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
TIA Overall	Mine Water Intake/Dischar	Water from RCP to WTI	Visual inspection	Overall condition, cracks or leaks, tundra damage	2 - Corrective Action Condition	Small leak observed (repairable with limited downtime, can be remediated with little effort) or conditions that could lead to	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Mine Water Intake/Dischar	Water from RCP to WTI	Visual inspection	Overall condition, cracks or leaks, tundra damage	3 - Critical Condition	Large leak or pipe break ongoing, reportable spill, significant unplanned discharge outside the ultimate tailings footprint	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Tailings Discharge Pipeline	Tailings transport	Visual inspection	Overall condition, cracks or leaks, tundra damage	0 - Normal Operating Condition	No apparent issues	NO	Regular Monitoring	TNP	Review Monitoring data	Monthly Monitoring Summary, display data on DMS
TIA Overall	Tailings Discharge Pipeline	Tailings transport	Visual inspection	Overall condition, cracks or leaks, tundra damage	1 - Early Warning Condition	No leaks but located on tundra (or in unplanned location leading to potential adverse impacts)	NO	Regular Monitoring	TNP and Work with EoR to review	Review Monitoring data	Monthly Monitoring Summary, display data on DMS, Notify site if an issue requires further investigation
TIA Overall	Tailings Discharge Pipeline	Tailings transport	Visual inspection	Overall condition, cracks or leaks, tundra damage	2 - Corrective Action Condition	Small leak observed (repairable with limited downtime, can be remediated with little effort) or conditions that could lead to	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP
TIA Overall	Tailings Discharge Pipeline	Tailings transport	Visual inspection	Overall condition, cracks or leaks, tundra damage	3 - Critical Condition	Large leak or pipe break ongoing, reportable spill, significant unplanned discharge outside the ultimate tailings footprint	NO	Regular monitoring, implement TPP	Implement TPP tasks and TNP	Review Monitoring data	Support implementation of TPP and TNP

OPERATIONS, MAINTENANCE AND SURVEILLANCE MANUAL: HOPE BAY DORIS TAILINGS IMPOUNDMENT AREA

HOPE BAY, NUNAVUT

Appendix H – Standard Operating Procedures

Hope Bay Project, North Dam Monitoring: Standard Operating Procedures – Revision 3

Prepared for

TMAC Resources Inc.

Prepared by

SRK Consulting (Canada) Inc.
1CT022.064
August 2020

Hope Bay Project, North Dam Monitoring: Standard Operating Procedures – Revision 3

August 2020

Prepared for

TMAC Resources Inc.
372 Bay Street, Suite 901
Toronto, ON
M5H 2W9

Tel: +1 416 520 3516
Web: www.tmacresources.com

Prepared by

SRK Consulting (Canada) Inc.
2200–1066 West Hastings Street
Vancouver, BC
V6E 3X2

Tel: +1 604 681 4196
Web: www.srk.com

Project No: 1CT022.064

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1 Introduction

1.1 Revision Summary

Table 1 provides a summary of the revision history for the North Dam Monitoring Standard Operating Procedures (SOP).

Table 1: Revision History for the North Dam Monitoring SOP

Revision	Status	Date	Major Changes
0	Issued for Use	July 2013	-
1	Issued for Use	September 2013	Updates to Section 6 and 7
2	Issued for Use	August 2017	Monitoring frequency requirements (Section 3.1), data download procedures (Section 4), ground survey monitoring (Section 5), water level monitoring via permanent datalogger (Section 7), addition of more detail on seepage monitoring (Section 9), Primary contact email (throughout) from Hopebay@srk.com to hopebaymonitoring@srk.com
3	Issued for Use	August 2020	Water level monitoring transmission frequency (Section 5), Seepage monitoring (Section 9) adding location TL-5 and the development of a Quality Assurance / Quality Control (QA/QC) program Minor updates to align with the South Dam SOP

1.1 Background

The North Dam at Hope Bay has been designed as a water retaining structure. Its successful performance is dependent on maintaining the integrity of the frozen core through preservation of permafrost in the dam foundation (SRK 2007). Because of complex foundation conditions, differential settlement longitudinally and transversely across the dam is expected. To track whether deformations are within the design limits for the dam, a rigorous monitoring program has been established (SRK 2012).

Table 2 lists the North Dam monitoring components and Figure 1 presents a general arrangement of the North Dam.

Table 2: North Dam Monitoring Components

Component	Instrument	Quantity
Thermal	Horizontal ground temperature cables	13
	Vertical ground temperature cables	11
	Thermosyphon monitoring temperature cables	12
Deformation	Deep settlement points	3
	Surficial survey points, located on the downstream shell of the dam	18
	Crest monitoring points, located along the crest of the dam	14
	Inclinometers installed downstream slope of the dam	6
Water level	Pressure transducer installed in Reclaim pond	1
Seepage	No defined instrumentation	n/a
Visual	No defined instrumentation	n/a

1.2 Objectives

Responsibility for implementing the North Dam monitoring program rests with TMAC, and the data will be reviewed annually by the Engineer of Record (EOR) as part of the annual geotechnical inspection. This document provides comprehensive Standard Operating Procedures (SOP) for carrying out the required monitoring.

1.3 Layout

Section 2 of this document provides a summary of the instrumentation that has been installed (SRK 2012). The required monitoring frequency and responsibility matrix is provided in Section 3. Sections 4 to 9 contain the specific SOPs.

2 Monitoring Overview

2.1 Thermal Monitoring

2.1.1 Ground Temperature Cables

The frozen core and the underlying foundation have been designed to remain frozen for the life of the structure. The core should at all times be a temperature of at least -2°C, while the underlying foundation soils must be a temperature of at least -8°C (SRK 2007). Thirteen horizontal ground temperature cables have been installed to monitor the core temperature, and eleven vertical ground temperature cables have been installed to monitor the foundation temperature (Figure 1 and 2). One of the horizontal ground temperature cable (ND-HTS-085-33.5) was damaged beyond repair during construction and a replacement could not be installed. Additionally, one vertical ground temperature cable (ND-VTS-060-US) was irreparably damaged prior to datalogger installation. Therefore, these cables are not included in the monitoring program.

All working ground temperature cables are connected to two automated dataloggers via a series of multiplexers, which allow data collection at any pre-programmed frequency. The location of these dataloggers and associated multiplexers are indicated on Figure 2. The SOP for downloading data from these dataloggers is presented in Section 4.

2.1.2 Thermosyphon Monitoring

Horizontal sloped passive thermosyphons are installed in the base of the key trench. These have been designed to promote freezing conditions in the foundation soils. The thermosyphons are sealed pressure vessels and do not have moving parts that require service or maintenance. A thorough physical inspection for signs of corrosion is however required on the exposed portions of the thermosyphon system as part of routine visual inspections.

Each thermosyphon is monitored by a cable connected to one thermistor bead. These are referred to as Thermosyphon Status Thermistors (TSTs) are attached to the riser of each thermosyphon radiator. These TSTs allow monitoring of the thermosyphon operation during the active cooling season. Monitoring is done by measuring the temperature of the radiator pipe where it exits in the ground (this is equivalent to measuring the temperature of the cooling agent in the thermosyphon) and comparing it to the ambient air temperature at the panel. During the active cooling season the cooling agent within the thermosyphon, where it exits in the ground, is expected to be a minimum of 5°C warmer than the air temperature.

The TSTs were attached to the thermosyphon radiators using epoxy resin adhesive. The TST attachments were made as close to the riser elbow as possible and were insulated using spray foam. In total 12 TSTs were installed (one for each radiator). Photos of the installation and a simplified schematic of the thermosyphon radiator layout are shown in Figure 9.

At the north radiator cluster the TST lead cables were connected into Multiplexer #9 in Node E. The leads from the south radiator cluster were routed to Node A and from there fed through the pre-installed metal conduits along the crest of the dam and connected into Multiplexer #9 in Node E (Figures 3 and 4).

2.2 Deformation Monitoring

2.2.1 Survey Point Monitoring

The North Dam is expected to undergo deformation because of creep over its design life; this includes differential longitudinal and transverse settlement. These settlements are expected to result in strains of less than 2% in the frozen core of the dam (SRK 2007). A total of 35 survey monitoring points was installed within the dam to track these deformations such that it can be confirmed that they are within the specified design limits.

The installed monitoring points are illustrated on Figures 1 and 3, and include the following:

- **Primary Survey Control Points:** five permanent survey control points were established on exposed bedrock locations outside of the North Dam peripheral.
- **Deep Settlement Points:** three deep settlement points are located on the downstream slope of the dam. The deep settlement points are intended to track deformation of the foundation soils near the shell. Deep settlement points are located along the downstream face of the dam approximately 7 m from the downstream crest of the dam, and were installed to a depth of 0.5 m below the original ground surface. They consist of 102 mm (4-inch) steel pipes protected by a 152 mm (6-inch) diameter outer steel casing. The top of the steel casing is protected by a fabricated steel cap.
- **Surficial Survey Points:** 18 surficial survey points are located on the downstream shell of the dam. The surficial survey points are intended to track deformation of foundation soils at the location of maximum expected deformation. The surficial survey points were installed by embedding 1 m diameter boulders in a grid pattern into the run-of-quarry material of the dam shell. Once these boulders were seated into the dam shell, holes were drilled and expansion bolts were installed into each boulder.
- **Crest Monitoring Points:** 14 crest monitoring points are located along the crest of the dam. These monitoring points are intended to monitor differential settlement and deformation of the upper portion of the frozen core. The crest monitoring monuments were manufactured on site and are comprised of steel rods attached to base plates. 102 mm (4-inch) steel pipe housing protects the rods, and a steel cap protects the top of each monitoring point housing.

The SOP for completing these manual surveys, are included in Section 5.

2.2.2 Inclinometer Monitoring

Six inclinometers were installed on the downstream slope of the dam. These inclinometers were installed along the zone of the dam expected to undergo the maximum amount of deformation, and thus subject to the maximum strain. The locations of the installed inclinometers are shown on Figure 3. The SOP for taking these readings are included in Section 6.

2.3 Water Level Monitoring

Reclaim pond water level monitoring recorded automatically using a datalogger and georeferenced by monthly survey monitoring during the open water season as described in Section 7.

Between July 2015 and June 2017, a pressure transducer datalogger was used to monitor the depth of water during open water season. This was installed at a depth of approximately 5 m below the Reclaim pond water level of 29.08 masl. The data was downloaded manually and provided to the EOR on an as-requested basis. In June 2017, a new temporary pressure transducer was connected to a Datagarrison data transmitter installed on the shore of the Reclaim pond. The data logger collects a reading every 15 minutes and the data is transmitted to the online portal every 5 days. This pressure transducer was permanently installed for year-round monitoring on September 28, 2017.

The pressure transducer records water level in the Reclaim pond as meters of water (head) above the datalogger and require a known elevation of the datalogger for accurate translation to elevations. Therefore, as part of the monthly survey data collection (Section 5) a survey of the Reclaim pond water level is required to calibrate the pressure transducer readings. The full monitoring SOP is provided in Section 7.

2.4 Visual Monitoring

Visual inspection must be carried out for the North Dam and all its components, looking for obvious signs of distress.

During the initial years of dam operations several depressions were identified on the shell of the dam. These depressions are likely due to settlement of shell material after construction; however, the known depressions and any future depressions must be monitored to ensure that they are not signs of larger issues or instability. Monitoring will continue until stability of the depression can be confirmed.

Additional details on the primary focus areas for the visual monitoring is presented in Section 8.

2.5 Seepage Monitoring

Previously water has been noted at the toe of the dam. When noted, additional monitoring is required. The SOP for seepage monitoring is provided in Section 9.

3 Monitoring Protocols

3.1 Monitoring Frequency/Responsibility

A summary of the monitoring requirements and associated responsibility is listed in Table 3. These monitoring requirements can be revised at any time under the direction of the North Dam EOR, or the qualified Licensed Geotechnical Engineer carrying out the annual geotechnical inspection after consultation with the North Dam EOR.

Table 3: Summary of Monitoring Requirements

Element	Item	Method	Responsibility	Frequency
Thermal	Ground Temperature Cables	Dataloggers	TMAC	Daily readings, monthly downloads
	Thermosyphons	Dataloggers	TMAC	Daily readings, monthly downloads
Deformation	Downstream Deep Settlement	Manual	TMAC	Monthly, May to November(1)
	Downstream Surface Settlement	Manual	TMAC	
	Crest Settlement	Manual	TMAC	
	Depression	Manual	TMAC	
	Inclinometers	Manual	TMAC	Monthly
Water Balance	Water Level	Datalogger	TMAC	Daily readings (online portal)
	Water Level	Manual	TMAC	Monthly, when Reclaim pond is not frozen
	Seepage Monitoring	Per Section 9	TMAC	Weekly when seepage is observed
	TL-5 Geochemical Sampling	Manual	TMAC	Monthly
	Geochemical QA/QC	Manual	TMAC	Monthly (in conjunction with other sampling)
Visual	Visual Walk over Inspection and Reporting	Manual	TMAC	Weekly (below FSL(2)) Daily (at or above FSL)
	Geotechnical Inspection	Manual	Independent Qualified Licensed Geotechnical Engineer	Annually
Maintenance	Datalogger Primary Batteries	Manually recharge	TMAC	Annually
	Datalogger Backup Batteries	Manually replace	TMAC	5-year cycle
	Datalogger Recalibration	Manual	TMAC	5-year cycle
	Desiccant Packs Replace	Manual	TMAC	As required

Note(s)

(1) Deformation monitoring is not required during the winter months when the ground is frozen, if thermal data from the ground temperature cables does not indicate any cause for concern.

(2) FSL: Full Service Level

3.2 Monitoring Data Management Protocols

All monitoring data collected must be stored electronically. Manual notes must be scanned and the raw data saved together with any transposed or processed data. All data must be reviewed by appropriate qualified staff immediately following collection to confirm integrity of the instrumentation, as well as to ensure that dam performance is consistent with expectations.
If staff is not qualified to draw such conclusions, the EOR must be contacted to perform these duties.

Reporting requirements are specified in each section typically via email, however where appropriate, agreed upon shared drives can be used for file transfer, but a notification email should be sent once the inspection is uploaded. Currently a South Dam monitoring shared folder is stored here:

https://van.files.srk.com/nextcloud/index.php/s/EERtAo85KZLocdy?path=%2FTIA%20Monitoring

4 Datalogger Standard Operating Procedures

For the thermal monitoring instrumentation, SOPs have been developed for the datalogger downloads. The dataloggers are connected to the ground temperature cables and permanent TSTs.

Figure 2 shows the location of the ground temperature cables and TSTs while Figures 4 and 5 show the general layout of the data acquisition system and associated monitoring nodes.

The Operator's manuals for the dataloggers (CR1000) and associated Compact Flash Module (CFM100) are provided in Appendix A1, and A2. The wiring diagrams for the dataloggers, multiplexers and ground temperature cables are presented in Appendix B, and for completeness Appendix C presents an overview of the CR1000 datalogger programming.

4.1 Objective

The datalogger SOP has been developed to provide TMAC staff with clear instructions on how to maintain and operate the two North Dam dataloggers. These dataloggers are used to record ground temperature and thermosyphon radiator performance data.

4.2 Overall Procedure

The datalogger SOP can be summarized by the following procedures:

1. **Field Data Extraction.** Data collection requires that the data either be downloaded directly from the datalogger or the exchange of the flash card with a blank flash card. Complete details of this field procedure are described in Section 4.3.
2. **Data Download and Processing.** Complete details on these office procedures are described in Sections 4.4 and 4.4.3. This task involves extraction of data from the memory flash cards and subsequent forwarding of this data to the EOR.
3. **Maintenance**. This field procedure defines basic maintenance procedures necessary for the ongoing successful operation of the dataloggers (Section 4.5).

4.3 Field Data Extraction (Direct Download or Card Exchange Procedure)

4.3.1 Direct Download

This is the preferred download procedure as over time it has led to fewer card errors and download issues. This procedure uses the PC200W software. Prior to any download the particular datalogger has to be initialized in the software. The current field computer is set up for this, however should the datalogger be renamed after recalibration or PC200W be reinstalled, communication to each datalogger will need to be re-initialized on the computer (Appendix A1). Once installed and set up, the download procedure is as follows and screenshots are provided in Figure 7:

- **Step 1:** Connect the dedicated data transfer cable to the RS 232 port of the datalogger. Connect the cable to the field computer using either a serial port or a USB port through a Serial-USB adapter.
- **Step 2:** Open PC200W.
- **Step 3:** From the stations list on the left of the window select the appropriate datalogger. Ensure the selection the same datalogger being downloaded from, otherwise the file names will be misleading.
- **Step 4:** Click “Connect”. Once this is finished, select the “Download all data” button. This should start the download.
- **Step 5:** Switch to “Collect Data” tab.
- **Step 6:** Select “All data from datalogger (Overwrite data files)” option is selected; this enables the download of all data stored in the datalogger’s memory. Tick off all the files in the list of files for the complete download. Click “Collect”. Data collection may take 20 minutes or more if the datalogger is full. If the cables get disconnected for any reason, you have to restart the download.
- **Step 7:** Take note of the path to the downloaded files. The computer defaults to the main drive (C:\ drive for most computers) where it creates a “Campbellsci” folder. Once back to the office, these will be the files sent to SRK.
- **Step 8:** Click “disconnect”. **IMPORTANT,** If you close without disconnecting, next time you open PC200W it will be looking for the datalogger that was last connected, causing various problems with the laptop.
- **Step 9:** Disconnect the cables from the datalogger and from the field laptop.

4.3.2 Card Exchange (Alternative Method)

This should be completed as required, i.e., when the direct download method is not working. Steps 1 through 5 below explain the procedure for exchanging the memory flash cards for each of the two dataloggers:

- **Step 1:** Open each of the two weatherproof enclosures containing the dataloggers. Their physical locations, and key elements within the weatherproof enclosures are shown on Figure 6.
- **Step 2:** Push the removal button on the CFM100 Compact Flash Module, which is connected to the CR1000 datalogger. Wait for a green light. The removal button is located on the upper left corner of the unit, as illustrated in Figure 6. Note that it may take a few seconds for the green light to illuminate.
- **Step 3:** Once the solid green light is on, open the flash card cover hinged door (Figure 6). To do this, loosen the securing screw with manual finger effort (no need for hand tools).
- **Step 4:** Press the card release button and remove the flash card (Figure 6). The card release button is the small square button immediately above the flash card.

- **Step 5:** Place the exchange card into the flash card slot (it can only go in one way). Make sure that the correct card (marked as CR1000 #1 or CR1000 #2) is placed into the appropriate individual datalogger.
  - *Warning: Installing the wrong card will cause an error in the program which will prevent transfer of data to the card.*
- **Step 6:** Close and secure the hinged door by hand-tightening the securing screw (no need for any tools).

4.4 Data Download Procedure

4.4.1 Direct Download

For the direct download method, the steps above result in the files saved on the computer. Please ensure the file name generated by the datalogger. The naming convention includes

- File 1 – 8: NorthDamCR1000#n_m

Where: *n* = datalogger number (either CR1000 #1 or CR1000 #2)

m = file type (Daily_Samples, Public, StationStatus or Status)

Once back in the office, email all eight downloaded files to SRK as listed in Section 4.4.4 below.

4.4.2 Card Exchange (Alternative Method)

If the card exchange method is used in place of the Direct Download, follow the steps below to extract the data from the cards:

- **Step 1:** Insert the memory flash card into the appropriate slot of the Media Reader (Figure 8).
- **Step 2:** Connect the reader to a computer.
- **Step 3:** Copy the two files from each of the two cards and save to the hard drive.
- **Step 4:** Once copied, email all four files to SRK as listed in Section 4.4.4 below.

Please note that the two files from each card should automatically follow the following naming convention, and should not be altered:

- File #1: “HB_NorthDam_CR1000_#n.Daily_Samples_YYYY_MM_DD_HHmm.dat”
- File #2: “HB_NorthDam_CR1000_#n.StationStatus_YYYY_MM_DD_HHmm.dat”

Where: *n* = datalogger number (either CR1000 #1 or CR1000 #2)

YYYY = calendar year

MM = calendar month

DD = calendar date

HHmm = time

Note: the data and timestamp in the filename will correspond to the time and data that was first transferred onto the card, i.e., when the card was placed into the datalogger.

4.4.3 Data Pre-Processing Procedure

If the files collected during the card exchange procedure are too large to be sent by email, some pre-processing will be required. Typically, this will not be required unless files sizes exceed 10 megabytes (MB). Steps 1 through 5 below describe these data processing procedures:

- **Step 1**: Open the LoggerNet software and choose the “**Card Convert**” option from the “**Data**” menu.
- **Step 2:** Select the correct card drive by clicking on the “**Select Card Drive**” button and navigating to the appropriate computer drive. Select the files to be pre-processed.
  - *Note:* there will always be two files created at the same time (see Section 4.4.2). Select both files.
- **Step 3:** Select the output directory for the processed files. It is recommended that a folder directory be created and dedicated to the field data on the C:\ drive. That way the data can always be backed up by the download computer.
- **Step 4:** Click on the “**Destination Files Options**” button. From the pop-up window, select the “**ASCII Table Data (TOA5)**” format for the output file. Make sure to tick off the “**TimeDate Filenames**”, “**Create New Filenames**”, and “**Store Time Stamp**” options.
- **Step 5:** Email the *.TOA5 output files to SRK as listed in Section 4.4.4 below.

Figure 7 provides example software screenshots from the key steps above.

4.5 Maintenance Procedure

4.5.1 Battery Maintenance

The two 12-volt batteries (Node B and Node D as shown on Figures 3 to 5) powering the data acquisition system must be charged at least once every year. They can be charged with an automotive / car battery charger (typically in the range of 2 to 6 amps for 12-volt lead acid batteries). This should ideally be done in the fall, in preparation for winter operation.

When not connected to the 12-volt battery the datalogger has an internal battery to ensure that the internal clock/ time is maintained. The rest of the electronics are solid state so upon re-hooking up the 12-volt battery the data gathering will resume.

Twenty-four hours after the 12-volt batteries are recharged or replaced and reconnected to the data acquisition system, a data download (Section 4.4) is required. This check is required to ensure that the system is operational.

4.5.2 Datalogger Re-Calibration

Every five years the CR1000 dataloggers must be re-calibrated and the internal battery replaced. This work must be done by a qualified person approved by the EOR. Additional details on datalogger (CR1000) care and maintenance can be found in Appendix A1.

4.5.3 Desiccant Pack Maintenance

Desiccant packs have been placed in each datalogger and multiplexer housing (i.e., Nodes A to E as shown in Figures 3 to 5). These packs absorb condensation moisture inside the housings to protect the internal electronics. Desiccant packs must be replaced or oven dried (standard vented oven at 93^{o}C [200^{o}F]) when moisture inside the readout housing is visible, or when the desiccant status indicators are flagged (Figure 6). Damaged desiccant packs must be replaced.

4.6 Reporting Procedure

Any manually downloaded data should be provided in the required format as listed above. Any additional observations (such as noted damage or issues with the datalogger or cables) that may assist with data interpretations should be recorded and sent along with the compiled data downloads or the Visual Monitoring reports (Section 8). SRK should also be informed when battery recharges or other maintenance occurs.

All data or observations should be sent to the EOR jkurylo@srk.com, Peter Luedke, pluedke@srk.com, and the SRK team at hopebaymonitoring@srk.com.

5 Ground Survey Standard Operating Procedure

5.1 Objective

Ground surveys of the control points, deep settlement points, surficial survey points and crest settlement monitoring points are required. Figure 1 shows a general arrangement, along with primary survey control points, and Figure 3 presents a plan view of the instrumentation layout, including location names and UTM coordinates. Figure 10 shows a typical layout for the installed North Dam deformation monitoring instrumentation while Figure 11 shows additional details on the deep settlement points and surficial survey points.

5.2 Survey Procedures

The ground surveys/deformation monitoring should be completed with survey instruments that have accuracy in the range of ± 2 mm (horizontal and vertical). Likely these surveys will be completed by a Total Station survey; however, if the specified is maintained, other appropriate survey methods may be adopted by a qualified sub-contractor or TMAC surveyor. Additional details on “suggested guidelines of surveying at the North Dam”, with a Total Station, are presented in Appendix D (from Cornelissen 2013). Specifically, these guidelines discuss:

- Expected manpower and time allocation;
- Equipment and accessories;
- Metadata/control points;
- Station set-ups; and
- General surveying and survey error reduction.

For the deep settlement points and crest monitoring points a steel cap / top was fabricated to protect the monitoring points. Any accumulated dirt or ice around these protective caps should be removed and the caps removed to access the protected points. Before leaving the North Dam area, after the monthly ground survey, all caps should be cleaned. If the caps are moist, it is suggested that the insides of the caps be dried prior to being placed back over the monitoring points to avoid jamming or freezing. Any damage noted to any of the survey / monitoring points should be recorded and submitted with the survey data.

In addition to the monitoring points, the water level of the TIA reclaim pond should be surveyed to correlate the water level data (from the pressure transducer) with an elevation.

5.3 Reporting Procedures

The survey data is expected to be supplied in Excel or csv format. Any additional observations (such as noted damage) that may assist with data interpretations should be noted and sent along with the compiled survey data. All data should be sent to the EOR jkurylo@srk.com, Peter Luedke, pluedke@srk.com, and the SRK team at hopebaymonitoring@srk.com.

6 Slope Inclinometer Standard Operating Procedure

6.1 Objective

Six inclinometers were installed on the downstream slope of the dam, along the dam area that is expected to undergo the maximum amount of deformation. Procedures for taking, reading and transferring the collected inclinometer data using the dedicated software is outline below. Additional details and photographs of the inclinometer instrumentation are presented in Figures 12 to 14.

6.2 Procedure

6.2.1 Instrument Description

The inclinometer instrumentation (Figure 12) is comprised of the following parts:

- Inclinometer probe (manual provided in Appendix A3);
- Digitilt DataMate readout box (manual provided in Appendix A4);
- Control cable (on a spool); and
- Inclinometer casing (installed permanently on the dam).

The inclinometer probe is transported and stored in a plastic carry case (see Figure 12). The probe is a very sensitive instrument, and must be protected from shocks and vibrations as much as possible, i.e., transport it on the seat inside the cab, opposed to the cargo box or platform of the truck.

6.2.2 Measurement Procedure

The following steps should be followed when taking a measurement:

- **Step 1:** Connect the readout to the probe using the control cable. Avoid over-tightening the connector at the probe end, which would reduce the effectiveness of the O-ring seal.
- **Step 2:** Remove the steel cap off the inclinometer casing, exposing the top of the inner (blue) guide casing.
- **Step 3:** Turn the readout box ON. This will power up the servo-accelerometers inside the probe, making them less vulnerable to shocks.
  - *Note:* the switch lever must be pulled up slightly when turning the readout on or off.
- **Step 4:** Cup the wheels of the probe with one hand and lower the probe in the casing. Make sure the upper wheel is aligned with the groove facing upstream (southeast/towards the reclaim pond and approximately perpendicular to the dam centerline), as shown in Figure 13.
  - *Note:* To avoid the need for data corrections, care should be taken to ensure that for the first set of readings at each location, the orientation of the upper inclinometer wheel is positioned in the groove towards the upstream.

- *Note:* After long periods between collecting inclinometer measurements (more than two months), the inclinometer holes should first be measured with a weighted tape measure to better determine an expected maximum reading depth. If water, soil or rock can make it within the plastic acrylonitrile butadiene styrene (ABS) casing, the maximum reading depth may be affected.

- **Step 5:** Lower the probe slowly to the bottom of the casing, making sure not to strike the bottom of the hole. The probe will therefore be about 15 cm past the deepest expected measurement marker on the control cable (expected depths provided in Table 4).

  - *Note:* To assist in estimating the total depth, the measurement beads on the inclinometer cable should be counted as they are lowered down hole. Total depth estimate in meters, can then determined by multiplying the counted number of beads by 0.5 m (or divide the number of beads lowered down the hole by two).

- **Step 6:** Wait ten minutes to allow the probe temperature to equilibrate with the temperature in the hole.

  - *Note:* If multiple holes/locations are being completed in one day, as long as the probe is not removed from the ambient air temperatures (i.e., moved or temporarily stored within a vehicle or heated container), then the temperature equilibration time can be reduced to five minutes for subsequent holes (i.e., 10 minutes equilibration on the first hole and then five minute equilibration on the remaining holes).

- **Step 7:** Once the probe has equilibrated, the arrows on the readout box should be used to move the cursor to select "**Read**" from the menu screen. Press "**Enter**" to complete the selection.

- **Step 8:** Next "**Record**" should be selected from the menu screen. Again "**Enter**" should be pushed for selection. From the installation list that comes up, select the station location that matches the location the current reading is being taken at. Press "**Enter**" to step past each parameter, as no edits should be needed. The complete list of locations is provided in Table 4.

Table 4: Inclinometer Installation and Measurement Details

Site Name	Installation	Minimum Reading Depth (m)	Maximum Expected Reading Depth* (m)	Reading Intervals (m)
N. Dam	070-1	0.5	14.5	0.5
N. Dam	070-2	0.5	14.0	0.5
N. Dam	070-3	0.5	12.5	0.5
N. Dam	120-1	0.5	12.0	0.5
N. Dam	120-2	0.5	11.0	0.5
N. Dam	120-3	0.5	4.5	0.5

*Based on initial set of readings completed / gather by SRK on September 8 and 9, 2012

- **Step 9:** The next screen will show the start depth (e.g., bottom reading for each hole, for example 14.5 for N.Dam:120-1) and the first readings for the A and B axis (A0 and B0 respectively). Figure 12 shows the designation of the A, B, A0 and B0 axes.
  - *Troubleshooting Note:* If there are discrepancies between what is pre-programmed into the readout box and what is measured in the field as the maximum reading depth, then one of the following options should be completed before proceeding to Step 10:
    1. Scroll up on the readout box until the measured maximum depth is reached; or
    2. Repeatedly press "**Enter**" on the readout box to input a 'dummy' or/stand-in value for the bottom intervals until the desired field measured maximum reading depth is reached. Notes should be taken to reflect which depths have 'dummy' numbers recorded in them.
- **Step 10:** Slowly raise the probe off the bottom of the inclinometer casing to the first measurement mark on the control cable. The range of measurement depths for each inclinometer station is provided in Table 4. Hold the top of the marker aligned with the top of the casing, as shown in Figures 13 and 14. The cable has yellow markers at 0.5 m intervals and red markers at 1 m intervals, i.e. alternating red and yellow markers.
- **Step 11:** Allow the readings to stabilize. A diamond will be displayed next to each number when the readings are stable. Press "**Enter**" to record the readings. The recorded readings will be marked with a star and shown on the bottom line of the display. The new depth will appear on the top line.
  - *Note:* every reading should be taken from the same point/location on the top of the inclinometer casing to limit measurement errors and discrepancies. These errors are often later apparent as large A & B checksum values when the data is downloaded, see Section 6.2.3. For best measurement repeatability, the location where measurements are being taken from should be marked on the top of the inclinometer casing with a permanent marker or tape.
- **Step 12:** If the readings do not seem to stabilize, record the average of the shown readings manually in your field book and then skip the level using the UP arrow. One average should be recorded for each A0 and B0 respectively.
- **Step 13:** Pull the cable up until the next measurement mark on the cable is aligned with the top of the inclinometer casing (at the same measurement location as used in Step 11). Record the reading when the numbers have stabilized.
  - *Note:* If any of the reading measurement markers are overshot then the probe should be lowered back to the previous level and then raised again to the exact marker depth. To ensure consistent measurements the probe must be drawn upward before each reading.
- **Step 14:** Repeat the process for each mark on the cable, until the probe is at the top of the casing (i.e., last reading will be at the 0.5 m mark on the cable).
- **Step 15:** After the last reading, the readout will display a menu screen. Select "**Continue**" from the menu options.

- **Step 16:** Carefully lift out the probe, cupping the wheel assemblies with your hand to prevent them from snapping open.
- **Step 17:** Holding the probe upright, slowly rotate it 180 degrees (do not flip), and re-insert the probe into the inner inclinometer casing. This time the upper wheel will be facing downstream (northwest/toward the camp or slightly west of the Doris Creek Bridge location).
  - Note: It is important that the probe is rotated 180 degrees and not into the inclinometer casing groves that are only 90 degrees from the initial groves. A full 180-degree rotation of the probe is required so that readings are taken both ways down the hole. This 180-degree rotation allows for a second set of measurements to be recorded which can then be later used to eliminate potential small errors in calibration. A reading should be taken from the same marked location at the top of the inclinometer casing, as outlined in Step 11.
- **Step 18:** Allow the probe to re-equilibrate for five minutes then repeat Steps 4 through 14. Parameters A and B will change to A180 and B180.
  - *Note:* These readings will be marked with the pi sign (π).
- **Step 19:** After the last reading select "**Done**" from the menu and move to the next station.
- **Step 20:** Make sure the blue protective cap for the inclinometer casing is placed back on and is secured. Before moving to the next inclinometer location, the steel cover should be re-placed back over the steel protective housing.

  Refer to the user manuals of the Digitilt Inclinometer (Appendix A3) and the Digitilt DataMate II (Appendix A4) for further details, if/as needed. Figure 2 shows the physical location of each inclinometer station.

6.2.3 Data Transfer

Once the data has been recorded, it is stored in the internal memory of the readout box. The data can be retrieved from the readout by connecting the readout box to a personal computer running a Windows operating system. Once connected, the Digitilt's DataMate Manager (DMM), DigiPro or DigiPro 2 program (all versions of the Durham Geo Slope Indicator software) can be used to complete the data transfer. A manual for the DMM for Windows, DigiPro and DigiPro 2 for Windows software is presented in Appendix A5, A6 and A7 respectively. The following steps should be followed to allow for a successful data transfer:

- **Step 1:** Download and install the DMM, DigiPro or DigiPro2 software (Slope Indicator software) from the Slope Indicator website (www.slopeindicator.com/downloads/dmm-download-page.html).
- **Step 2:** Start the Slope Indicator software program.
- **Step 3:** Power up the readout.
- **Step 4:** Connect the readout to the PC using the USB cable provided.
- **Step 5:** On the readout box, choose "**Comm**" from the main menu.

- **Step 6:** Open the Slope Indicator software. Go to "**File**" on the menu bar and then select "**New**" to create a new file or "**Open**" to navigate and open and existing database file.
  - Note: only once you have created or selected an existing database file will you be able to access the "DataMate" menu bar outlined in Step 7.
- **Step 7:** In the Slope Indicator software, select the "**DataMate**" drop-down menu.
- **Step 8:** Select the appropriate "**Comm Port**" (communication port) from the drop-down menu.
  - *Note:* each port (such as USB port) on your computer may have a different "Communication Port" number designation. Make sure you select the right Communication Port number for the installed cable driver. If the selected Communication Port is not responding, then you may need to try a different Communication Port number. If all ports do not work, you may need to download a new driver for the cable by connecting to the internet then connecting the port to your computer. Alternately drivers can be downloaded from www.slopeindicator.com.
- **Step 9:** From the main menu of the Slope Indicator software, select "DataMate" and then pick "Retrieve All" from the drop-down menu (Figure 14).
  - *Note:* different retrieved surveys may be dragged and dropped into a saved / compiled project database (i.e., a database with all the data for each round of measurements saved into it). Alternately you can go to "**File**" then "Import" on the drop-down menu to add in additional field data, if/as desired, to a compiled site inclinometer database.
- **Step 10:** From the main menu of the Slope Indicator software, select "**File**" and then pick "**Save As**" from the fly-down menu (for the older DMM or DigiPro software). Alternately if you are using DigiPro2 create a backup database by selecting "**File**" and then "**Backup Database**" from the fly-down menu (Figure 14).
  - *Note:* once the inclinometer survey / field data is received into the Slope Indicator software it can be viewed by clicking the drop-down sections / inclinometer location groupings on the left-hand side of the screen. Note that each of the individual field surveys can then be viewed by again clicking / expanding the file tree list below each inclinometer location / grouping.
    - When viewing the raw field data, the "**A_Checksum**" and "**B_Checksum**" columns can be used to check the quality of the survey data. Typically, these A and B checksum values (unit less) should be $\pm$ 50 or less, and with no more than two values for any given survey location being between 50 and 100; excluding the top 0.5 m depth rows / readings. Checks on the data quality will be done by the EOR however; the steps outlined above can proactively be completed by site personnel to limit the chance of re-surveys being asked for.
- **Step 11:** Save the data as a project database (or backup database) to the computer's desktop. The file can then be moved and stored for archiving after it has been e-mailed to the EOR.

The primary component of the file name is the date the data was collected on. The file names should be similar to the example “Copy of DataMate_*YYYY_MM_DD*.mdb” Where:

YYYY – calendar year

MM – calendar month

DD – calendar date

- **Step 12:** Close the software and turn off the readout.
- **Step 13:** Send the data to the EOR jkurylo@srk.com, Peter Luedke, pluedke@srk.com, and the SRK team at hopebaymonitoring@srk.com.. Any additional field notes that outline details about how the inclinometer field survey was completed or about conditions at the time of this survey should be supplied with the updated database file.

6.3 Instrument Maintenance

6.3.1 General

When all measurements are complete, disconnect the control cable from the probe and the readout. Wipe the probe and the cable clean and replace the protective caps of the readout and the probe for transport.

Once back inside (e.g., office), open the probe carry case and remove all protective caps of the probe and the readout to allow the instruments and the connectors to dry for a few hours.

Before initially heading out to the field, the probe should be connected to the readout and tested in the office to ensure that a proper connection between the probe and DataMate is being made.

6.3.2 Battery Maintenance

The Digitilt DataMate battery should be charged overnight prior to collecting the survey data. The Digitilt DataMate has an AC main socket for the battery charger attachment or for external power if/as required. Battery levels can be checked by going to the ‘**Utilities**’ menu, then by choosing ‘**Batt**’. A new, fully charged battery should show approximately 6.6 volts with a full charge. The battery should be recharged if below 6 volts. It is best to charge the battery overnight if possible.

6.3.3 Desiccant Pack Maintenance

The desiccant is located inside the Digitilt DataMate. To check the moisture level in the DataMate go to the ‘**Utilities**’ menu and choose ‘**Temp**’. The DataMate displays humidity and temperature. Humidity levels from 20% to 60% are normal and if the humidity exceeds 75%, replace the desiccant (Appendix A4, page 16 of Digitilt DataMate manual).

7 Water Level Monitoring Standard Operating Procedure

7.1 Objective

Performance monitoring of the North Dam can only be properly done in conjunction with an accurate determination of the water level behind the dam. Water levels are recorded and transmitted to the online portal on regular basis.

7.2 Measurement Procedures

The water level measurements are recorded at TIA-2 using a permanent data logger (Instrumentation Northwest Inc.) paired with a HOBO Energy Pro Datalogger (Onset Computer Corp.). The data is then transmitted by a solar-powered iridium satellite transceiver where it can be accessed on the online portal. There is also a back-up datalogger installed but is not part of the regular monitoring SOP (Appendix F)

The data logger is configured to collect a reading every 15 minutes and the data is transmitted to an online portal on a regular basis (currently every 5 days). The login details are as follows:

> https://datagarrison.com/
> Username: 300234010417660
> Password: hobo

Water level data will be monitored by SRK from the online portal. If modification to the datalogger-transmitter configuration are made, provide details to SRK at hopebaymonitoring@srk.com.

Water levels are measured as meters of water (head) above the data logger and require a known elevation of the datalogger or, more easily acquired, a surveyed water level for accurate translation to elevations for comparison to critical dam elevations. When initially installed by ERM (September 2017) a constant of 27.761 m was to be added for conversion to an elevation (Appendix F). As such, the only steps for active monitoring of the water level are as follows:

- **Step 1:** Regularly inspect the datalogger-transmitter setup at TIA-2 to confirm no damage or modification has occurred. Possible causes could be ice movement, human modification or animal interaction.
- **Step 2:** If damage or modification is noted, it must be reported with the time, date, detailed observations and at least one photo to SRK at hopebaymonitoring@srk.com.
- **Step 3:** As part of the monthly survey data collection (Section 5) a survey point of the water level must be collected.
- **Step 4:** In addition, ERM proposes to complete bi-annual water level surveys of the TIA reclaim pond to update the water level conversion constant, when received, these must also be provided to SRK to ensure agreement between surveys.

7.3 Reporting Procedures

Water level data recorded by the TIA-2 logger-transmitter system will be downloaded from the online portal discussed in this section. The water level survey data is expected to be supplied in Excel compatible format and would be sent along with the ground survey data (Section 5). Any observed changes to the TIA-2 configuration should be sent to the EOR jkurylo@srk.com, Peter Luedke, pluedke@srk.com, and the SRK team at hopebaymonitoring@srk.com.

8 Visual Monitoring Standard Operating Procedure

8.1 Objective

Formal visual (walk over) inspections of the South Dam, and immediate surrounding area, is required to act as an early notification for potential issues in areas not directly monitored by the installed instrumentation or other monitoring activities. Two levels of inspection are proposed:

1) Daily monitoring to identify issues or observations that may adversely impact the dam.

2) Full weekly visual (walk over) inspections.

8.2 Daily Visual Inspection

It is expected that the tailings deposition operations are monitored daily by qualified site staff at the TIA. The daily inspections are not intended to be an intensive exercise, rather it should include a walking or driving from one end of the dam to the other inspecting for major changes that have the potential to compromise its performance between weekly inspections. These inspections should include:

1. Settlement, depressions, sinkholes, cracking or signs of movement along the crest, the downstream or upstream face of the dam;

2. Significant changes in the observed seepage conditions compared to the prior weekly inspection;

3. Rapidly changing erosion conditions at the interface of the dam and the tundra;

4. Any other atypical conditions observed that are concerning or have the potential to compromise the dam performance.

There is no reporting requirement for the daily visual inspections and should be conducted as part of a daily ‘round’ at the TIA.

8.3 Weekly Visual (Walk Over) Inspection and Reporting

The upstream and downstream slopes and crests of the dams should be the focus during the walk over visual inspections. Specifically, the following should be noted:

1. Erosion

    (a) Any erosion over 5 cm in depth should be noted. Erosion locations should be recorded (using a handheld GPS or survey) and photographed.

    (b) If erosion is notable then it should be monitored carefully to ensure that conditions do not worsen (i.e., getting larger, deeper, to greater extent).

    (c) If erosion can be measured, then simple visual estimates or measurements with a tape measure should be completed on the larger erosional features.

2. Settlements / Depressions / Sinkholes.

   (a) If observed, then locations should be recorded (with GPS), photographed and the dimension / extents estimated.

3. Cracks/ Movements

   (a) If signs of cracking or movement are apparent then the crest on the upstream and downstream should be noted, photographed and the approximate crack dimension should be estimated or measured.

4. Debris and Vegetation

   (a) Any debris or vegetation growing on the upstream and downstream slopes of the dam should be noted.

   (b) Materials should not be stockpiled on the dam surface. Any debris on the dam should be removed to assist with better performing visual inspections over these areas.

   (c) Snow can affect thermal performance of the dam. Natural snow drifting over 1.0 m should be noted.

5. Ponding or Potential Seepage

   (a) Seepage is defined as water in contact with and flowing downstream of the dam. Walk the full length of the downstream dam toe to identify and currently flowing seepage locations or location that appear to have evidence of past seepage (which can be monitored going forward).

   (b) If seepage water is found, note the location (by dam chainage/station or GPS), photograph and provide a preliminary estimate the seepage rate if possible.

   (c) Ponded water exists only at the lowest point at the downstream toe of the dam. If new ponded areas are observed along the downstream toe, note the location and approximate extent on the inspection form and photograph.

   (d) Notify the on-site environmental coordinator to assess and conduct seepage monitoring (Section 9).

6. Instrumentation

   (a) Look for visual damage to instrumentation (i.e., does all instrumentation appear to be intact or has it been damaged by equipment, animals or personnel?).

   (b) If damage is noted, then photographs and notes / observations should be collected to assist with determining if repair of the instrumentation is possible.

7. Thermosyphon Radiators

   (a) Look for visual damage or corrosion to thermosyphon radiators (i.e., is any rust notable, is any physical damage notable, and is the thermosyphon radiators generally still upright).

(b) If damage is noted, then photographs and notes / observations should be collected.

A monitoring checklist is presented in Appendix E. This inspection form, along with any photos or notes from the inspection should be formally recorded and submitted to the EOR jkurylo@srk.com, Peter Luedke, pluedke@srk.com, and the SRK team at hopebaymonitoring@srk.com.

The EOR should be notified immediately after any inspection where notable changes to any of the areas / items listed above are observed. The EOR will work with TMAC to provide further guidance on monitoring or sampling requirements and to determine if mitigation measures are required.

9 Seepage Monitoring Standard Operating Procedure

9.1 Objective

Seepage or contact water flowing from the toe of the North Dam has been observed since dam construction. With deposition of tailings ongoing, seepage monitoring is required to confirm that the source is not seepage from the TIA.

This procedure must be conducted when potential seepage is identified during the Visual Monitoring (Section 8) or **weekly** once potential seepage has been identified.

9.2 Procedure

Seepage is defined as water flowing from the toe of the North Dam. Monitoring and sample collection are to be performed by on-site environmental personnel, who are trained in seepage identification and sample collection methods. Seepage monitoring of the North Dam toe specifically is described as follows:

1. Complete a walk over survey on foot. This will consist of walking the full length of the downstream dam toe to identify any currently flowing seepage locations or location that appear to have evidence of past seepage (which can be monitored going forward). Ponded water should be inspected for seepage feeding into the ponded water, if none, no sampling is required.
2. At each flowing seepage location, collect water samples for the parameters listed in the laboratory analytical suite (LAS) listed in this section and record the following field data:
   - GPS coordinates,
   - Photographs (upstream and downstream shots),

   (a) Volumetric flow rate

   1. Volumetric flow rates determined as follows:

   For samples collected at the v-notch weir:

   - The height of the water in the weir reservoir, relative to the bottom of the v-notch itself, should be measured. The level should not be measured in the v notch (this could be done as a check but should not be the primary measurement).
   - For calibration of the v-notch weir, a container of known volume should be filled from the flow passing through the v-notch. The time required to fill the entire container (of a know volume – e.g. 1L) should be recorded. This should be repeated three times per sampling event. This is most critical during the first sampling events of the year.
   - All seepage that reports the v-notch weir area should be directed through the weir. Where a large proportion of the seepage is flowing around the weir, the

percentage of total seepage flowing through the weir should be estimated and reported with the field notes.

For samples collected at the toe of the dam (not at the v-notch weir):

- Flow volume and velocity can be estimated by taking a container of a known volume and recording the time it takes for the seepage to fill the known volume. Alternatively, estimate the cross-sectional area of the flow and using a stop watch visually estimate the velocity of the water (time for identifiable debris to travel a known distance through the estimated cross-sectional area). To help improve accuracy of the estimate / measurement, at least three iterations of the estimate should be completed.

(b) Field measurements: temperature, pH, electrical conductivity (EC), chloride, and oxidation reduction potential (ORP),

(c) Date and time,

(d) Name of sampler, and

The seepage sampling frequency is **once per week** while seepage is occurring or at the discretion of the EOR.

3. For every seepage sampling event, collect additional samples at the following locations:

(a) SNP station TL-1 (Reclaim Barge)

1. Field measurements (temperature, pH, EC, chloride, ORP), and
2. Water samples for lab parameters listed below (LAS).

(b) Upstream side of the North Dam (reservoir touching the upstream slope)

1. Field measurements (temperature, pH, EC, chloride, ORP), and
2. Water samples are not required at this location.

4. **Once per month**, collect the following QA/QC samples to validate the geochemical data set:

(a) One field duplicate, one travel blank and one field blank for lab parameters listed below (LAS); and

(b) For the field duplicate only, field measurements (temperature, pH, EC, chloride, ORP).

5. **Once per month** during routine sampling of SNP station TL-5 (tailings supernatant discharge from the mill), collect samples for the analysis of:

(a) Field measurements (temperature, pH, EC, chloride, ORP), and

(b) Water samples for lab parameters listed below (LAS).

(c) This monthly sampling of TL-5 satisfies the TL-5 monitoring requirements outlined in the South Dam SOP (SRK, 2020).

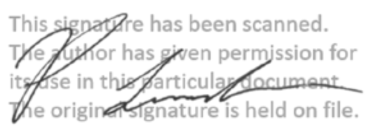
The laboratory analytical suite (LAS) for North Dam Seepage Monitoring Program is as follows:

- Lab pH and EC
- SO_4, Cl
- Alkalinity
- Ammonia, NO_3, NO_2, Total N
- Total CN, Free CN
- SCN, CNO
- Total metals (including sulphur and mercury)
- Dissolved metals (including sulphur and mercury)

9.3 Sample Shipment and Reporting Procedure

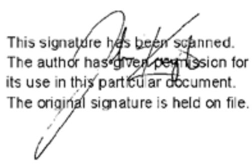
Water samples are to be shipped to ALS Environmental. When samples are shipped, the appropriate Chain of Custody (COC) form and the field data should be sent to SRK, and the Engineer of Record (EOR) should be notified that the sample have been collected and shipped. Upon receipt of the lab results, these should also be sent to SRK. All documentation and results should be sent to Lbarazzuol@srk.com (Lisa Barazzuol) rcocuaco@srk.com (Rosie Cocuaco), mting@srk.com (Maritess Ting) and Hopebaymonitoring@srk.com (SRK Hope Bay monitoring account).

This report, “Hope Bay Project, North Dam Monitoring: Standard Operating Procedures – Revision 3”, was prepared by SRK Consulting (Canada) Inc.

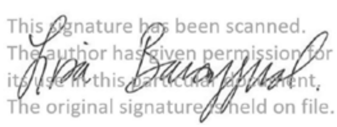


Peter Luedke, EIT
Consultant

and reviewed by:



John Kurylo, MEng PEng
Senior Consultant



Lisa Barazzuol, PGeo
Principal Consultant (Geochemistry)

All data used as source material plus the text, tables, figures, and appendices of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

10 References

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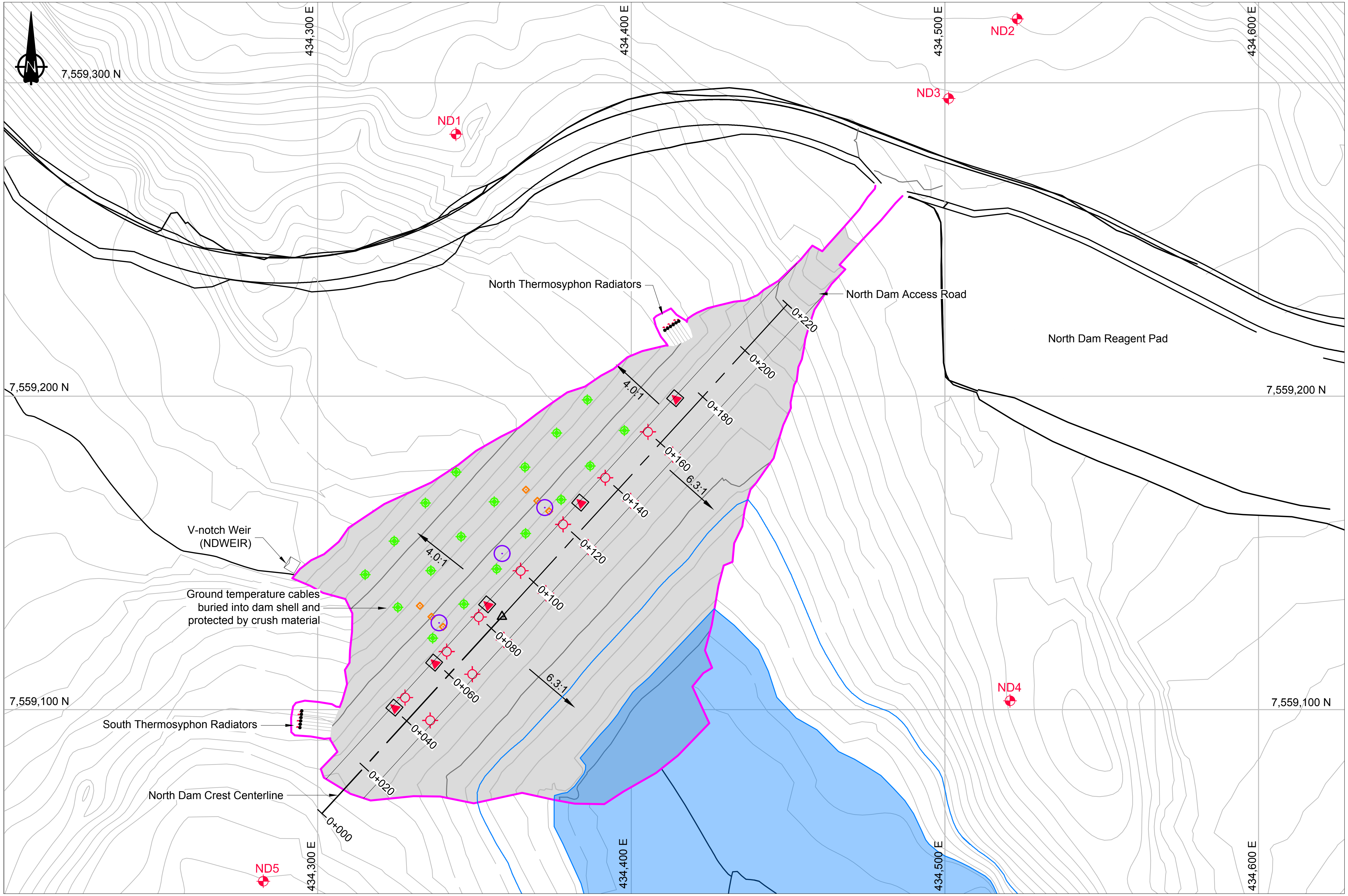
Figures



LEGEND

- Primary Control Point
- Survey Monitoring Point (Crest)
- Deep Settlement Point
- Surficial Survey Point
- Inclinometer Location
- Major Contour
- North Dam Extents
- Full Supply Level (Elev. 33.5m)
- Thermosyphon Radiator
- GTC Instrumentation Node

NOTES

1. Topographic contour data was provided by the Client. As-Built contour data for terrain model was provided by the Contractor.
2. Contours shown at 1.0m intervals.
3. Details and names for instrumentation presented on Figure 2.

REFERENCE

NAD83 UTM Zone 13.

PRIMARY CONTROL POINTS STAKE OUT TABLE

Point ID	Northing	Easting	Elev. (m)
ND1	7559283.611	434344.083	42.905
ND2	7559320.367	434522.981	46.915
ND3	7559295.013	434501.167	45.38
ND4	7559102.79	434520.744	44.236
ND5	7559045.274	434282.658	42.871

0m 10 20 30 40 50

srk consulting

SRK JOB NO.: 1CT022.036.500

FILE NAME: 1CT022.036 - Monitoring SOP.dwg

MAC RESOURCES

Hope Bay Project

North Dam SOP

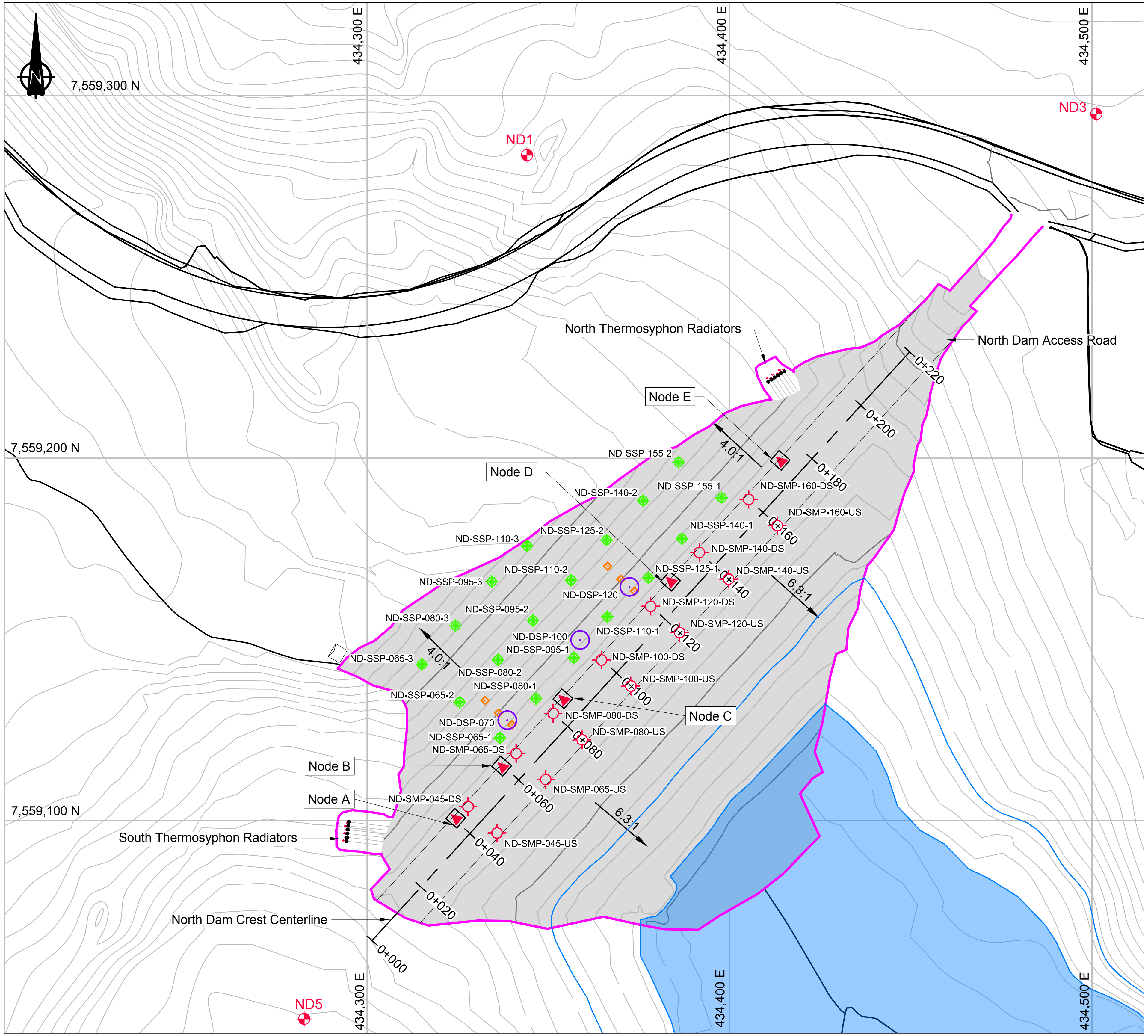
North Dam General Arrangement and Primary Control Points

DATE: August 2019

APPROVED: PL

FIGURE: 1

P:\01_SITES\Hope Bay\!ACAD\2019 Drawings\North Dam SOP\1CT022.036 - Monitoring SOP.dwg



LEGEND

- Primary Control Point As-Built
- Survey Monitoring Point (Crest)
- Deep Settlement Point
- Surficial Survey Point
- Inclinometer Location
- Major Contour
- Final Surface Extents
- Full Supply Level (Elev. 33.5m)
- Thermosyphon Radiator
- GTC Instrumentation Node

NOTES

1. Topographic contour data was provided by the Client. As-Built contour data for terrain model was provided by the Contractor.
2. Contours shown at 1.0m intervals.
3. Nodes B and D are the two weatherproof enclosures which house the GTC instrumentation nodes

REFERENCE

NAD83 UTM Zone 13.

AS-BUILT DEEP SETTLEMENT POINTS STAKEOUT TABLE

ID	Northing	Easting	Elev. (m)
ND-DSP-070	7559127.69	434338.65	36.95
ND-DSP-100	7559149.78	434358.75	36.86
ND-DSP-120	7559164.46	434372.37	36.92

AS-BUILT SURFICIAL SURVEY POINTS STAKEOUT TABLE

ID	Northing	Easting	Elev.(m)
ND-SSP-065-1	7559122.80	434336.67	36.77
ND-SSP-065-2	7559132.67	434325.55	32.81
ND-SSP-065-3	7559143.10	434315.11	29.43
ND-SSP-080-1	7559133.65	434346.59	36.79
ND-SSP-080-2	7559144.37	434336.10	32.92
ND-SSP-080-3	7559153.75	434324.36	29.33
ND-SSP-095-1	7559144.90	434357.04	36.58
ND-SSP-095-2	7559155.21	434345.72	32.85
ND-SSP-095-3	7559165.92	434334.35	28.70
ND-SSP-110-1	7559156.20	434366.29	36.32
ND-SSP-110-2	7559166.31	434356.29	32.88
ND-SSP-110-3	7559175.79	434344.10	28.97
ND-SSP-125-1	7559166.97	434377.61	36.77
ND-SSP-125-2	7559177.37	434366.08	32.91
ND-SSP-140-1	7559177.75	434386.85	36.48
ND-SSP-140-2	7559188.28	434376.19	32.84
ND-SSP-155-1	7559189.07	434397.79	36.80
ND-SSP-155-2	7559198.85	434385.98	32.91

AS-BUILT SURVEY MONITORING POINTS STAKEOUT TABLE

ID	Northing	Easting	Elev. (m)
ND-SMP-065-DS	7559118.52	434341.14	38.46
ND-SMP-065-US	7559111.31	434349.30	38.36
ND-SMP-080-DS	7559129.57	434351.35	38.41
ND-SMP-080-US	7559122.27	434359.34	38.40
ND-SMP-100-DS	7559144.32	434364.71	38.39
ND-SMP-100-US	7559137.12	434372.77	38.46
ND-SMP-120-DS	7559159.12	434378.24	38.41
ND-SMP-120-US	7559151.88	434386.24	38.46
ND-SMP-140-DS	7559173.98	434391.69	38.39
ND-SMP-140-US	7559166.62	434399.77	38.42
ND-SMP-160-DS	7559188.64	434405.30	38.40
ND-SMP-160-US	7559181.37	434413.18	38.43

Node (Station)	GTC Name
Node A (0+040)	1.ND-VTS-040-KT
	12.ND-HTS-040-31.5
	13.ND-HTS-040-33.5
Node B (0+060)	2.ND-VTS-060-KT
	3.ND-VTS-060-US
	4.ND-VTS-060-DS
	14.ND-HTS-060-28.8
	15.ND-HTS-060-31.0
	16.ND-HTS-060-33.5
Node C (0+085)	5.ND-VTS-085-KT
	6.ND-VTS-085-US
	7.ND-VTS-085-DS
	17.ND-HTS-085-25.3
	18.ND-HTS-085-29.4
	19.ND-HTS-085-33.5
Node D (0+130)	8.ND-VTS-130-KT
	9.ND-VTS-130-US
	10.ND-VTS-DS
	20.ND-HTS-130-28.8
	21.ND-HTS-130-31.0
	22.ND-HTS-130-33.5
Node E (0+175)	11.ND-VTS-175-KT
	23.ND-HTS-175-32.5
	24.ND-HTS-175-33.5
	25.N Thermosyphons (x6)
	26.S Thermosyphons (x6)

AS-BUILT INCLINOMETER LOCATION STAKEOUT TABLE

ID	Northing	Easting	Elev. (m)
ND-IN-070-1	7559126.41	434340.00	37.44
ND-IN-070-2	7559129.63	434336.27	36.20
ND-IN-070-3	7559133.13	434332.57	34.85
ND-IN-120-1	7559163.31	434373.78	37.44
ND-IN-120-2	7559166.64	434370.03	36.05
ND-IN-120-3	7559170.15	434366.40	34.95

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SRK JOB NO.: -

FILE NAME: 1CT022.036 - Instrumentation LO.dwg

MAC RESOURCES

Hope Bay Project

North Dam SOP

North Dam Instrumentation Layout

DATE: August 2019 | APPROVED: - | FIGURE: 2

P:\01_SITES\Hope Bay\!ACAD\2019 Drawings\North Dam SOP\1CT022.036 - Instrumentation LO.dwg

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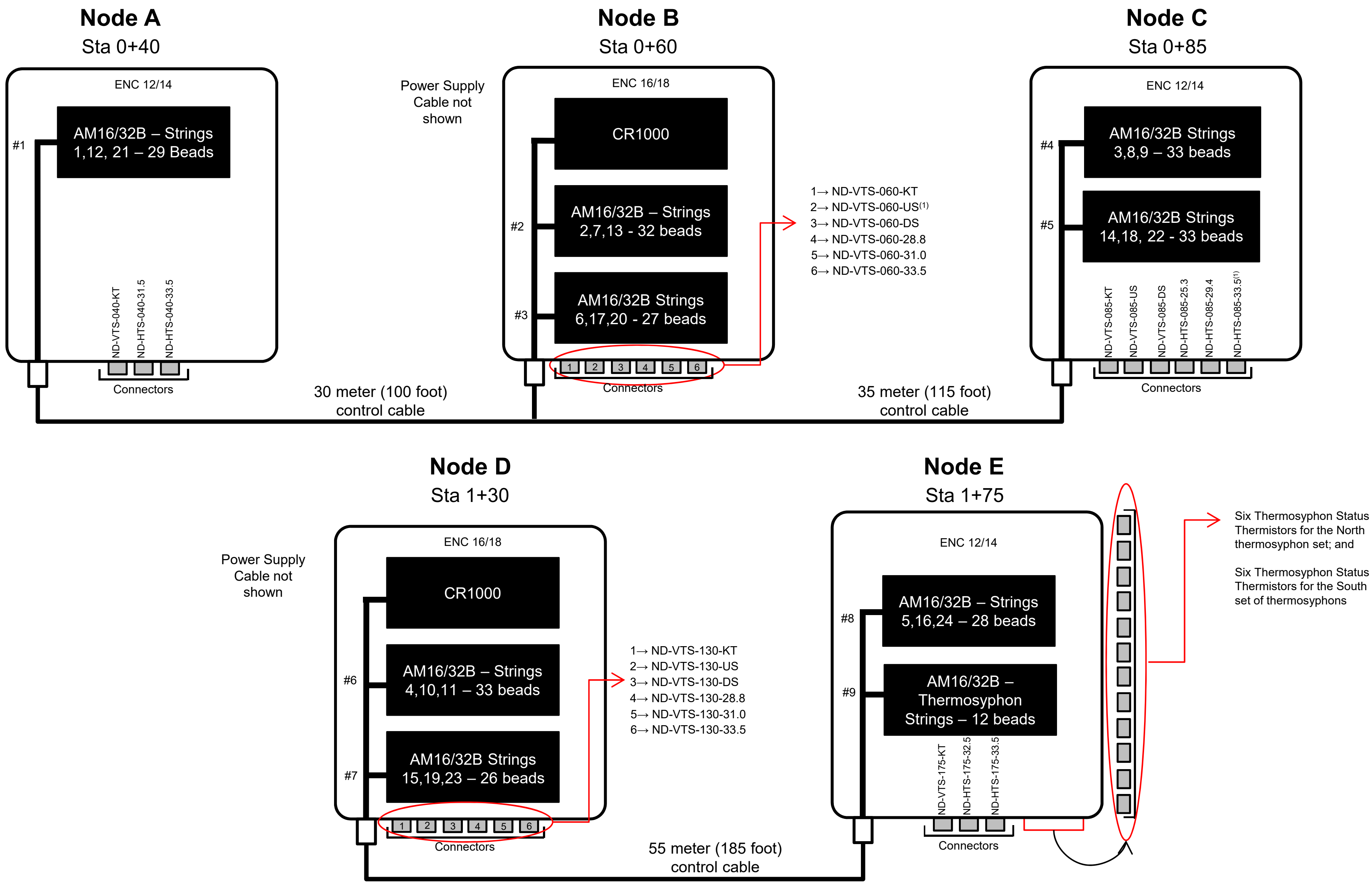
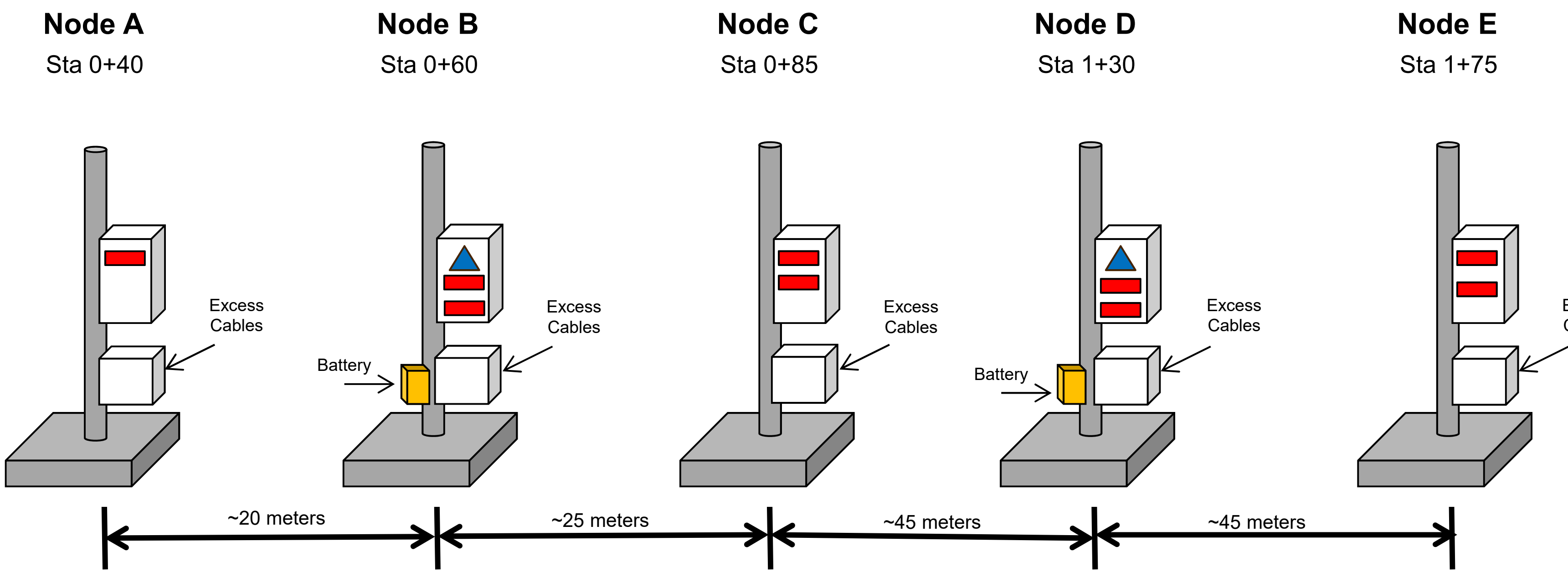


Notes:
Internal temperature of data logger housing is measured continuously.
(1) GTC irreparably damaged, no recorded data.

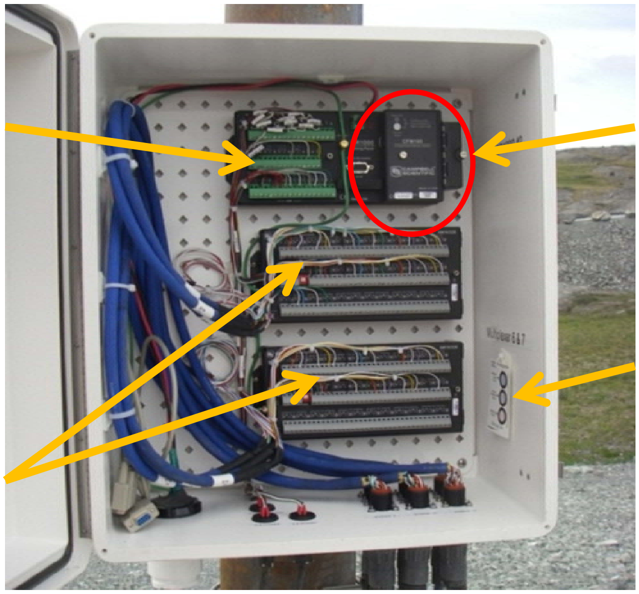
srk consulting	TMAC RESOURCES	North Dam Monitoring SOP (Revision 3)
		Monitoring Nodes A through E
Job No: 1CT022.000 Filename: HopeBay_NorthDamMonitoringSOP_Rev03_Landscape_1CT022.000_pl_Rev00	Doris Mine	Date: July 2020 / Approved: JBK/IM/PL / Figure: 3



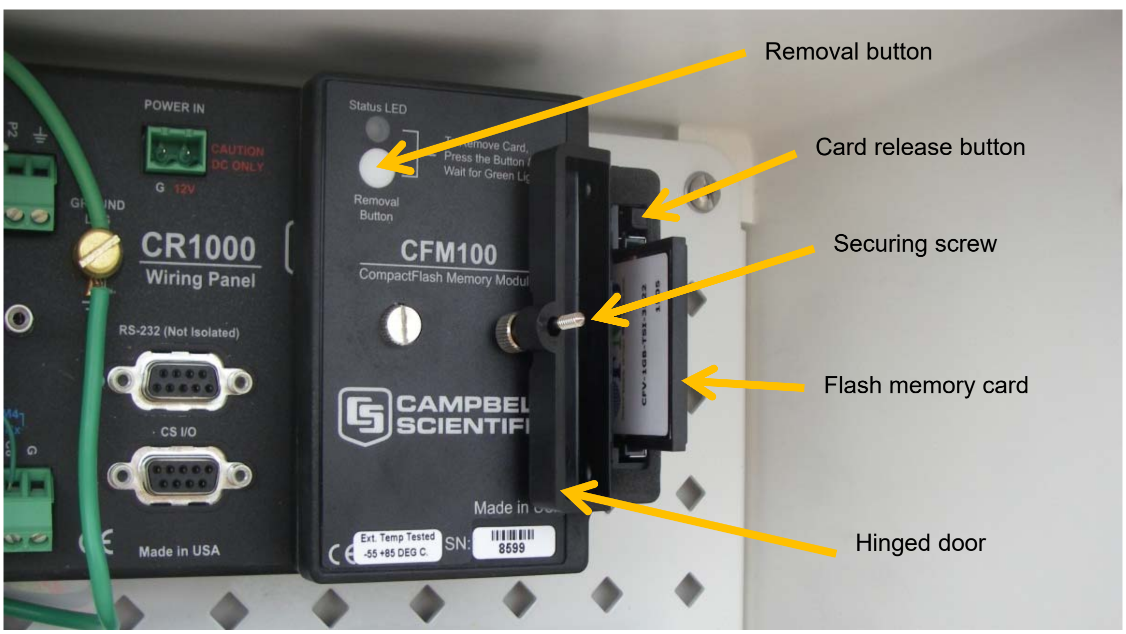
Legend

(red rectangle)	AM 16/32 Multiplexer
(blue triangle)	CR1000 Datalogger

srk consulting	TMAC RESOURCES	North Dam Monitoring SOP (Revision 3)
		Layout of Data Acquisition System
Job No: 1CT022.000 Filename: HopeBay_NorthDamMonitoringSOP_Rev03_Landscape_1CT022.000_pl_Rev00	Doris Mine	Date: July 2020 · Approved: JBK/IM/PL · Figure: 4



Key components inside the weatherproof enclosure

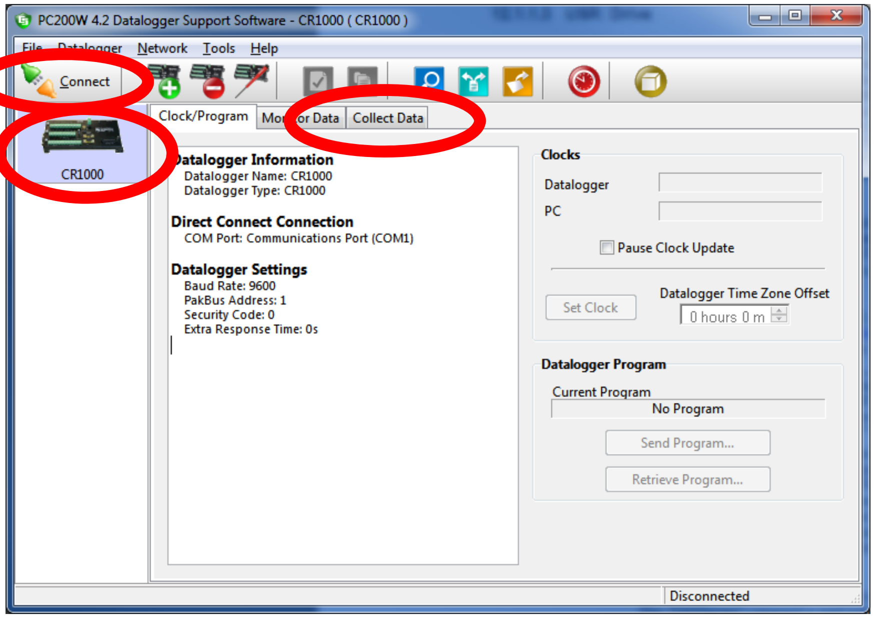


Close-up view of the CR1000 data logger and CFM 100 Compact Flash Module inside the weatherproof enclosure

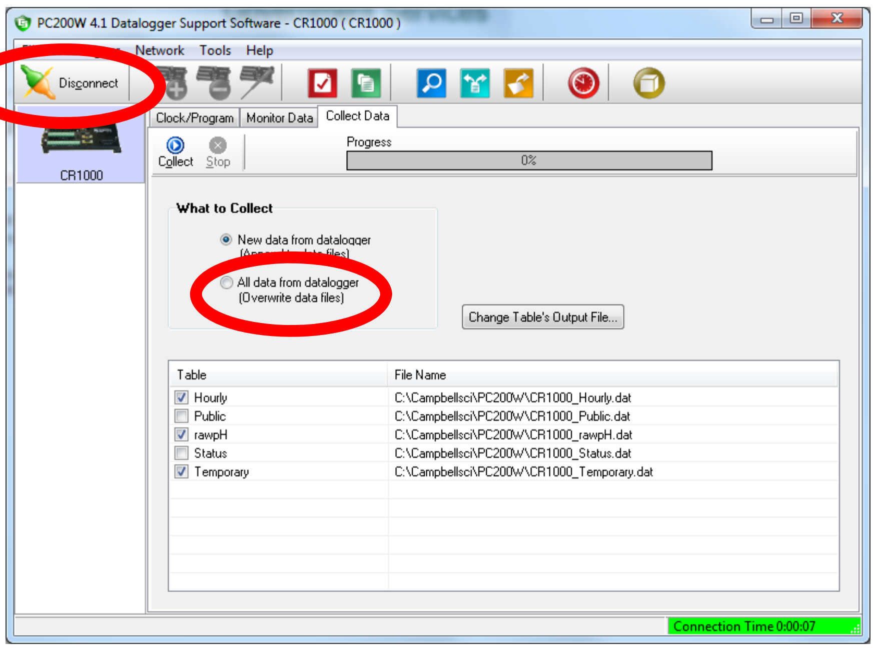
srk consulting	TMAC RESOURCES	North Dam Monitoring SOP (Revision 3)		
		Weatherproof Enclosure and Datalogger Components		
Job No: 1CT022.000 Filename: HopeBay_NorthDamMonitoringSOP_FIGURES	Doris Mine	Date: July 2020	Approved: JBK/IM/PL	Figure: 5

\\srk.ad\dfs\na\van\Projects\01_SITES\Hope.Bay\1CT022.036_2019 General Compliance\080_Deliverables\510_NorthDam_MonSOP\040_Figures\HopeBay_NorthDamMonitoringSOP_REV3_FIGURES 8_11-13_1CT022.000_PL_Rev00.pptx

Step 1



PC200W Datalogger connection (Section 4.3.1)



PC200W 'Collect Data' tab (Section 4.3.1)

\\srk.ad\dfs\na\van\Projects\01_SITES\Hope.Bay\1CT022.036_2019 General Compliance\080_Deliverables\510_NorthDam_MonSOP\040_Figures\HopeBay_NorthDamMonitoringSOP_REV3_FIGURES 8_11-13_1CT022.000_PL_Rev00.pptx

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MAC RESOURCES

North Dam Monitoring SOP (Revision 3)

Datalogger Direct Download Details / Screenshots

Job No: 1CT022.000

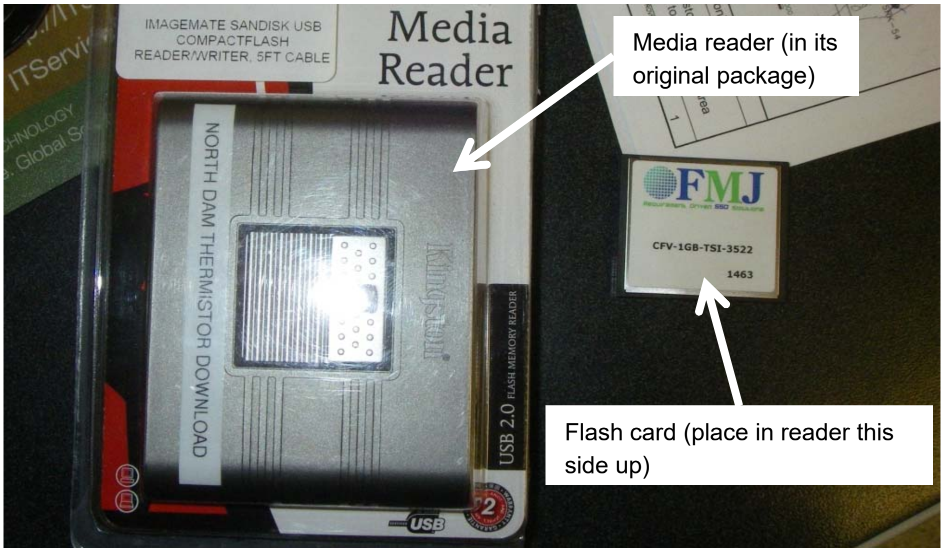
Filename: HopeBay_NorthDamMonitoringSOP_FIGURES

Doris Mine

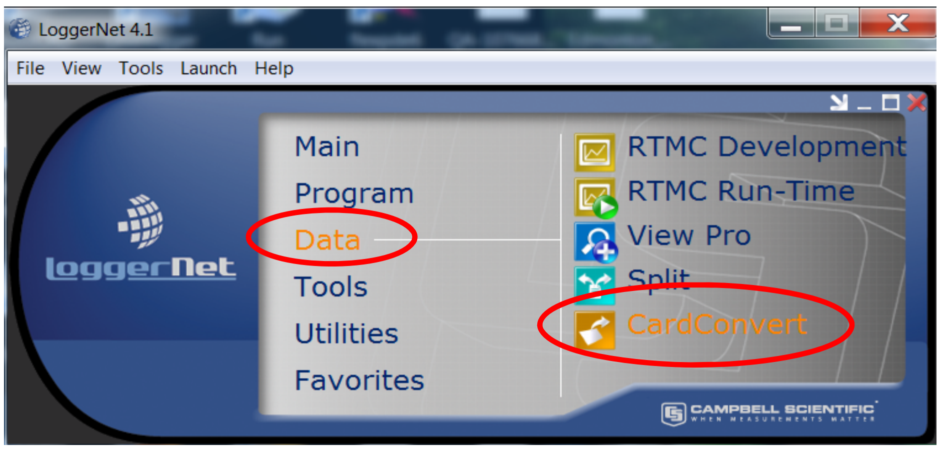
Date: July 2020

Approved: JBK/IM/PL

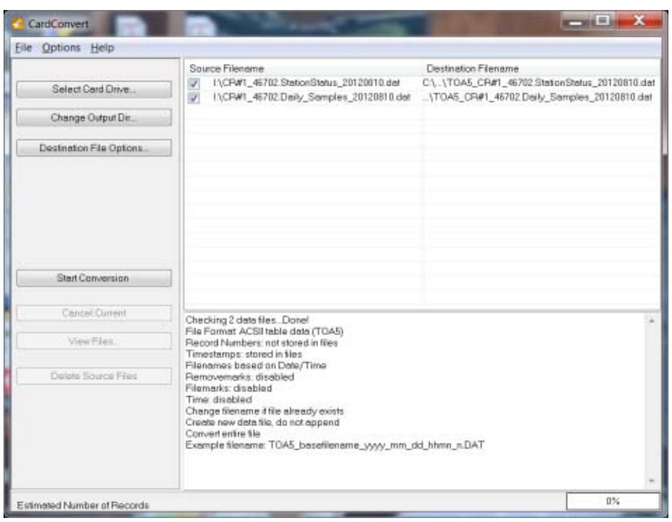
Figure: 6

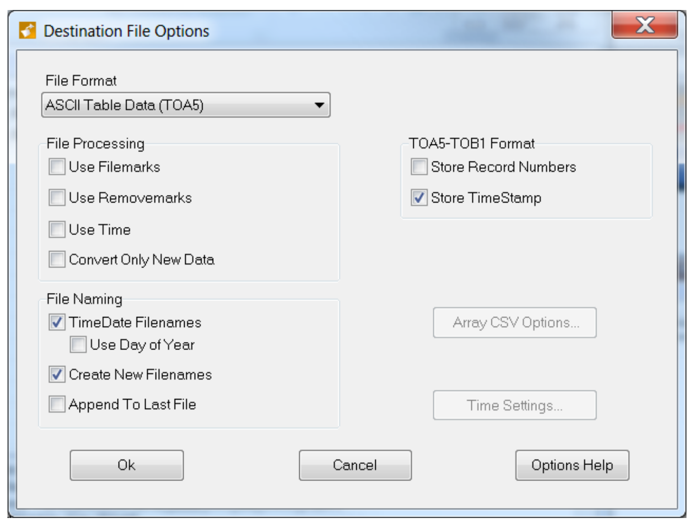


View of media card reader and flash memory card



Screenshot of LoggerNet starting menu (outlined in Section 4.5)





Screenshot of the file selection screen referred to in Step 2 (Section 4.5)

Screenshot of the "Destination File Options" referred to in Step 4 (Section 4.5)

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TMAC RESOURCES

North Dam Monitoring SOP (Revision 3)

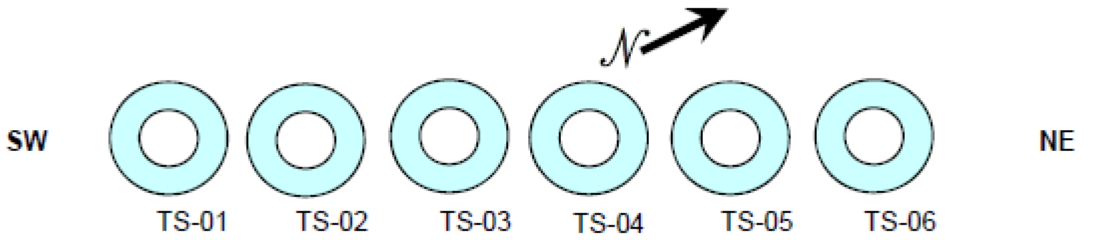
Datalogger Flash Card Exchange Details / Screenshots

Job No: 1CT022.000

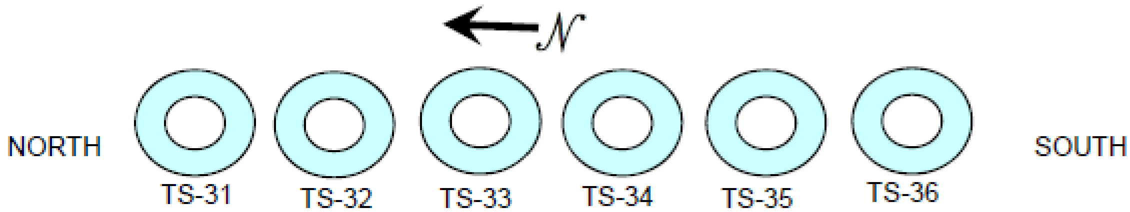
Filename: HopeBay_NorthDamMonitoringSOP_FIGURES

Doris Mine

Date:	Approved:	Figure:
July 2020	JBK/IM/PL	7



Simplified Plan Layout of North Thermosyphons



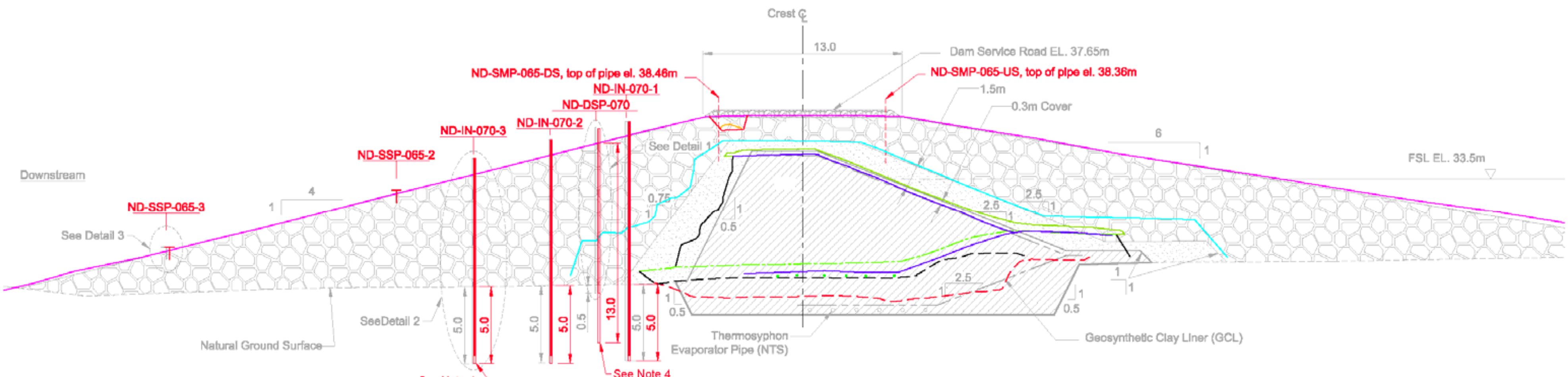
Simplified Plan Layout of South Thermosyphons

Thermosyphon status thermistors attached to thermosyphon risers using epoxy resin and zip-ties.

Thermosyphon status thermistors after being heat-insulated using expanding spray foam.

srk consulting	TMAC RESOURCES	North Dam Monitoring SOP (Revision 3) **Thermosyphons Status Thermistor Details**
Job No: 1CT022.000 Filename: HopeBay_NorthDamMonitoringSOP_FIGURES	Doris Mine	Date: July 2020 / Approved: JBK/IM/PL / Figure: **8**

\\srk.ad\dfs\na\van\Projects\01_SITES\Hope.Bay\1CT022.036_2019 General Compliance\080_Deliverables\510_NorthDam_MonSOP\040_Figures\HopeBay_NorthDamMonitoringSOP_REV3_FIGURES 8_11-13_1CT022.000_PL_Rev00.pptx



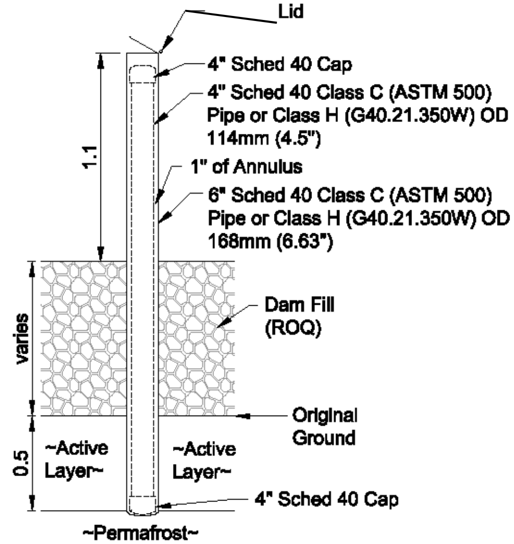
NORTH DAM TYPICAL SECTION

0 1 2 3 4 5
Scale in Metres

Core Material	GCL As-built
Transition Material	Core Material As-built
Run of Quarry (ROQ)	Core Material (2011) As-built
Surfacing Material	Levelling Course (Core Material) As-built
Bedrock	Instrumentation Trench Cover As-built
Peat	Key Trench / Instrumentation Trench As-built
	GCL Cover Material As-built
	Transition Material As-built
	ROQ Material As-built
	Thermosyphon Evaporator Pipes As-built

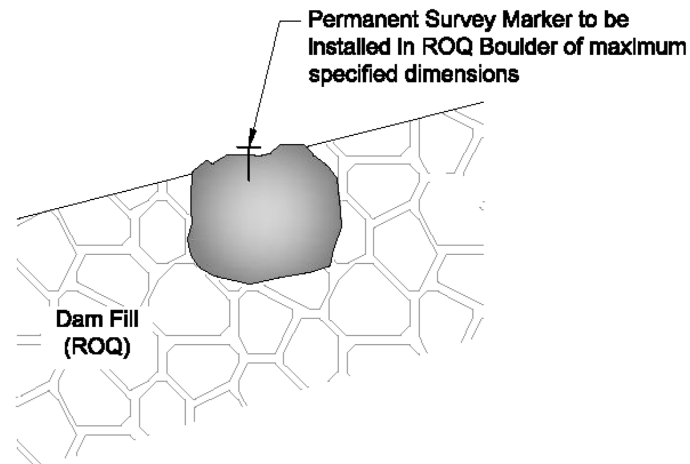
Example of as-built instrumentation installed on the downstream of dam.

srk consulting	MAC RESOURCES	North Dam Monitoring SOP (Revision 3)
		Deformation Monitoring Instrumentation Layout
Job No: 1CT022.000 Filename: HopeBay_NorthDamMonitoringSOP_Rev03_Landscape_1CT022.000_pl_Rev00	Doris Mine	Date: July 2020 · Approved: JBK/IM/PL · Figure: 9



DETAIL
DEEP SETTLEMENT POINT INSTALLATION
Not to Scale

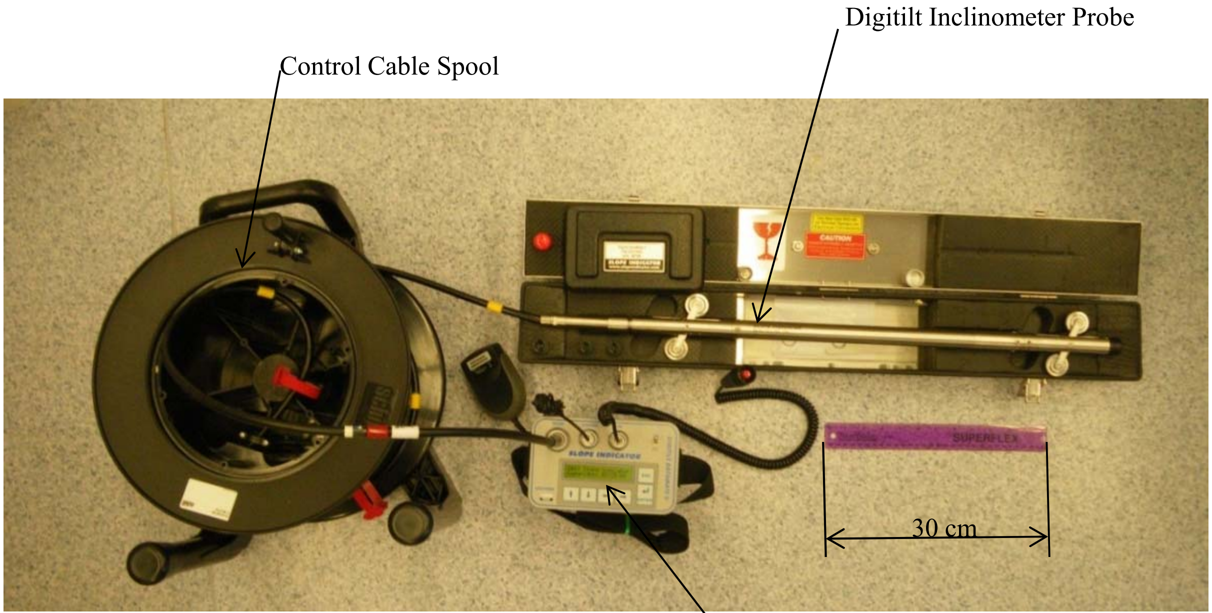
Examples of crest survey monument. Note the small rock bolt /anchor installed in the boulders seated into the dam shell.



DETAIL
SURFICIAL SURVEY POINT INSTALLATION
Not to Scale

Example of deep settlement points installed in the downstream of the dam.

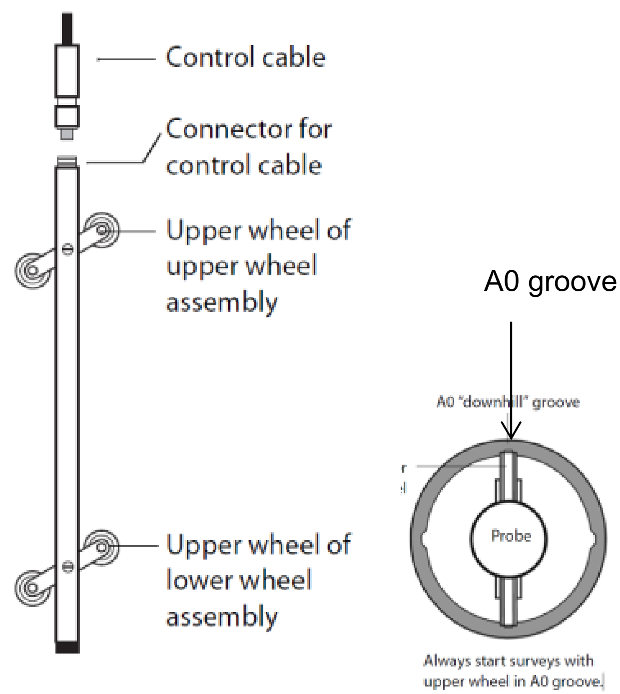
srk consulting	MAC RESOURCES	North Dam Monitoring SOP (Revision 3)
		Deep Settlement Points and Surficial Survey Points Details
Job No: 1CT022.000 Filename: HopeBay_NorthDamMonitoringSOP_Rev03_ Landscape_1CT022.000_pl_Rev00	Doris Mine	Date: July 2020 | Approved: JBK/IM/PL | Figure: 10



Inclinometer probe with readout and control cable spool

Inclinometer instruments packages wrapped up for storage

Example of Digitilt Inclinometer Set-Up

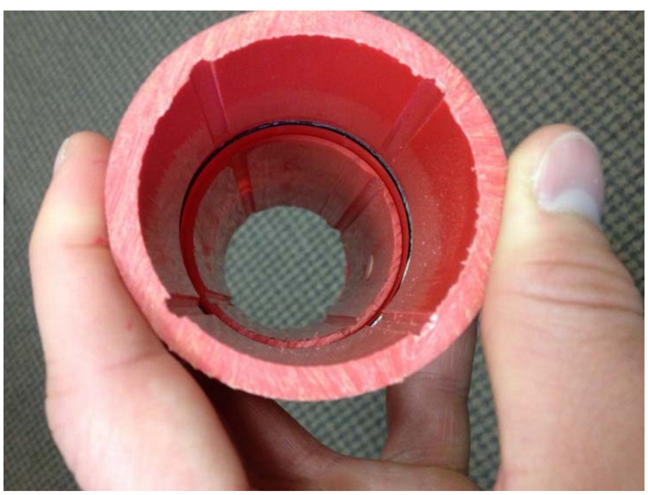


Schematic reproduced from www.slopeindicator.com

Schematic of Upper wheel and upstream marker from Slope Indicator manual (Appendix A)

srk consulting	MAC RESOURCES	North Dam Monitoring SOP (Revision 3) **Inclinometer Instrumentation Details**		
Job No: 1CT022.000 Filename: HopeBay_NorthDamMonitoringSOP_FIGURES	Doris Mine	Date: July 2020	Approved: JBK/IM/PL	Figure: **11**

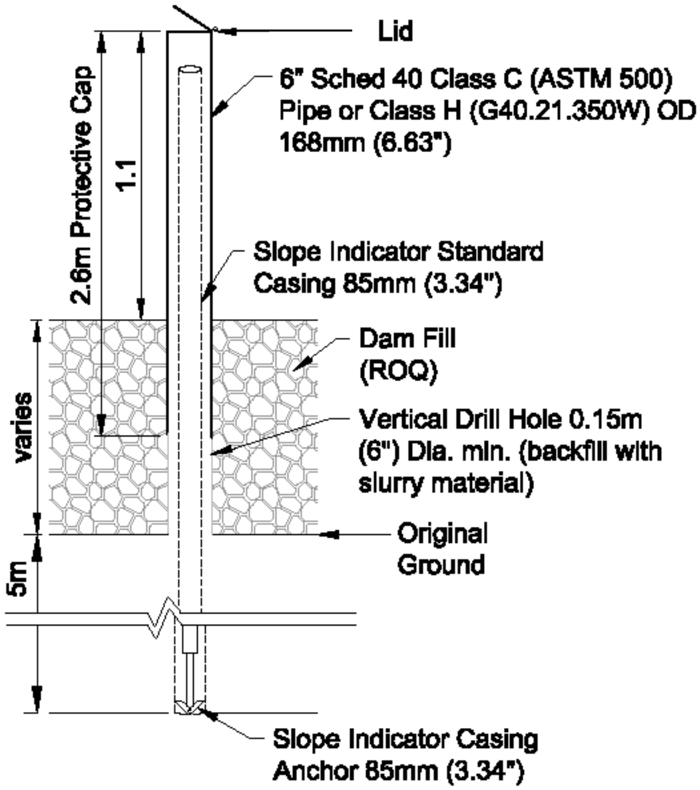
Example of inclinometer protective casing, with and without top cap on.



Example of four inner groves spaced at ~90^{o} angles. Note that only one set of grooves is used for the two sets of measurements (i.e. 180^{o} rotation of instrument)

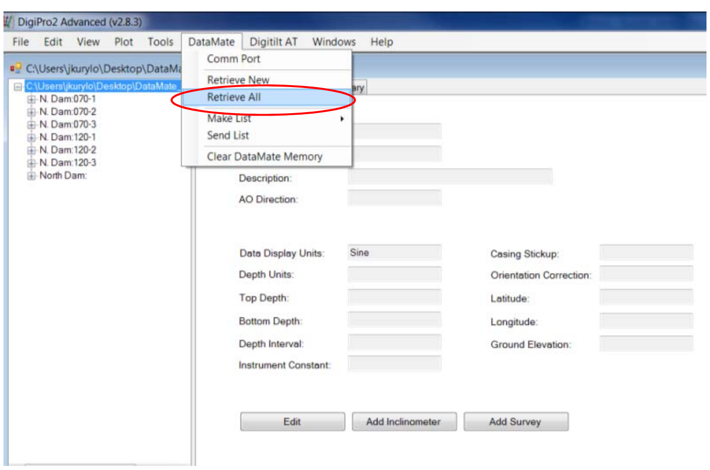
srk consulting	MAC RESOURCES	North Dam Monitoring SOP (Revision 3)
		Photographs of Inclinometer Set-Up
Job No: 1CT022.000	Doris Mine	Date: July 2020
Filename: HopeBay_NorthDamMonitoringSOP_FIGURES		Approved: JBK/IM/PL
		Figure: **12**

\\srk.ad\dfs\na\van\Projects\01_SITES\Hope.Bay\1CT022.036_2019 General Compliance\080_Deliverables\510_NorthDam_MonSOP\040_Figures\HopeBay_NorthDamMonitoringSOP_REV3_FIGURES 8_11-13_1CT022.000_PL_Rev00.pptx

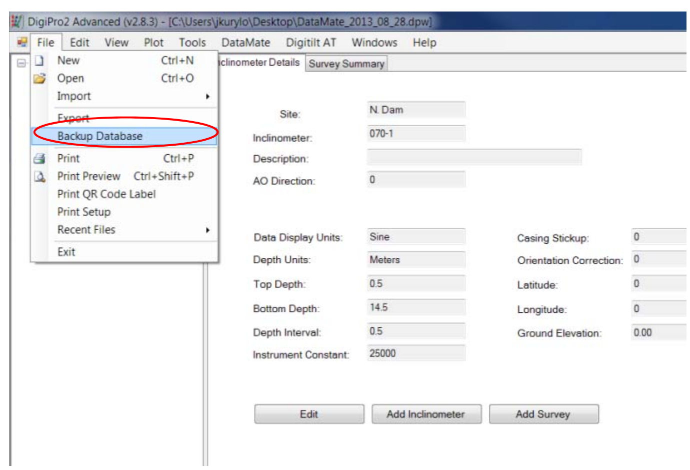


DETAIL
INCLINOMETER INSTALLATION
Not to Scale

Marker being correctly held and aligned with top of inclinometer casing



Main DataMate menu from DigiPro2 Inclinometer software



Backup menu from DigiPro2 Inclinometer software

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MAC RESOURCES

North Dam Monitoring SOP (Revision 3)

Inclinometer Measurements and Software Details

Job No: 1CT022.000	Doris Mine	Date: July 2020	Approved: JBK/IM/PL	Figure: 13
Filename: HopeBay_NorthDamMonitoringSOP_FIGURES				

Appendix A - Operator's Manuals

Appendix A1 - CR1000 Measurement and Control System

OPERATOR'S MANUAL

CR1000 Measurement and Control System

Revision: 7/11

WARRANTY AND ASSISTANCE

This equipment is warranted by CAMPBELL SCIENTIFIC (CANADA) CORP. ("CSC") to be free from defects in materials and workmanship under normal use and service for **thirty-six (36) months** from date of shipment unless specified otherwise. ** **Batteries are not warranted.** ** CSC's obligation under this warranty is limited to repairing or replacing (at CSC's option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CSC. CSC will return such products by surface carrier prepaid. This warranty shall not apply to any CSC products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CSC is not liable for special, indirect, incidental, or consequential damages.

Products may not be returned without prior authorization. To obtain a Return Merchandise Authorization (RMA), contact CAMPBELL SCIENTIFIC (CANADA) CORP., at (780) 454-2505. An RMA number will be issued in order to facilitate Repair Personnel in identifying an instrument upon arrival. Please write this number clearly on the outside of the shipping container. Include description of symptoms and all pertinent details.

CAMPBELL SCIENTIFIC (CANADA) CORP. does not accept collect calls.

Non-warranty products returned for repair should be accompanied by a purchase order to cover repair costs.

CAMPBELLSCIENTIFIC
CANADA CORP.
11564 - 149 street - edmonton - alberta - T5M 1W7
tel 780.454.2505 fax 780.454.2655
www.campbellsci.ca

PLEASE READ FIRST

About this manual

Please note that this manual was originally produced by Campbell Scientific Inc. (CSI) primarily for the US market. Some spellings, weights and measures may reflect this origin.

Some useful conversion factors:

Area:	1 in^2 (square inch) = 645 mm^2
Length:	1 in. (inch) = 25.4 mm 1 ft (foot) = 304.8 mm 1 yard = 0.914 m 1 mile = 1.609 km
Mass:	1 oz. (ounce) = 28.35 g 1 lb (pound weight) = 0.454 kg
Pressure:	1 psi (lb/in2) = 68.95 mb
Volume:	1 US gallon = 3.785 litres

In addition, part ordering numbers may vary. For example, the CABLE5CBL is a CSI part number and known as a FIN5COND at Campbell Scientific Canada (CSC). CSC Technical Support will be pleased to assist with any questions.

Select Sections extracted from CR100 Measurement and Control System (Revision: 7/11) Operator's Manual.

Full manual can be found online at: http://s.campbellsci.com/documents/us/manuals/cr1000.pdf

Table of Contents

Section 1. Introduction

Whether in extreme cold in Antarctica, scorching heat in Death Valley, salt spray from the Pacific, micro-gravity in space, or the harsh environment of your office, Campbell Scientific dataloggers support research and operations all over the world. Our customers work a broad spectrum of applications, from those more complex than any of us imagined, to those simpler than any of us thought practical. The limits of the CR1000 are defined by our customers. Our intent with the CR1000 manual is to guide you to the tools you need to explore the limits of your application.

You can take advantage of the CR1000's powerful analog and digital measurement features by spending a few minutes working through the *Quickstart Tutorial* (p. 3) and the *Overview* (p. 27). For more demanding applications, the remainder of the manual and other Campbell Scientific publications are available. If you are programming with CRBASIC, you will need the extensive Help available with the CRBASIC Editor software. Formal CR1000 training is also available from Campbell Scientific.

This manual is organized to take you progressively deeper into the complexity of CR1000 functions. You may not find it necessary to progress beyond the *Quickstart Tutorial* (p. 3) or *Overview* (p. 27) sections. *Quickstart Tutorial* (p. 3) gives a cursory view of CR1000 data acquisition and walks you through a first attempt at data acquisition. *Overview* (p. 27) reviews salient topics, which are covered in-depth in subsequent sections and appendices.

More in-depth study requires other Campbell Scientific publications, most of which are available on-line at *www.campbellsci.com*. Generally, if a particular feature of the CR1000 requires a peripheral hardware device, more information is available in the manual written for that device. Manuals for Campbell Scientific products are available at *www.campbellsci.com*.

If you are unable to find the information you need, please contact us at 435-753-2342 to speak with an applications engineer. Or, you can email us at *support@campbellsci.com*.

Section 2. Quickstart Tutorial

This tutorial gives a cursory look at CR1000 data acquisition.

2.1 Primer - CR1000 Data Acquisition

Data acquisition with the CR1000 is the result of a step wise procedure involving the use of electronic sensor technology, the CR1000, a telecommunications link, and *datalogger support software* (p. 439, p. 490).

2.1.1 Components of a Data Acquisition System

A typical data acquisition system is conceptualized in *FIGURE. Data Acquisition System Components* (p. 4). A CR1000 is only one part of a data acquisition system. To acquire good data, suitable sensors and a reliable data retrieval method are required. A failure in any part of the system can lead to "bad" data or no data.

2.1.1.1 Sensors

Suitable sensors accurately and precisely transduce environmental change into measurable electrical properties by outputting a voltage, changing resistance, outputting pulses, or changing states.

Read More! *APPENDIX. Accuracy, Precision, and Resolution* (p. 454)

2.1.1.2 Datalogger

CR1000s can measure almost any sensor with an electrical response. CR1000s measure electrical signals and convert the measurement to engineering units, perform calculations and reduce data to statistical values. Every measurement does not need to be stored. The CR1000 will store data in memory awaiting transfer to the PC via external storage devices or telecommunications.

2.1.1.3 Data Retrieval

The products of interest from a data acquisition system are data in data files, usually stored on and accessible by a PC.

Data are copied, not moved, from the CR1000 to the PC. Multiple users may have access to the same CR1000 without compromising data or coordinating data collection activities.

RS-232 and CS I/O ports are integrated with the CR1000 wiring panel to facilitate data collection.

On-site serial communications are preferred if the datalogger is near the PC, and the PC can dedicate a serial (COM) port for the datalogger. On-site methods such as direct serial connection or infrared link are also used when the user visits a remote site with a laptop or PDA.

In contrast, telecommunications provide remote access and the ability to discover problems early with minimum data loss. A variety of devices, and combinations of devices, such as telephone modems, radios, satellite transceivers, and TCP/IP network modems are available for the most demanding applications.

FIGURE 1. Data Acquisition System Components

2.1.2 CR1000 Module and Power Supply

The CR1000 module integrates electronics within a sealed stainless steel clamshell, making it economical, small, and very rugged.

2.1.2.1 Wiring Panel

The CR1000 module connects to the wiring panel. As shown in *FIGURE. CR1000 Wiring Panel* (p. 5), the wiring panel provides terminals for connecting sensors, power and communications devices. Internal surge protection is incorporated with the input channels.

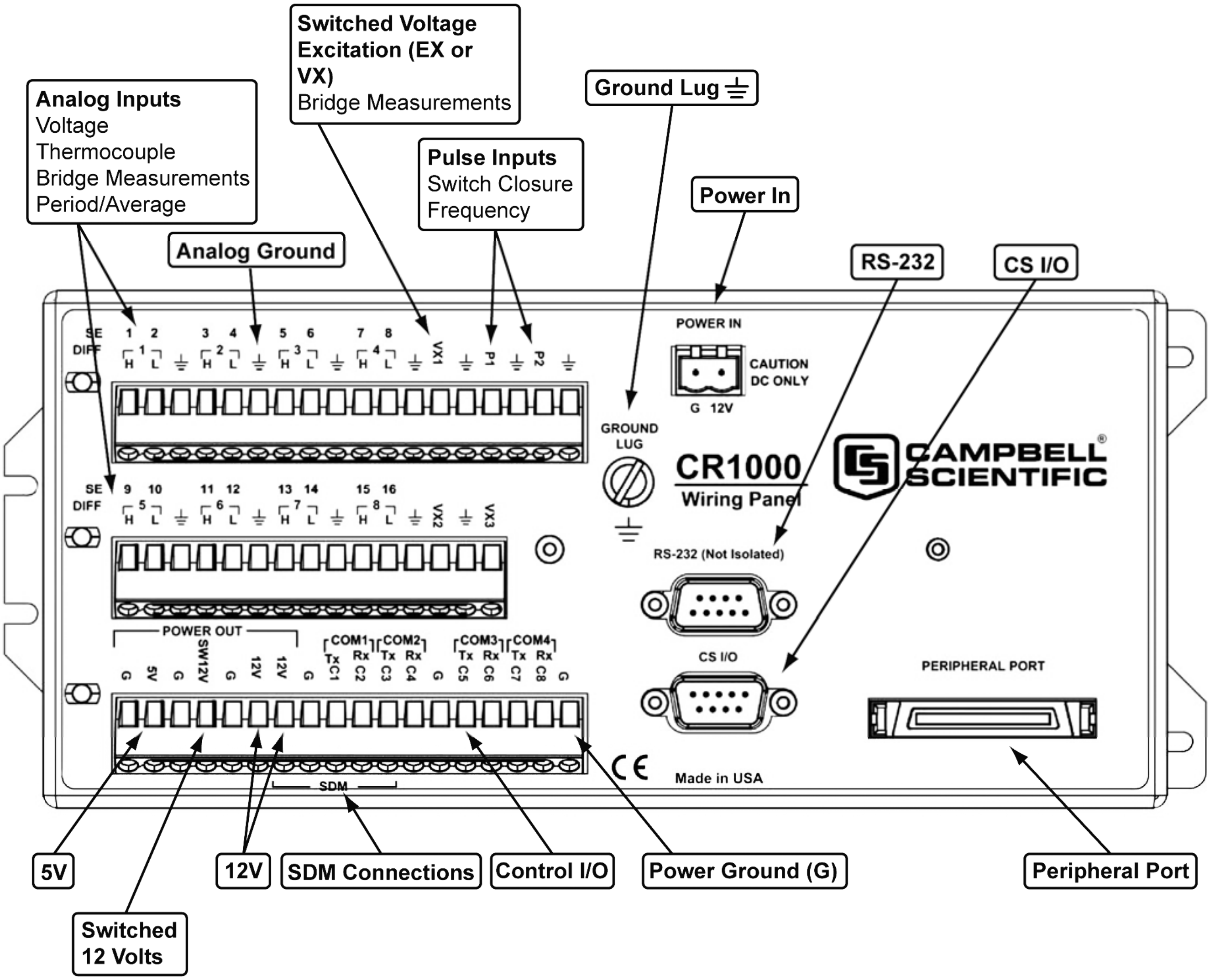


FIGURE 2.   Wiring Panel

2.1.2.2   Power Supply

The CR1000 is powered by a nominal 12 Vdc source. Acceptable power range is 9.6 to 16 Vdc.

External power connects through the green "POWER IN" on the face of the CR1000. The "POWER IN" connection is internally reverse polarity protected.

2.1.2.3   Backup Battery

A lithium battery backs up the CR1000 clock, program, and memory in case of power loss. See *SECTION. Internal Battery* (p. 41)

2.1.3 Sensors

Most electronic sensors, whether or not manufactured or sold by Campbell Scientific, can be interfaced to the CR1000. Check for on-line content concerning interfacing sensors at *www.campbellsci.com*, or contact a Campbell Scientific applications engineer for assistance.

2.1.3.1 Analog Sensors

Analog sensors output continuous voltages that vary with the phenomena measured. Analog sensors connect to analog terminals. Analog terminals are configured as single-ended, wherein sensor outputs are measured with respect to ground (*FIGURE. Analog Sensor Wired to Single-Ended Channel #1* (p. 6)) or configured as differential, wherein high sensor outputs are measured with respect to the low output (*FIGURE. Analog Sensor Wired to Differential Channel #1* (p. 6)). *TABLE. Single-ended and Differential Input Channels* (p. 6) lists channel assignments.

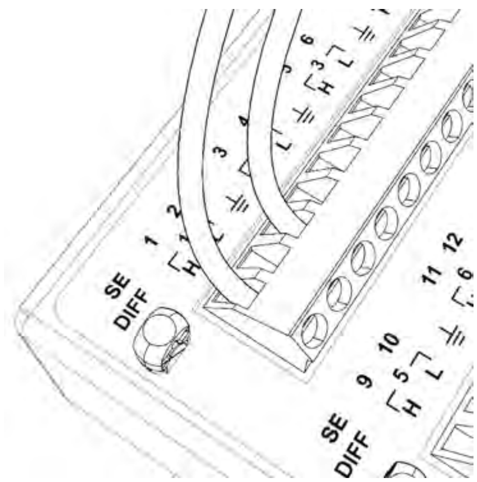


FIGURE 3. Analog Sensor Wired to Single-Ended Channel #1

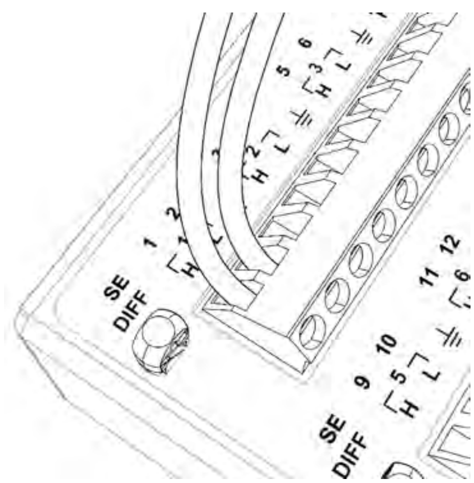


FIGURE 4. Analog Sensor Wired to Differential Channel #1

TABLE 1.   Single-ended and Differential Input Channels

Differential Channel	***Single-Ended Channel***
1H 1L	1 2
2H 2L	3 4
3H 3L	5 6
4H 4L	7 8
5H 5L	9 10
6H 6L	11 12
7H 7L	13 14
8H 8L	15 16

2.1.3.2 Bridge Sensors

Many sensors use a resistive bridge to measure phenomena. Pressure sensors and position sensors commonly use a resistive bridge. For example, a specific resistance in a pressure transducer strain gage correlates to a specific water pressure. A change in resistance in a wind vane potentiometer correlates to a change in wind direction.

2.1.3.2.1 Voltage Excitation

Bridge resistance can be determined by measuring the difference between a known voltage applied to a bridge and the measured return voltage. The CR1000 supplies a precise scalable voltage excitation via excitation terminals. Return voltage is measured on analog terminals. Examples of bridge sensor wiring using voltage excitation are illustrated in *FIGURE. Half Bridge Wiring -- Wind Vane Potentiometer* (p. 8) and *FIGURE. Full Bridge Wiring -- Pressure Transducer* (p. 8).

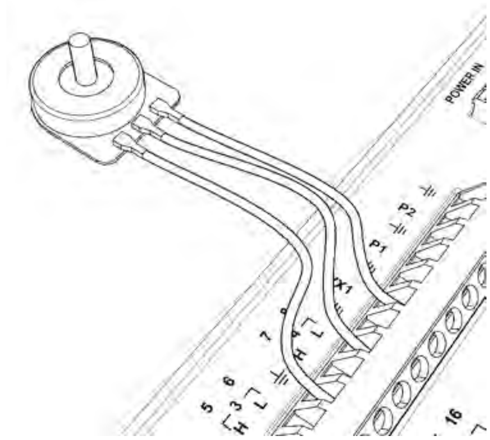


FIGURE 5. Half Bridge Wiring -- Wind Vane Potentiometer

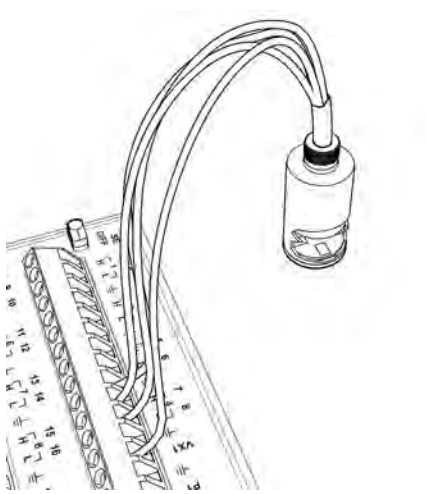


FIGURE 6. Full Bridge Wiring -- Pressure Transducer

2.1.3.3 Pulse Sensors

Pulse sensors are measured on CR1000 pulse measurement channels. The output signal generated by a pulse sensor is a series of voltage waves. The sensor couples its output signal to the measured phenomenon by modulating wave frequency. The CR1000 detects each wave as the wave transitions between voltage extremes (high to low or low to high). This is termed “state transition”. Measurements are processed and presented as counts, frequency, or timing data.

Note Period averaging sensors, while technically frequency output sensors, are typically connected to single-ended analog channels and measured with the PeriodAverage() instruction.

2.1.3.3.1 Pulses Measured

FIGURE. Pulse Sensor Output Signal Types (p. 9) illustrates three pulse sensor output signal types.

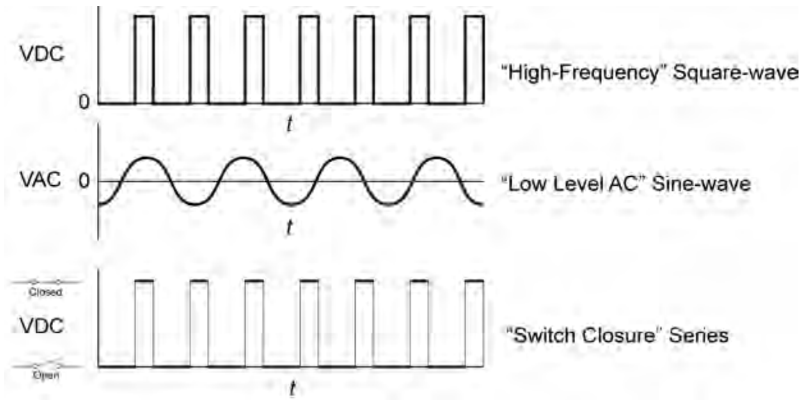


FIGURE 7. Pulse Sensor Output Signal Types

2.1.3.3.2 Pulse Input Channels

TABLE. Pulse Input Channels and Measurements (p. 9) lists devices, channels and options for measuring pulse signals.

TABLE 2. Pulse Input Channels and Measurements

Channels Available for Pulse Input	***Input Types***	***Data Option***	***CRBASIC Instruction***
P1, P2	High Frequency Low-Level ac Switch Closure	Counts Frequency Run Avg of Freq	PulseCount ()
C1, C2, C3, C4, C5, C6, C7, C8	High Frequency Switch Closure Low-Level ac (with LLAC4 Low-Level AC Conversion Module)	Counts Frequency Run Avg of Freq Interval Period State	PulseCount () TimerIO ()

2.1.3.3.3 Pulse Sensor Wiring

Wiring a pulse sensor to a CR1000 is straight forward, as shown in *FIGURE. Pulse Input Wiring -- Anemometer Switch* (p. 10). Pulse sensors have two active wires, one of which is always ground. Connect the ground wire to a ⏚ channel. Connect the other wire to a pulse channel. Sometimes the sensor will require power from the CR1000, so there will be two more wires – one of which is always ground. Connect power ground to a G channel. Do not confuse the pulse wire with the positive power wire, or damage to the sensor or CR1000 may result. Some switch closure sensors may require a pull-up resistor. Consult *FIGURE. Connecting Switch Closures to Digital I/O* (p. 86) for information on use of pull-up resistors.

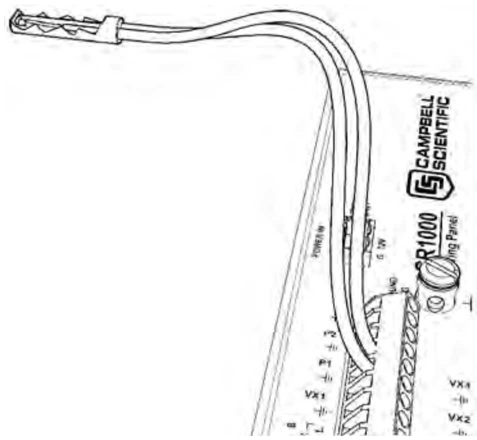


FIGURE 8.   Pulse Input Wiring -- Anemometer Switch

2.1.3.4   RS-232 Sensors

The CR1000 has 6 ports available for RS-232 input as shown in *FIGURE. Location of RS-232 Ports* (p. 10). As indicated in *FIGURE. Use of RS-232 and Digital I/O when Reading RS-232 Devices* (p. 10), RS-232 sensors can be connected to the RS-232 port or to digital I/O port pairs. Ports can be set up with various baud rates, parity options, stop bit options, and so forth as defined in CRBASIC Help.

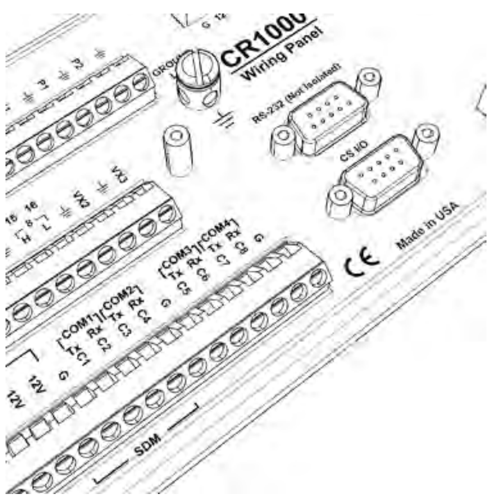


FIGURE 9.   Location of RS-232 Ports

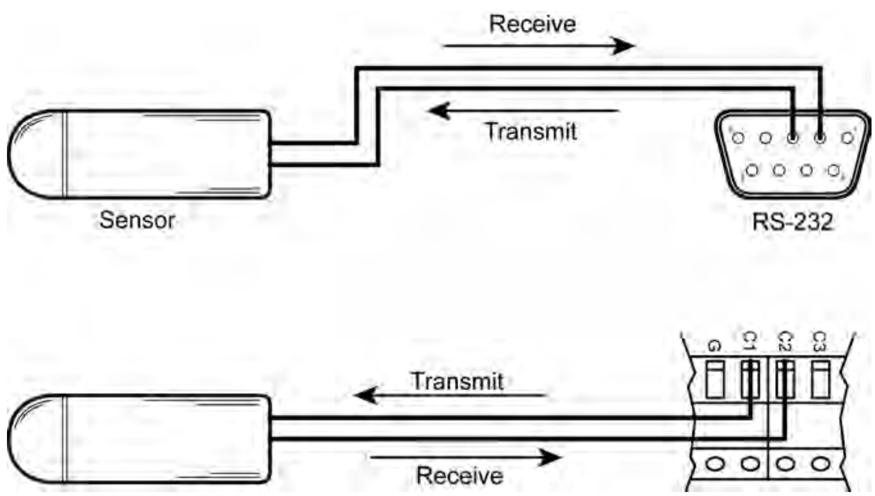


FIGURE 10. Use of RS-232 and Digital I/O when Reading RS-232 Devices

2.1.4 Digital I/O Ports

The CR1000 has 8 digital I/O ports selectable as binary inputs or control outputs. These are multi-function ports. Edge timing, switch closure, and high frequency pulse functions are introduced in *SECTION. Pulse Sensors* (p. 8) and discussed at length in *SECTION. Pulse Measurements* (p. 81). Other functions include device driven interrupts, asynchronous communications and SDI-12 communications. *FIGURE. Control and Monitoring with Digital I/O* (p. 12), illustrates a simple application wherein digital I/O ports are used to control a device and monitor the state (whether on or off) of the device.

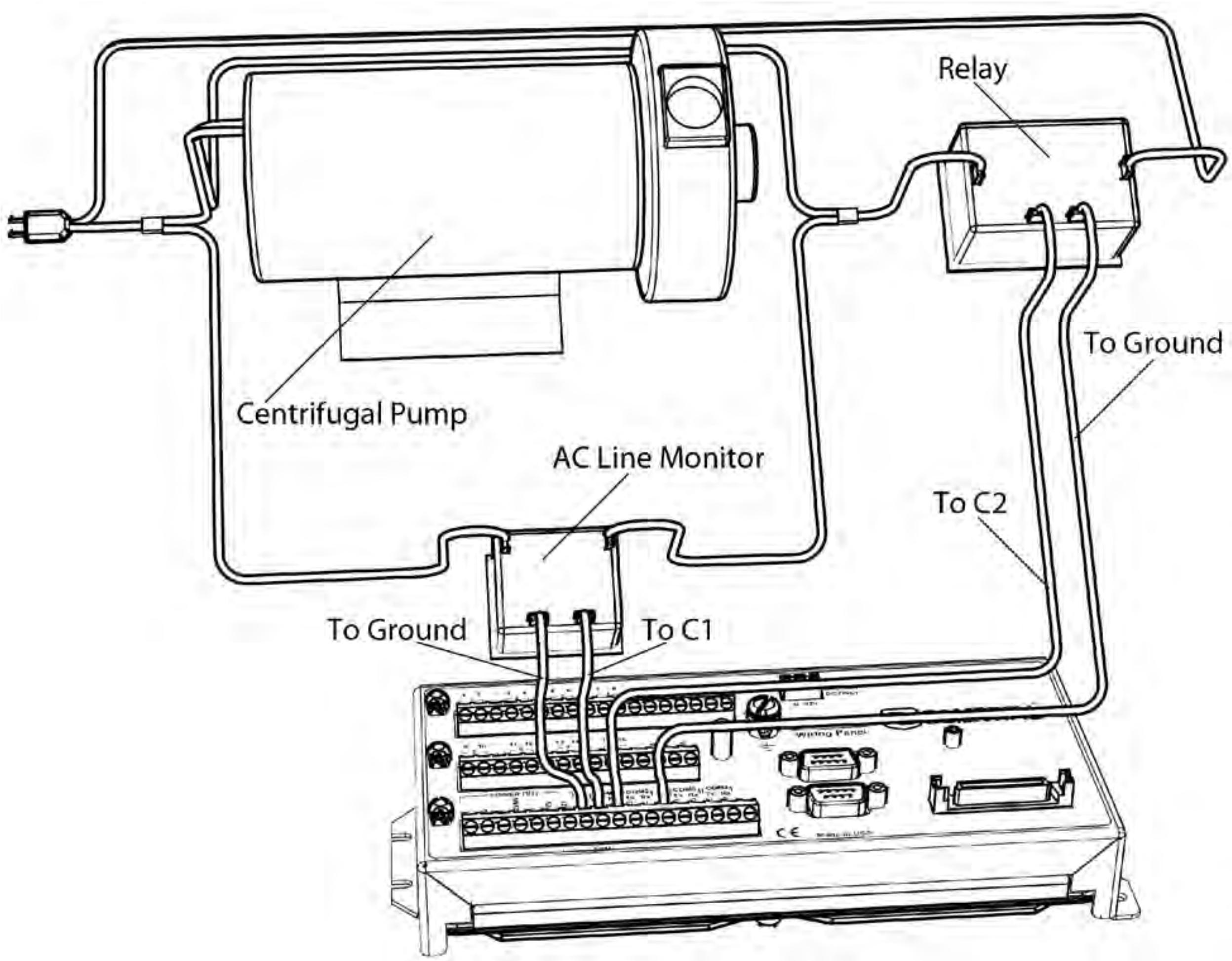


FIGURE 11. Control and Monitoring with Digital I/O

2.1.4.1 SDM Channels

SDM devices and a brief description of the their uses can be found in *APPENDIX. Sensors and Peripherals* (p. 495).

Digital I/O ports C1, C2 and C3 are used for SDM (Serial Device for Measurement) communications.

2.1.5 Input Expansion Modules

Modules are available from Campbell Scientific to expand the number of input and digital I/O ports on the CR1000. *APPENDIX. Digital I/O Expansion* (p. 498) lists available modules.

2.2 Exercise - Measuring a Thermocouple

This tutorial is designed to illustrate the function of the CR1000. During the exercise, the following items will be described.

- Attaching a thermocouple to analog differential terminals
- Creating a program for the CR1000
- Making a simple thermocouple measurement
- Sending data from the CR1000 to a PC
- Viewing the data from the CR1000

2.2.1 What You Will Need

The following items are needed to complete this exercise.

- Campbell Scientific CR1000 datalogger
- Campbell Scientific PS100 12 Vdc power supply (or other compatible power supply) with RED and BLACK wire leads.
- Thermocouple (included with the CR1000)
- Personal Computer (PC) with an available RS-232 serial port. A USB to RS-232 cable may be used if an RS-232 port is not available.
- RS-232 cable (included with the CR1000).

Note If the PC is to be connected to the RS-232 port for an extended period, use Campbell Scientific's SC32B interface to provide optical isolation. This protects low level analog measurements from outside interference.

- PC200W software. This software is available on the Campbell Scientific Resource CD or at www.campbellsci.com.

2.2.2 Hardware Set-Up

Note The thermocouple is attached to the CR1000 later

2.2.2.1 External Power Supply

With reference to *FIGURE. Power and RS-232 Connections* (p. 14),

1. Remove the green power connector from the CR1000.
2. Verify the RED wire on the PS100 is attached to a PS100 12V terminal, and the BLACK wire is attached to a PS100 G terminal.

3. Verify the On/Off switch on the PS100 is in the Off position.

4. Attach the RED wire from the PS100 to the terminal labeled 12V on the green connector.

5. Attach the BLACK wire from the PS100 to the terminal labeled G on the green connector.

6. After confirming the correct polarity on the wire connections, insert the green power connector into its receptacle on the CR1000.

7. Connect the RS-232 cable between the RS-232 port on the CR1000 and the RS-232 port on the PC (or to the USB to RS-232 cable).

8. Move the On/Off switch on the PS100 to the On position.

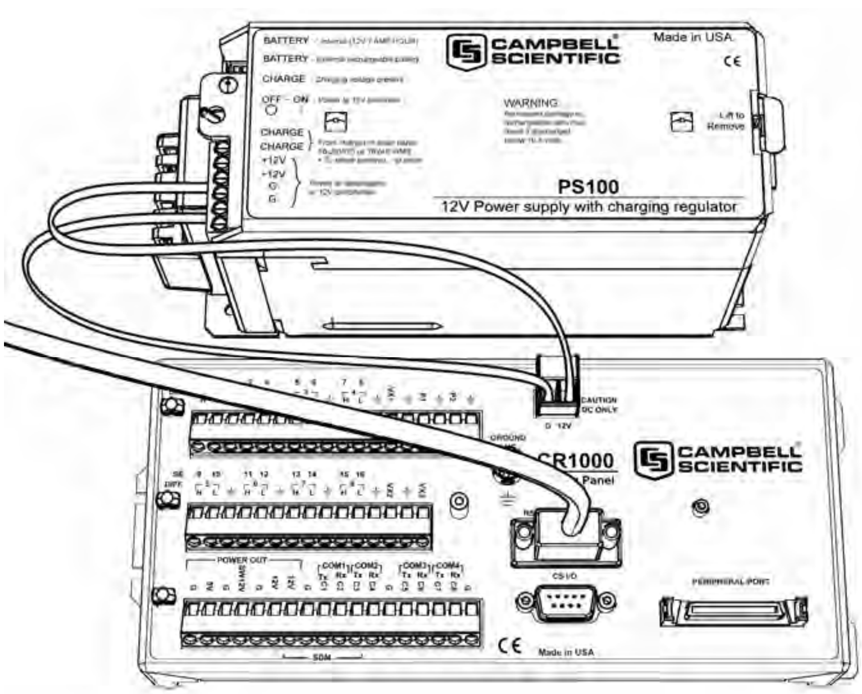


FIGURE 12. Power and RS-232 Connections

2.2.3 PC200W Software Setup

1. Install the PC200W software onto a PC. Follow the on-screen prompts during the installation process for the Program Folder and Destination Location.

2. Open the PC200W software (*FIGURE. PC200W Main Window* (p. 15)). When the software is first run, the EZSetup Wizard will be run automatically in a new window. This will configure the software to communicate with the CR1000. *TABLE. PC200W EZSetup Wizard Example Selections* (p. 15) indicates what information needs to be entered

on each screen. Click on Next at the bottom of the screen to advance to the next screen.

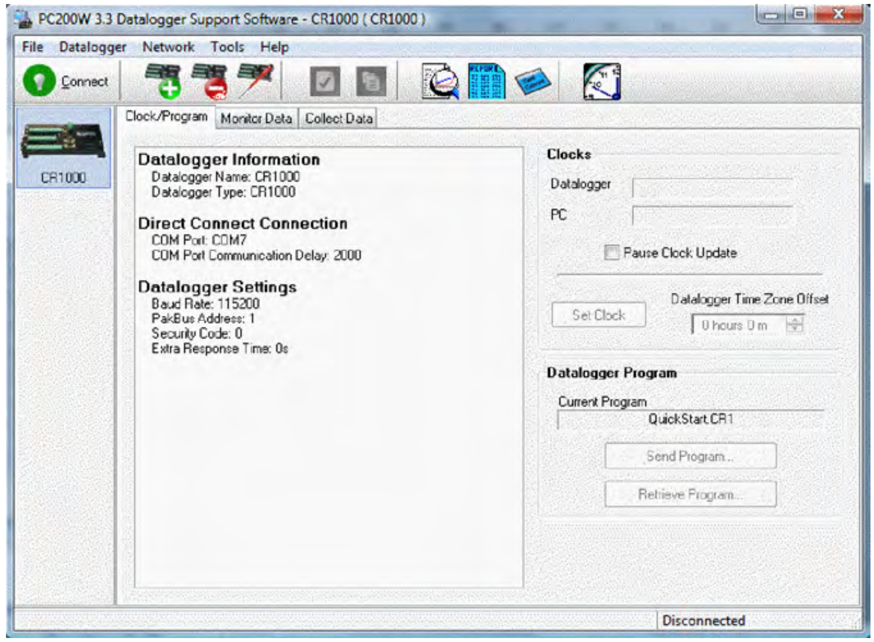


FIGURE 13. PC200W Main Window

TABLE 3. PC200W EZSetup Wizard Example Selections.

Start the wizard to follow table entries

Screen Name	***Information Needed***
Introduction	Provides and introduction to the EZSetup Wizard along with instructions on how to navigate through the wizard.
Datalogger Type and Name	Select the CR1000 from the scroll window. Accept the default name of "CR1000."
COM Port Selection	Select the correct COM port for RS-232 connection. Typically, this will be COM1. Other COM numbers are possible, especially when using a USB to serial cable. Leave the COM Port Communication Delay at "00 seconds." Note: When using a USB to serial cable, the COM number may change if the cable is moved to a different USB port. This will prevent data transfer between the software and CR1000. Should this occur, simply move the USB cable back to the original port. If this is not possible, it will be necessary to close the PC200W software and open it a second time to refresh the available COM ports. Click on "Edit Datalogger Setup" and change the COM port to the new port number.
Datalogger Settings	Used to configure how the CR1000 communicates through the COM port. For this tutorial, accept the default settings.

TABLE 3. PC200W EZSetup Wizard Example Selections.	
Start the wizard to follow table entries	
Screen Name	***Information Needed***
Communication Setup Summary	Provides a summary of the settings made in previous screens.
Communications Test	A communications test between the CR1000 and PC can be performed in this screen. For this tutorial, the test is not required. Press Finish to exit the Wizard.

After exiting the wizard, the main PC200W window becomes visible. The window has several tabs available. By Default, the Clock/Program tab is visible. This tab displays information on the currently selected datalogger along with clock and program functions. The Monitor Data or Collect Data tabs may be selected at any time.

A number of icons are available across the top of the window. These access additional functions available to the user.

2.2.4 Write Program with Short Cut

Short Cut Programming Objectives:

This portion of the tutorial will use Short Cut to create a program that measures the CR1000 power supply voltage, wiring panel temperature, and ambient air temperature. The CR1000 will take samples once per second and store averages of these values at one minute intervals.

2.2.4.1 Procedure: (Short Cut Steps 1-6)

1. Click on the Short Cut icon in the upper-right corner of the PC200W window. The icon resembles a clock face.

2. A new window will appear showing the option to create a new program or open an existing program. Select **New Program**.

3. A drop-down list will appear showing different dataloggers. Select the CR1000.

4. The program will now ask for the scan interval. Set the interval to 1 second and click on okay.

Note The first time Short Cut is run, a prompt will appear asking for a choice of "ac Noise Rejection." Select "60 Hz" for the United States and other countries using 60 Hz ac voltage. Select "50 Hz" for Europe and other countries operating on 50 Hz ac voltage.

5. A second prompt will ask for a choice of "Sensor Support." Select "Campbell Scientific, Inc."

6. Under Available Sensors, expand the "Sensors" folder by clicking on the "+" symbol. This shows several sub-folders. Expand the "Temperature" folder to view the available sensors.

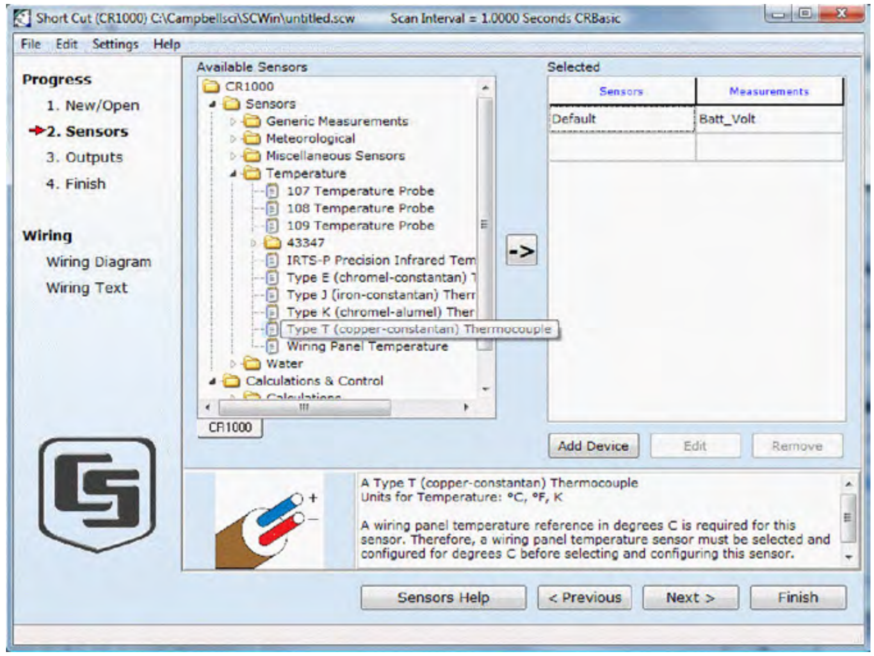


FIGURE 14. Short Cut Temperature Sensor Folder

2.2.4.2 Procedure: (Short Cut Steps 7-9)

7. Double-click the Wiring Panel Temperature sensor to add it to the Selected category. Alternatively, highlight the Wiring Panel Temperature sensor by clicking on it once, and then click on the arrow between Available Sensors and Selected to add it to the Selected sensors.

8. Double-click the Type T Thermocouple to add it to the Selected category. A prompt will appear asking for the number of sensors. Change this value to "1." A second prompt screen will appear. Set the Reference Temperature Measurement to "Ptemp_C," and then click OK to close the prompt.

9. Click on the Wiring Diagram link to view the sensor wiring diagram. Attach the Type T Thermocouple to the CR1000 as shown in the diagram.

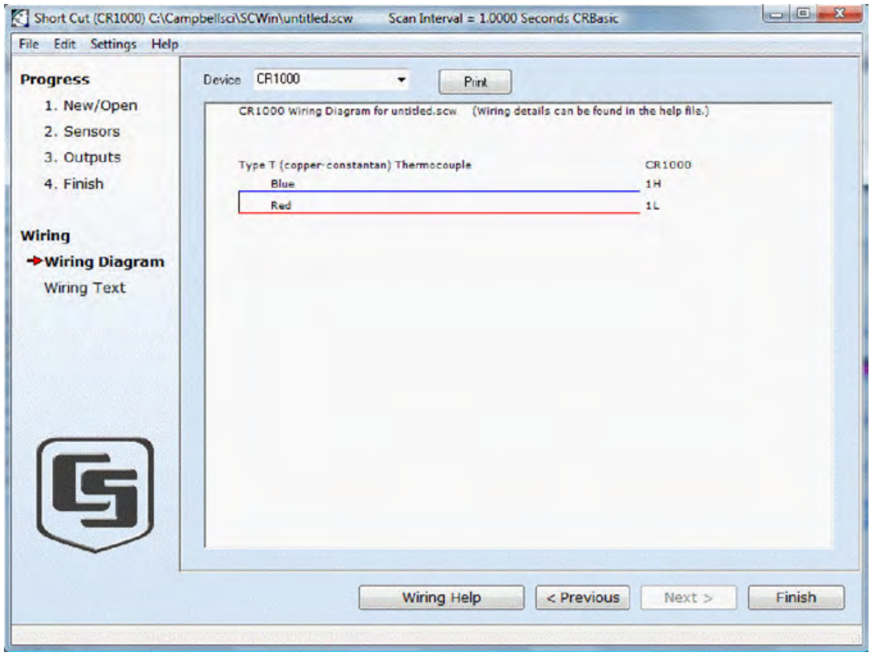


FIGURE 15. Short Cut Thermocouple Wiring

2.2.4.3 Procedure: (Short Cut Steps 10-11)

Historical Note In the space race era, a field thermocouple measurement was a complicated and cumbersome process incorporating a thermocouple wire with three junctions, a micro-voltmeter, a vacuum flask filled with an ice slurry, and a thick reference book. One thermocouple junction was connected to the micro-voltmeter. Another sat in the vacuum flask. The third was inserted into the location of the temperature of interest. When the temperature settled out, the micro-voltmeter was read. This value was then looked up on the appropriate table in the reference book to determine the temperature.

Then along came Eric and Evan Campbell. Campbell Scientific designed the first CR7 datalogger to make thermocouple measurements without the need of vacuum flasks, third junctions, or reference books. Now, there's an idea!

Nowadays, a thermocouple consists of two wires of dissimilar metals, such as copper and constantan, joined at one end. The joined end is the measurement junction; the junction that is created when the thermocouple is wired to the CR1000 is the reference junction.

When the two junctions are at different temperatures, a voltage proportional to the temperature difference is induced into the wires. The thermocouple measurement requires the reference junction temperature to calculate the measurement junction temperature using proprietary algorithms in the CR1000 operating system.

---

10. Click on Outputs to advance to the next step.

11. The Outputs window displays a list of selected sensors on the left, and data storage Tables on the right.

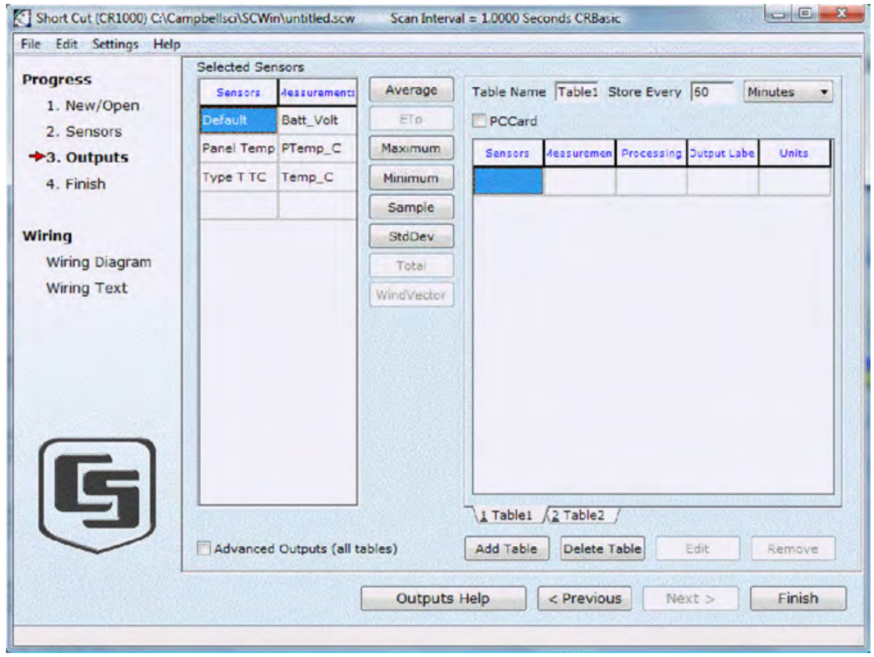


FIGURE 16. Short Cut Outputs Tab

2.2.4.4 Procedure: (Short Cut Steps 12-16)

12. By default, there are two Tables initially available. Both Tables have a Store Every field along with a drop-down box to select the time units. These are used to set the time interval when data is stored.

13. Only one Table is needed for this tutorial, so Table 2 can be removed. Select Table 2 by clicking on its tab, and then click on Delete Table.

14. Change the Table Name to OneMin, and then change the interval to 1 minute (Store Every 1 Minutes).

15. Adding a measurement to the table is done by selecting the measurement under Selected Sensors, and then clicking on one of the processing buttons in the center of the window.

16. Apply the Average function to the Batt_Volt, PTemp_C, and Temp_C measurements.

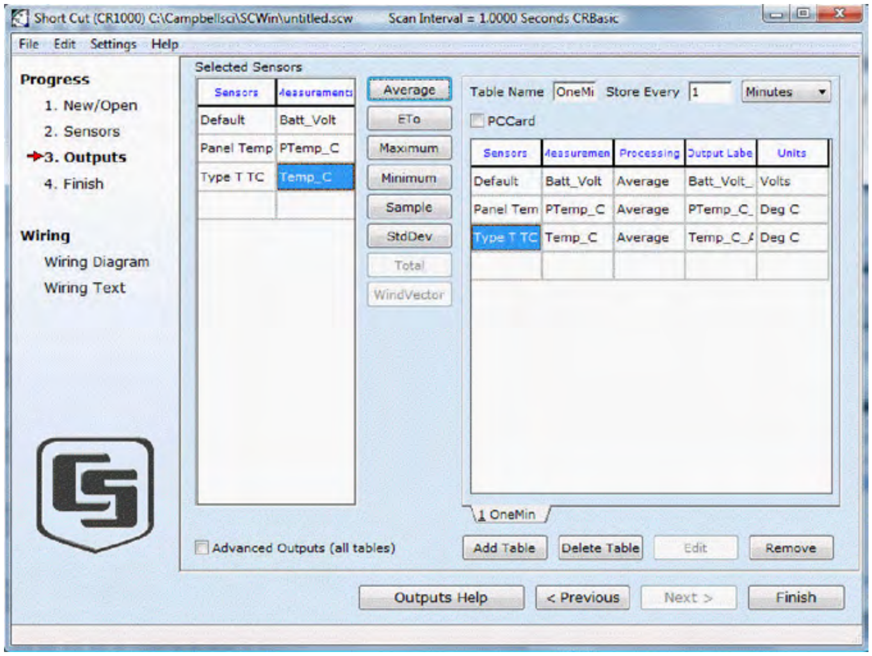


FIGURE 17. Short Cut Output Table Definition

2.2.4.5 Procedure: (Short Cut Steps 17-18)

17. Click on **Finish** to compile the program. Give the program the name "QuickStart." A summary screen will appear showing the compiler results. Any errors during compiling will also be displayed.

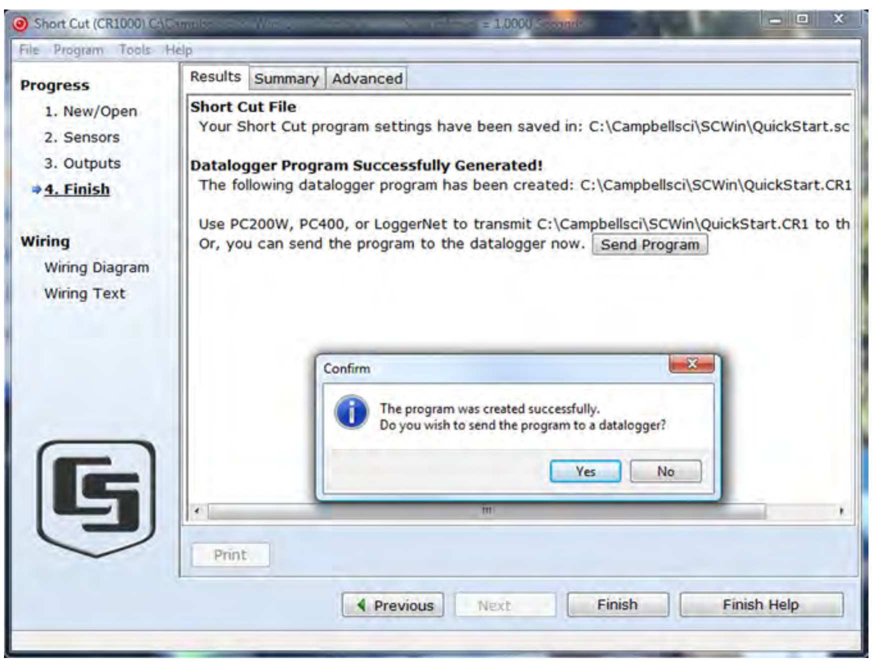


FIGURE 18. Short Cut Compile Confirmation

18. Close this window by clicking on the "X" in the upper right corner.

2.2.5 Send Program and Collect Data with PC200W

PC200W Support Software Objectives:

This portion of the tutorial will use PC200W to send the program to the CR1000, collect data from the CR1000, and store the data to the PC

2.2.5.1 Procedure: (PC200W Step 1)

1. From the PC200W Clock/Program tab, click on the *Connect* button to establish communications with the CR1000. When communications have been established, the text on the button will change to Disconnect.

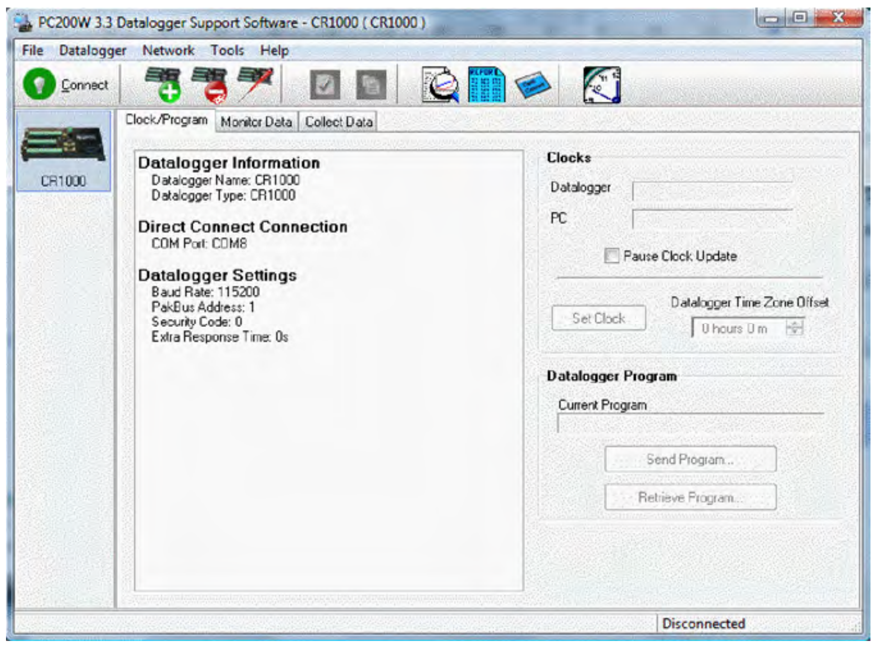


FIGURE 19. PC200W Connect Button

2.2.5.2 Procedure: (PC200W Steps 2-4)

2. Click the Set Clock button to synchronize the datalogger's clock with the computer's clock.

3. Click on the Send Program button. A window will appear warning that data on the datalogger will be erased. Answer "yes" to the prompt. Another window will open. Browse to the C:\CampbellSci\SCWin folder, select the QuickStart.CR1 file, and then click the Open button. A status bar will appear while the program is sent to the CR1000 followed by a confirmation that the transfer was successful. Click OK to close this window.

4. After sending a program to the CR1000, a good practice is to monitor the measurements to ensure they are reasonable. Select the Monitor Data tab. The window now displays data found in the Public Table coming from the CR1000. To view the OneMin table, select an empty cell in the display area, and then click on the Add button.

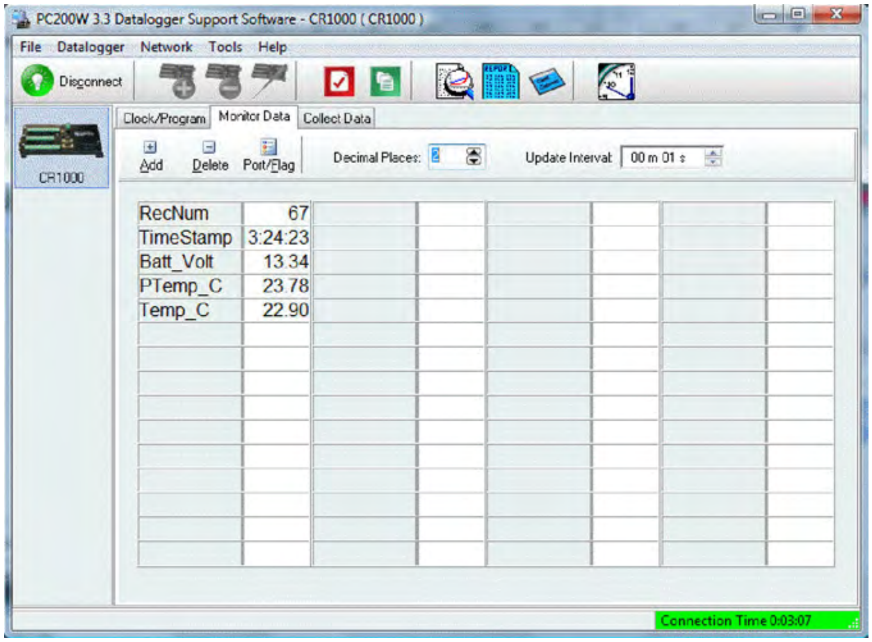


FIGURE 20. PC200W Monitor Data Tab - Public Table

2.2.5.3 Procedure: (PC200W Step 5)

5. In the Add Selection window, click on the OneMin table, and then click Paste. The OneMin table is now displayed in the main display.

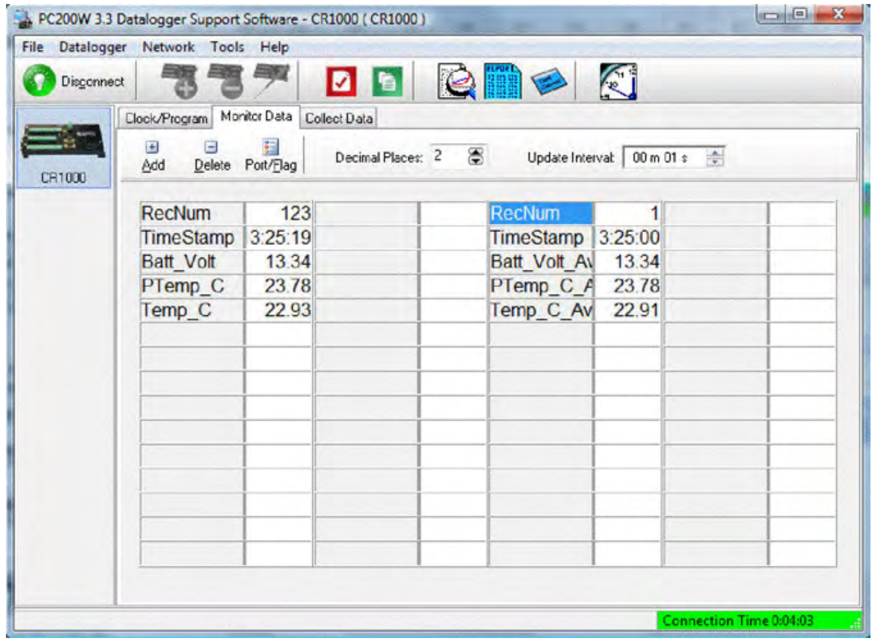


FIGURE 21. PC200W Monitor Data Tab - Public and OneMin Tables

2.2.5.4 Procedure: (PC200W Step 6)

6. Click on the Collect Data tab. From this window, data is chosen to be collected as well as the location where the collected data will be stored.

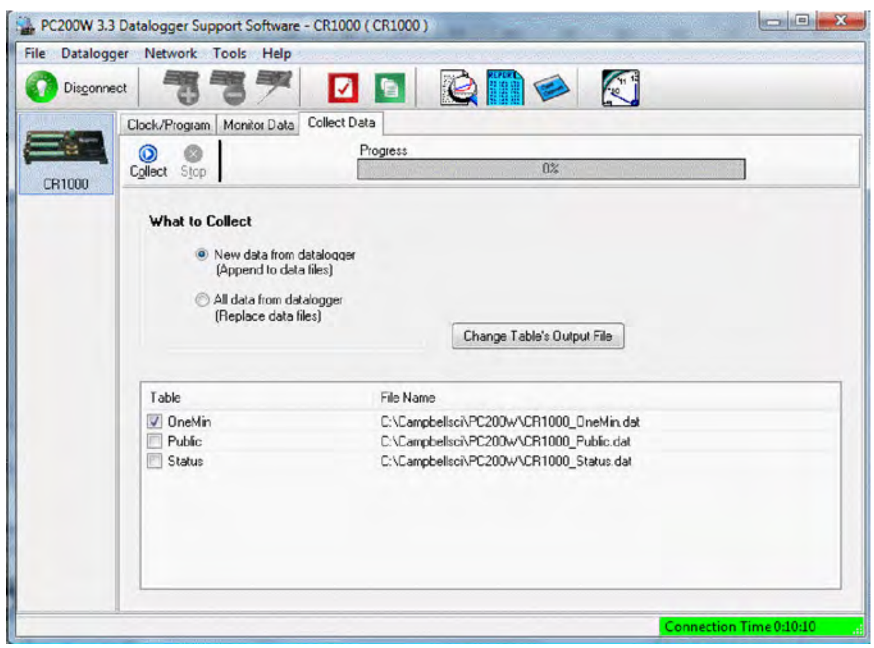


FIGURE 22. PC200W Collect Data Tab

2.2.5.5 Procedure: (PC200W Steps 7-9)

7. Click the OneMin box so a check mark appears in the box. Under the "What to Collect" heading, select "New data from datalogger." This selects which data will be collected.

8. Click on the Collect button. A requester box will appear, prompting for a filename. Click on Save to accept the default filename of "CR1000_OneMin.dat." A progress bar will appear as the data is collected, followed by the message, "Collection Complete." Click OK to continue.

9. To view the data, click on the View icon at the top of the window. This opens a new window.

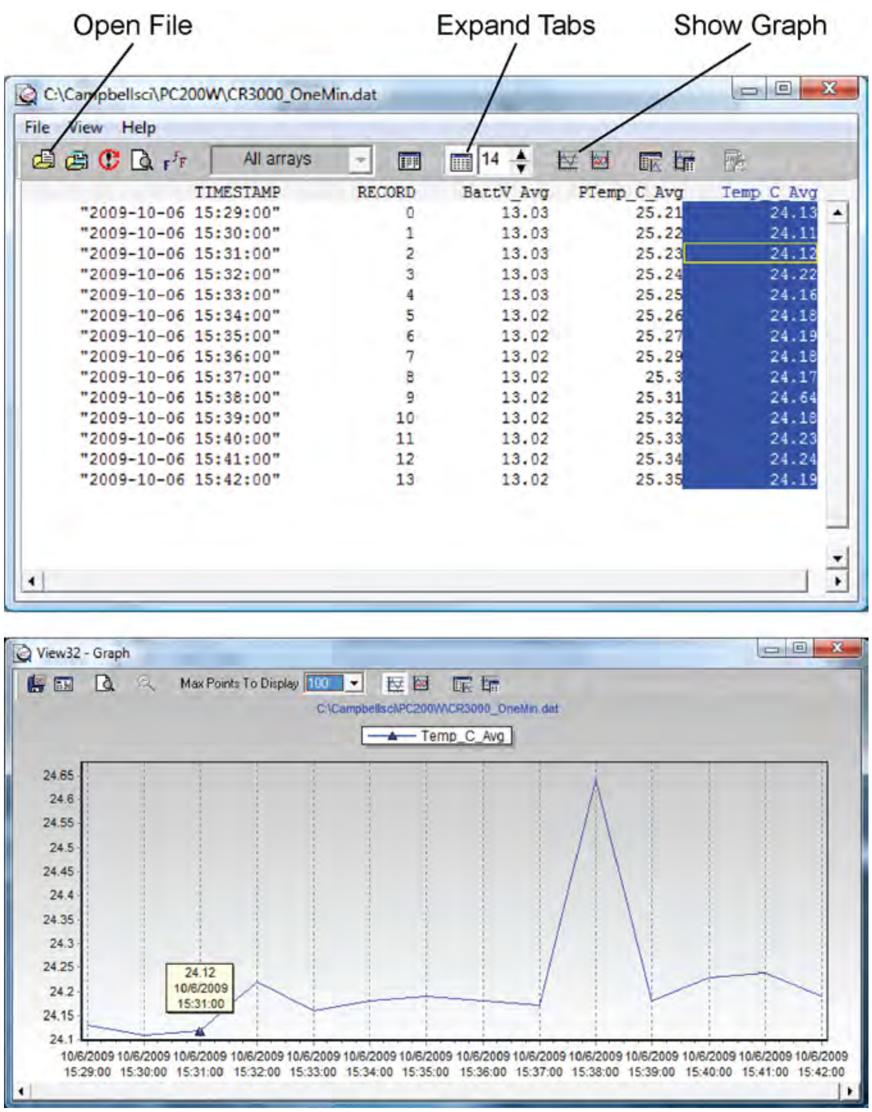


FIGURE 23. PC200W View Data Utility

2.2.5.6 Procedure: (PC200W Steps 10-11)

10. Click on the Open File icon to open a file for viewing. Select the "CR1000_OneMin.dat" file and click on Open. The collected data is now shown.

11. Click on Expand Tabs to display the data in columns with column headings.

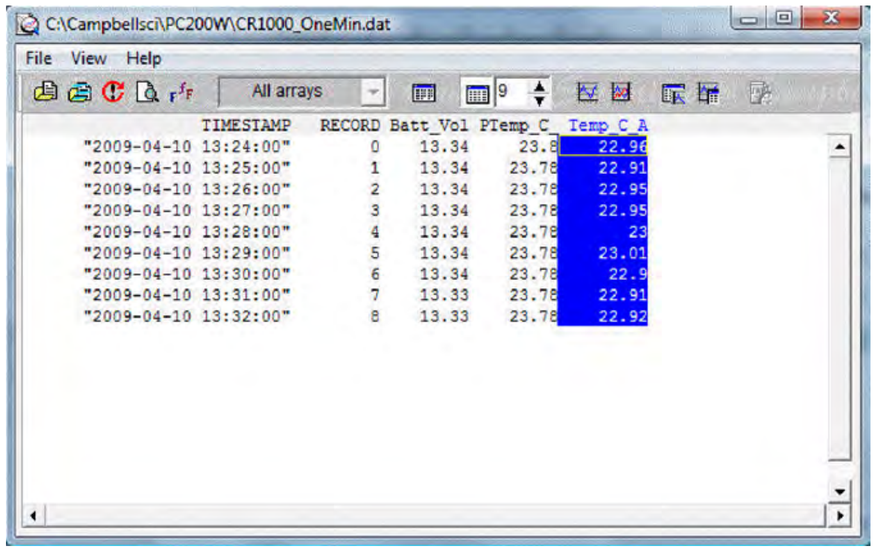


FIGURE 24. PC200W View Data Table

2.2.5.7 Procedure: (PC200W Steps 12-13)

12. Select any data column by clicking on it. To display the data in graphical form, click on one of the Show Graph buttons. A graph with one Y-axis or two Y-axes will be generated.

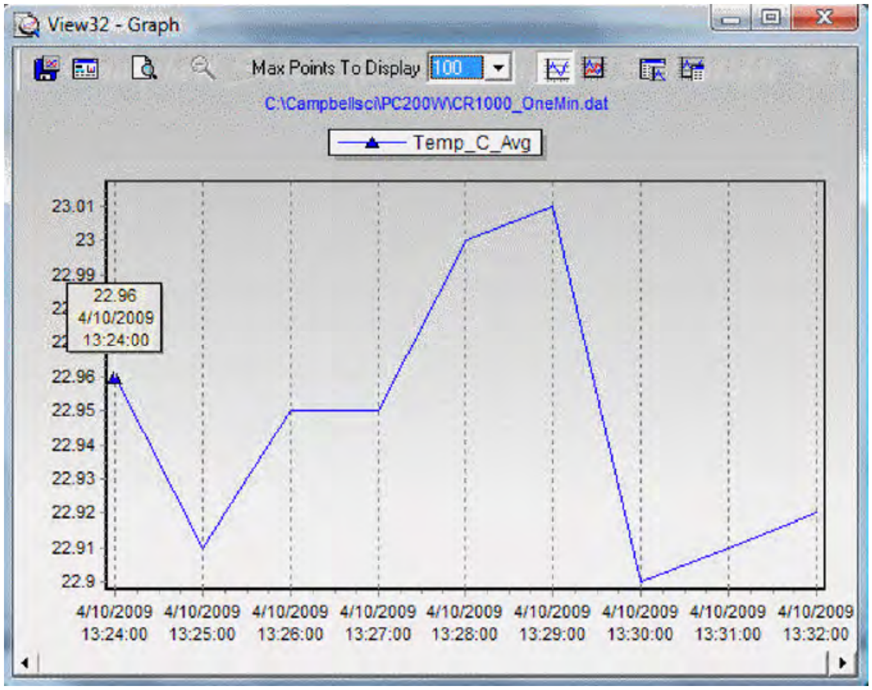


FIGURE 25. PC200W View Data Graph

13. Close the Graph and View windows, and then close the PC200W program.

Section 3. System Overview

A data acquisition system consists of hardware, user entered programs, and datalogger support software. *FIGURE. Features of a Data Acquisition System* (p. 27) illustrates a common CR1000-based data acquisition system.

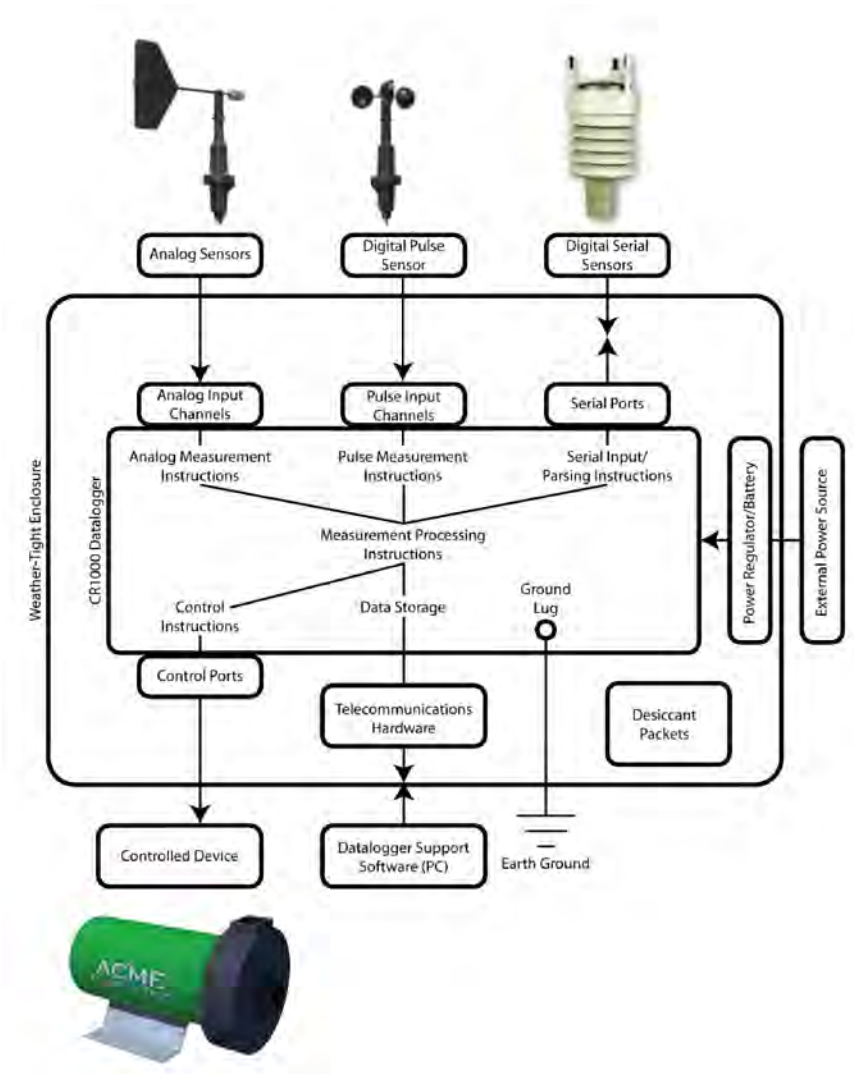


FIGURE 26. Features of a Data Acquisition System

3.1 CR1000 Datalogger

The CR1000 Datalogger is a precision instrument designed for demanding low-power measurement applications. CPU, analog and digital inputs, analog and digital outputs, and memory are controlled by the operating system in conjunction with the user program. The user program is written in CRBASIC, a programming language that includes data processing and analysis routines and a standard BASIC instruction set. Campbell Scientific's datalogger support software facilitates program generation, editing, data retrieval, and real-time data monitoring (see *SECTION. Support Software* (p. 395)).

The CR1000 is a multimeter with memory and timekeeping. It is one part of a data acquisition system. To acquire quality data, suitable sensors and reliable telecommunications devices are also required.

Sensors transduce phenomena into measurable electrical forms, outputting voltage, current, resistance, pulses, or state changes. The CR1000, sometimes with the assistance of various peripheral devices, can measure nearly all electronic sensors.

The CR1000 measures analog voltage and pulse signals, representing the magnitudes numerically. Numeric values are scaled to the unit of measure such as milliVolts and pulses, or in user specified engineering units such as wind direction and wind speed. Measurements can be processed through calculations or statistical operations and stored in memory awaiting transfer to a PC via external storage or telecommunications.

The CR1000 has the option of evaluating programmed instructions sequentially, or in pipeline mode, wherein the CR1000 decides the order of instruction execution.

3.1.1 Sensor Support

Read More! See *SECTION. Sensor Support* (p. 43).

The following sensor types are supported by the CR1000 datalogger. Refer to *APPENDIX. Sensors* (p. 495) for information on sensors available from Campbell Scientific.

- Analog voltage
- Analog current (with a shunt resistor)
- Thermocouples
- Resistive bridges
- Pulse output
- Period output
- Frequency output
- Serial smart sensors
- SDI-12 sensors

A library of sensor manuals and application notes are available at *www.campbellsci.com* to assist in measuring many sensor types. Consult with a Campbell Scientific applications engineer for assistance in measuring unfamiliar sensors.

3.1.2 CR1000 Wiring Panel

The wiring panel of the CR1000 is the interface to all CR1000 functions. Most CR1000 functions are best introduced by reviewing features of the CR1000 wiring panel. *FIGURE. CR1000 Wiring Panel* (p. 5) illustrates the wiring panel and some CR1000 functions accessed through it.

Read More! Expansion accessories increase the input / output capabilities of the wiring panel. Read *SECTION. Measurement and Control Peripherals* (p. 95) for more information.

3.1.2.1 Measurement Inputs

Measurements require a physical connection with a sensor at an input channel and CRBASIC programming to instruct the CR1000 how to make, process, and store the measurement. The CR1000 wiring panel has the following input channels:

Analog Voltage: 16 channels (Diff 1 - 8 / SE 1 - 16) configurable as 8 differential or 16 single-ended inputs.

- Input voltage range: -5000 mV to +5000 mV.
- Measurement resolution: 0.67 µV to 1333 µV

Period Average: 16 channels (SE 1 -16)

- Input voltage range: -2500 mV to +2500 mV.
- Maximum frequency: 200 kHz
- Resolution: 136 ns

Note Both pulse count and period average measurements are used to measure frequency output sensors. Yet pulse count and period average measurement methods are different. Pulse count measurements use dedicated hardware -- pulse count accumulators, which are always monitoring the input signal, even when the CR1000 is between program scans. In contrast, period average measurement instructions only monitor the input signal during a program scan. Consequently, pulse count scans can usually be much less frequent than period average scans. Pulse counters may be more susceptible to low frequency noise because they are always "listening", whereas period averaging may filter the noise by reason of being "asleep" most of the time. Pulse count measurements are not appropriate for sensors that are powered off between scans, whereas period average measurements work well since they can be placed in the scan to execute only when the sensor is powered and transmitting a correct signal.

Period average measurements utilize a high-frequency digital clock to measure time differences between signal transitions, whereas pulse count measurements simply accumulate the number of counts. As a result, period average measurements offer much better frequency resolution per measurement interval, as compared to pulse count measurements. The frequency resolution of pulse count measurements can be improved by extending the measurement interval by increasing the scan interval and by averaging.

Pulse: 2 channels (P1 - P2) configurable for counts or frequency of the following signal types:

- High level 5V square waves
- Switch closures
- Low-level A/C sine waves

Digital I/O: 8 channels (C1 - C8) configurable for serial input, SDM, SDI-12, state, frequency, pulses, edge counting and edge timing.

- C1 - C8: state, frequency, pulse, edge counting and edge timing measurements.
- Edge Timing Resolution: 540 ns
- C1, C2 and C3: Synchronous Devices for Measurement (SDM) input / output.
- C1, C3, C5, C7: SDI-12 input / output.
- C1 & C2, C3 & C4, C5 & C6, C7 & C8: serial communication input / output.

9-Pin RS-232: 1 port (Computer RS-232) configurable for serial input.

Refer to *APPENDIX. Digital I/O Expansion* (p. 498), *APPENDIX. Pulse / Frequency Input Expansion Modules* (p. 498), and *APPENDIX. Serial Input / Output Peripherals* (p. 499) for information on available input expansion modules.

3.1.2.2 Voltage Outputs

The CR1000 has several terminals capable of supplying switched voltage and current to peripherals, sensors, or control devices.

Read More! See *SECTION. Control Output* (p. 95).

- **Switched Analog Output (Excitation)**: three channels (VX1 - VX3) for precise voltage excitation ranging from -2500 mV to +2500 mV. These channels are regularly used with resistive bridge measurements. Each channel will source up to 25 mA.
- **Digital I/O**: 8 channels (C1 - C8) configurable for on / off and pulse output duration.
- **Switched 12 Volts dc (SW-12)**: One terminal controls (switch on / off) primary voltage under program control for control of external devices requiring 12 Vdc, such as humidity sensors. SW-12 can source up to 900 mA. See *TABLE. Current Sourcing Limits* (p. 102).
- **Continuous Analog Output**: available by adding a peripheral analog output device available from Campbell Scientific. Refer to *APPENDIX. CAO Modules* (p. 498) for information on available output expansion modules.

3.1.2.3 Grounding Terminals

Read More! See *SECTION. Grounding* (p. 105).

Proper grounding will lend stability and protection to a data acquisition system. It is the easiest and least expensive insurance against data loss-and the most neglected. The following terminals are provided for connection of sensor and datalogger grounding:

- **Signal Grounds**: 12 ground terminals (⏚) used as reference for single-ended analog inputs, pulse inputs, excitation returns, and as a ground for sensor shield wires. Signal returns for pulse inputs should use ⏚ terminals located next to pulse inputs.
- **Power Grounds**: 6 terminals (G) used as returns for 5V, SW-12, 12V, and C1-C8 outputs. Use of G grounds for these outputs minimizes potentially large current flow through the analog voltage measurement section of the wiring panel, which can cause single-ended voltage measurement errors.
- **Ground Lug**: 1 terminal (⏚), the large ground lug is used to connect a heavy gage wire to earth ground. A good earth connection is necessary to secure the ground potential of the datalogger and shunt transients away from electronics. Minimum 14 AWG wire is recommended.

3.1.2.4 Power Terminals

Read More! See *SECTION. CR1000 Power Supply* (p. 99).

Power In

Note: Refer to *APPENDIX. Power Supplies* (p. 495) for information on available power supplies.

- **External Power Supply**: One green plug (POWER IN): for connecting power from an external power source to the CR1000. This is the only terminal used to input power; other 12V terminals and the SW-12 terminal are output only terminals for supplying power to other devices. Review power requirements and power supply options in *SECTION. CR1000 Power Supply* (p. 99) before connecting power.

Power Out

- See *SECTION. Powering Sensors* (p. 100)
- **Peripheral 12 Vdc Power Source**: 2 terminals (12V) and associated grounds (G) supply power to sensors and peripheral devices requiring nominal 12 Vdc. This supply may drop as low as 9.6 Vdc before datalogger operation stops. Precautions should be taken to minimize the occurrence of data from underpowered sensors.
- **Peripheral 5 Vdc Power Source**: 1 terminal (5V) and associated ground (G) supply power to sensors and peripheral devices requiring regulated 5 Vdc.

3.1.2.5 Communications Ports

Read More! See *SECTION. RS-232 and TTL Recording* (p. 91), *SECTION. Telecommunications and Data Retrieval* (p. 369) and *SECTION. PakBus Overview* (p. 373).

The CR1000 is equipped with 6 communications ports. Communication ports allow the CR1000 to communicate with other computing devices, such as a PC, or with other Campbell Scientific dataloggers.

Note RS-232 communications normally operate well up to a transmission cable capacitance of 2500 picofarads, or approximately 50 feet of commonly available serial cable.

- **9-pin RS-232**: 1 DCE port for communicating with a PC through the supplied serial cable, serial sensors, or through 3rd party serial telecommunications devices. Acts as a DTE device with a null-modem cable.

Read More! See *APPENDIX. Serial Port Pin Outs* (p. 479).

Note The 9-pin RS-232 port is not electrically isolated. "Isolation" means isolated, by means of optical isolation components, from the communications node at the other end of the connection. Optical isolation prevents some electrical problems such as ground looping, which can cause significant errors in single-ended analog measurements. Campbell Scientific offers a peripheral optically isolated RS-232 to CS I/O interface as a CR1000 accessory. Refer to *APPENDIX. Serial Input / Output Peripherals* (p. 499) for model information.

- **9-pin CS I/O port**: 1 port for communicating through Campbell Scientific telecommunications peripherals. Approved CS I/O telecommunication interfaces are listed in *APPENDIX. Serial Input / Output Peripherals* (p. 499).
- **2-pin RS-232**: 4 ports configurable from Control I/O ports for communication with serial sensors or other Campbell Scientific dataloggers.
- **Peripheral**: 1 port for use with some Campbell Scientific CF memory card modules and IP network link hardware. See *SECTION. Data Table Declarations* (p. 177) for CF card precautions.

3.1.3 Power Requirements

Read More! See *SECTION. CR1000 Power Supply* (p. 99).

The CR1000 operates from a dc power supply with voltage ranging from 9.6 to 16 V, and is internally protected against accidental polarity reversal. The CR1000 has modest input power requirements. In low power applications, it can operate for several months on non-rechargeable batteries. Power systems for longer-term remote applications typically consist of a charging source, a charge controller, and a rechargeable battery. When ac line power is available, an ac/ac or ac/dc wall adapter, a charge controller, and a rechargeable battery can be used to construct a UPS (uninterruptible power supply). Contact a Campbell Scientific applications engineer for assistance in acquiring the items necessary to construct a UPS.

Applications requiring higher current requirements, such as satellite or cellular phone communications, should be evaluated by means of a power budget with a knowledge of the factors required by a robust power system. Contact a Campbell Scientific applications engineer if assistance is required in evaluating power supply requirements.

Common power devices are:

- Batteries
  - Alkaline D-cell - 1.5 Vdc / cell
  - Rechargeable Lead-Acid battery
- Charge Sources
  - Solar Panels
  - Wind Generators
  - ac/ac or ac/dc wall adapters

Refer to *APPENDIX. Power Supplies* (p. 495) for specific model numbers of approved power supplies.

3.1.4 Programming

The CR1000 is a highly programmable instrument, adaptable to the most demanding measurement and telecommunications requirements.

3.1.4.1 Firmware: OS and Settings

Read More! See *SECTION. CR1000 Configuration* (p. 111).

Firmware consists of the operating system (OS) and durable configuration settings. OS and settings remain intact when power is cycled.

Note The CR1000 is shipped factory ready with all settings and firmware necessary to communicate with a PC via RS-232 and to accept and execute user application programs. OS upgrades are occasionally made available at *www.campbellsci.com*.

For more complex applications, some settings may need adjustment. Adjustments are accomplished with DevConfig Software (*DevConfig* (p. 111)), the optional keyboard display (see *SECTION. Using the Keyboard Display* (p.

395)), or through datalogger support software (see *APPENDIX. Software* (p. 489)).

OS files are sent to the CR1000 with DevConfig or through the program Send button in datalogger support software. When the OS is sent via DevConfig, most settings are cleared, whereas, when sent via datalogger support software, most settings are retained.

OS files can also be sent to the CR1000 with a CompactFlash card (CRD: drive) or CS mass storage media (USB: drive).

Read More! See *SECTION. Programming* (p. 129) and *SECTION. CRBASIC Programming Instructions* (p. 175) and CRBASIC help for more programming assistance.

A CRBASIC program directs the CR1000 how and when sensors are to be measured, calculations made, and data stored. A program is created on a PC and sent to the CR1000. The CR1000 can store a number of programs in memory, but only one program is active at a given time. Three Campbell Scientific software applications, Short Cut, CRBASIC Editor, and Transformer Utility create CR1000 programs.

- Short Cut creates a datalogger program and wiring diagram in four easy steps. It supports most sensors sold by Campbell Scientific and is recommended for creating simple programs to measure sensors and store data.

- Programs generated by Short Cut are easily imported into CRBASIC Editor for additional editing. For complex applications, experienced programmers often create essential measurement and data storage code with Short Cut, then edit the code with CRBASIC Editor. Note that once a Short Cut generated program has been edited with CRBASIC Editor, it can no longer be modified with Short Cut.

3.1.5 Memory and Data Storage

Read More! See *SECTION. Memory and Data Storage* (p. 349).

CR1000 memory size is posted in the Status Table (*APPENDIX. Status Table and Settings* (p. 457)).

The CR1000 stores these data:

- Operating system. Held in up to 2 Mbytes Flash EEPROM.

- Settings. Held in 512 K Flash.

- Programs, system data, and measurement data. Held in 4 Mbytes SRAM.

Note -- Maximum memory allowed for program storage is 490 kbytes.

Programs are stored as files on the automatically partitioned CPU: drive. Photographic images and measurement data files are stored on the USR: drive, which is partitioned by the user from data storage memory (See *APPENDIX. Cameras* (p. 504)). TableFile() instruction output files are usually stored on USR:. TableFile() also stores files on a USB: drive (*APPENDIX. Mass Storage Devices* (p. 504)). Data formats available for storage by TableFile() include TOA5, TOB1, CSIXML, CSIJSON.

Note CR1000s with serial numbers smaller than 11832 were usually supplied with only 2 Mbytes of SRAM.

Additional final data storage is available by using the optional CompactFlash® card with a CompactFlash® module listed in *APPENDIX. Card Storage Modules* (p. 503), or with a mass storage device (*APPENDIX. Mass Storage Devices* (p. 504)).

3.1.6 Data Retrieval

Data tables are transferred to PC files through a telecommunications link (*SECTION. Telecommunications and Data Retrieval* (p. 369)) or by transporting a CompactFlash card (CRD: drive) or CS mass storage media (USB: drive) to the PC.

3.1.6.1 Via Telecommunications

Data are usually transferred through a telecommunications link to an ASCII file on the supporting PC using Campbell Scientific datalogger support software (*APPENDIX. Software* (p. 489)). See also the manual and Help for the software package being used.

3.1.6.2 Via Mass Storage Device

Caution When removing a CS mass storage device (thumb drive) from the CR1000, do so only when the LED is not lit or flashing. Removing a CS mass storage device from the CR1000 while the device is active can cause data corruption.

Data stored on CS mass storage devices are retrieved through a telecommunication link to the CR1000 or by removing the device, connecting it to a PC, and copying / moving files using Windows Explorer.

3.1.6.3 Via CF Card

Caution When installing a CF card module, first turn off the CR1000 power.

Before removing a CF card module from the datalogger, disable the card by pressing the "removal button" (NOT the eject button), wait for the green LED, then turn CR1000 power off.

Removing a card or card module from the CR1000 while the CF card is active can cause garbled data and can damage the card.

Sending a program to the CR1000 may erase all SRAM and CF card data. To prevent losing data, collect data from the CF card before sending a program to the datalogger.

The CR1000 manages data on a CF card as final storage table data, accessing the card as needed to fill data collection requests initiated with the Collect button in *datalogger support software* (p. 439, p. 490). If desired, binary data can be collected using the File Control utility in *datalogger support software* (p. 439, p. 490). Before collecting data this way, stop the CR1000 program to ensure data are not written to CF while data are retrieved, other wise, data corruption and confusion will result.

Data stored on CF cards are retrieved through a telecommunication link to the CR1000 or by removing the card, carrying it to a computer, and retrieving the data via a third party CF adaptor. Retrieving data, especially large files, is much faster through a CF adaptors than via telecommunications.

The format of data files collected via a CF adaptor is different than the format created by *datalogger support software* (p. 489). Data files read from the CF card via a CF adaptor can be converted to a Campbell Scientific format using CardConvert. CardConvert is included with mid- and top-level *datalogger support software* (p. 489). Consult the software manual for more CardConvert information.

3.1.6.4 Data File Formats in CR1000 Memory

Routine CR1000 operations store data in binary data tables. However, when the TableFile() instruction is used, data are also stored in one of several formats in discrete text files in internal or external memeory. See *SECTION. Data Storage* (p. 352) for more information on the use of the TableFile() instruction.

3.1.6.5 Data Format on Computer

CR1000 data stored on a PC via support software is formatted as either ASCII or Binary depending on the file type selected in the support software. Consult the software manual for details on the various available data file formats.

3.1.7 Communications

Read More! See *SECTION. Telecommunications and Data Retrieval* (p. 369).

The CR1000 communicates with external devices to receive programs, send data, or act in concert with a network. The primary communication protocol is PakBus. Modbus and DNP3 communication protocols are also supported. Refer to *APPENDIX. Telecommunications Hardware* (p. 501) for information on available communications devices.

3.1.7.1 PakBus

Read More! See *SECTION. PakBus Overview* (p. 373).

The CR1000 communicates with Campbell Scientific support software, telecommunication peripherals, and other dataloggers via PakBus, a proprietary network communications protocol. PakBus is a protocol similar in concept to IP (Internet protocol). By using signatured data packets, PakBus increases the number of communications and networking options available to the CR1000. Communication can occur via RS-232, CS I/O, or digital I/O ports.

Advantages of PakBus:

- Simultaneous communication between the CR1000 and other devices.
- Peer-to-peer communication-no PC required.
- Other PakBus dataloggers can be used as "sensors" to consolidate all data into one CR1000.
- Routing - the CR1000 can act as a router, passing on messages intended for another logger. PakBus supports automatic route detection and selection.
- Short distance networks with no extra hardware-A CR1000 can talk to another CR1000 over distances up to 30 feet by connecting transmit, receive and ground wires between the dataloggers. PC communications with a PakBus datalogger via the CS I/O port, over phone modem or radio, can be routed to other PakBus dataloggers.
- Datalogger to datalogger communications-special CRBASIC instructions simplify transferring data between dataloggers for distributed decision making or control.
- In a PakBus network, each datalogger is set to a unique address before being installed in the network. Default PakBus address is 1. To communicate with the CR1000, the datalogger support software (see *SECTION. Telecommunications and Data Retrieval* (p. 369)) must know the CR1000's PakBus address. The PakBus address is changed using the optional keyboard display, DevConfig software, CR1000 status table, or PakBus Graph software.

3.1.7.2 Modbus

Read More! See *SECTION. Modbus* (p. 388).

The CR1000 supports Modbus Master and Modbus Slave communication for inclusion in Modbus SCADA networks.

3.1.7.3 DNP3 Communication

Read More! See *SECTION. DNP3* (p. 385).

The CR1000 supports DNP3 Slave communication for inclusion in DNP3 SCADA networks.

3.1.7.4 Keyboard Display

Read More! See *SECTION. Using the Keyboard Display* (p. 395).

The optional keyboard display is a powerful tool for field use. It allows complete access to most datalogger tables and function, allowing the user to monitor, make modifications, and troubleshoot a datalogger installation conveniently and in most weather conditions.

3.1.7.4.1 Custom Menus

Read More! To implement custom menus, see CRBASIC Help for the DisplayMenu() instruction.

CRBASIC programming in the CR1000 facilitates creation of custom menus for the optional keyboard display.

FIGURE. Custom Menu Example (p. 39) shows windows from a simple custom menu named "DataView". "DataView" appears as the main menu on the keyboard display. DataView has menu item, "Counter", and submenus "PanelTemps", "TCTemps", and "System Menu". "Counter" allows selection of 1 of 4 values. Each submenu displays two values from CR1000 memory. PanelTemps shows the CR1000 wiring panel temperature at each scan, and the one minute sample of panel temperature. TCTemps displays two thermocouple temperatures.

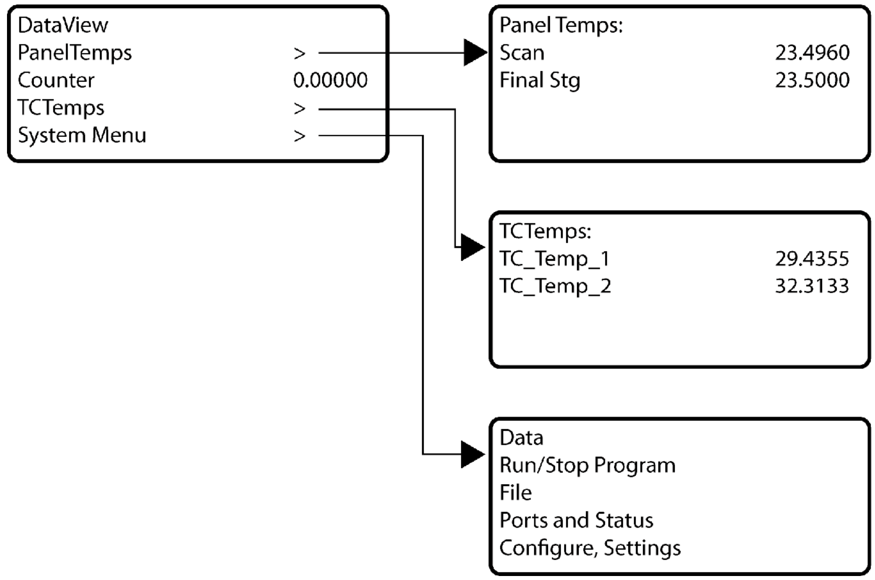


FIGURE 27. Custom Menu Example

3.1.8 Security

CR1000 applications may include collection of sensitive data, operation of critical systems, or networks accessible by many individuals. CR1000 security provides means by which partial or complete lock-out can be accomplished in the CRBASIC program code.

Up to three levels of security can be set in the datalogger. Level 1 must be set before Level 2. Level 2 must be set before Level 3. If a level is set to 0, any level greater than it will also be set to 0 (e.g., if Level 2 is 0, Level 3 is 0). Valid security codes are 1 through 65535 (0 is no security). Each level must have a unique code. If security is set to a negative code in the CR1000, a positive code must be entered to unlock the CR1000. That positive code = 65536 + (negative security code). For example, a security code of -1111 must be entered as 64425 to unlock the CR1000.

Security can be enabled using DevConfig, the optional keyboard display, Status Table, or the SetSecurity () instruction.

Note -- If SetSecurity () is used in the CRBASIC program, the security settings persist if a new program that has no SetSecurity () instruction is sent to the CR1000.

Functions affected by each level of security are:

- **Level 1**: collecting data, setting the clock, and setting variables in the Public table are unrestricted. Enter level 1 password to change or retrieve the datalogger program or set variables in the Status table.

- **Level 2**: collecting data are unrestricted. Enter level 2 password to set the clock or change variables in the public table. Enter level 1 password to change the datalogger program or non-read-only postings in the status table.

- **Level 3**: Enter level 3 password to collect data. Enter level 2 password to collect data, set public variable and set the clock. Enter level 1 password to open all datalogger functions to unrestricted use.

In addition to passwords, recording and monitoring program signatures are important components of a security scheme. Read more about use of program signatures in *SECTION. System Signatures* (p. 173).

3.1.9 Maintenance

Read More! See *SECTION. Care and Maintenance* (p. 409).

With reasonable care, the CR1000 should give many years of reliable service.

3.1.9.1 Protection from Water

The CR1000 and most of its peripherals must be protected from moisture. Moisture in the electronics will seriously damage, and probably render un-repairable, the CR1000. Water can come from flooding or sprinkler irrigation, but most often comes as condensation. In most cases, protecting from water is as easy as placing the CR1000 in a weather tight enclosure with desiccant and elevating the enclosure above the ground. The CR1000 is shipped with desiccant to reduce humidity. Desiccant should be changed periodically. Do not completely seal the enclosure if lead acid batteries are present; hydrogen gas generated by the batteries may build up to an explosive concentration. Refer to *APPENDIX. Enclosures* (p. 497) for information on available weather tight enclosures.

3.1.9.2 Protection from Voltage Transients

Read More! See *SECTION. Grounding* (p. 105).

The CR1000 must be grounded to minimize the risk of damage by voltage transients associated with power surges and lightning induced transients. Earth grounding is required to form a complete circuit for voltage clamping devices internal to the CR1000. Refer to *APPENDIX. Voltage Transient Suppressors* (p. 503) for information on available surge protection devices.

3.1.9.3 Calibration

Read More! See *SECTION. Self-Calibration* (p. 60).

The CR1000 uses an internal voltage reference to routinely calibrate itself. To maintain electrical specifications, Campbell Scientific recommends factory recalibration every two years. For calibration services, contact Campbell Scientific to obtain a Return Materials Authorization (RMA) prior to shipping.

3.1.9.4 Internal Battery

Caution -- Misuse of the lithium battery or installing it improperly can cause severe injury. Fire, explosion, and severe burn hazard! Do not recharge, disassemble, heat above 100°C (212°F), solder directly to the cell, incinerate, nor expose contents to water. Dispose of spent lithium batteries properly.

The CR1000 contains a lithium battery that operates the clock and SRAM when the CR1000 is not externally powered. In a CR1000 stored at room temperature, the lithium battery should last approximately 3 years (less at temperature extremes). In installations where the CR1000 is powered most of the time, the lithium cell should last much longer. Lithium battery voltage can be monitored from the CR1000 Status Table. Operating range of the battery is 2.7 to 3.6 Vdc. Replace the battery as directed in *SECTION. Replacing the Internal Battery* (p. 411) when the voltage is below 2.7 Vdc.

3.2 PC Support Software

Read More! See *SECTION. Support Software* (p. 395).

Several datalogger support software products for Windows are available. Software for datalogger setup and simple applications, PC200W and Short Cut, are available at no cost at *www.campbellsci.com*. For more complex programming, telecommunications, networking, and reporting features, full-featured products are available from Campbell Scientific.

- PC200W Starter Software is available at no charge at *www.campbellsci.com*. It supports a transparent RS-232 connection between PC and CR1000, and includes Short Cut for creating CR1000 programs. Tools for setting the datalogger clock, sending programs, monitoring sensors, and on-site viewing and collection of data are also included.

- PC400 supports a variety of telecommunication options, manual data collection, and data monitoring displays. Short Cut, CRBASIC Editor, and Transformer Utility are included for creating CR1000 programs. PC400 does not support complex communication options, such as phone-to-RF, PakBus® routing, or scheduled data collection.

- LoggerNet supports combined telecommunication options, customized data monitoring displays, and scheduled data collection. It includes Short Cut, CRBASIC Editor, and Transformer Utility programs for creating CR1000 programs. It also includes tools for configuring, trouble-shooting, and managing datalogger networks. LoggerNet Admin and LoggerNet Remote are also available for more demanding applications.

3.3 CR1000 Specifications

SPECIFICATIONS valid from -25° to +50°C, non-condensing environment, unless otherwise specified. Recalibration recommended every two years. Critical specifications and system configuration should be confirmed with Campbell Scientific before purchase.

PROGRAM EXECUTION RATE
(10) ms to 1 day @ 10 ms increments

ANALOG INPUTS (SE 1-16 or DIFF 1-8)
(8) differential (DF) or 16 single-ended (SE) individually configured input channels. Channel expansion provided by optional analog multiplexers.

RANGES and RESOLUTION: Basic resolution (Basic Res) is the A/D resolution of a single conversion. Resolution of DF measurements with input reversal is half the Basic Res.

Range (mV)[1]	DF Res (µV)[2]	Basic Res (µV)
±5000	667	1333
±2500	333	667
±250	33.3	66.7
±25	3.33	6.7
±7.5	1.0	2.0
±2.5	0.33	0.67

[1]Range overhead of ≈9% on all ranges guarantees full-scale voltage will not cause over-range.
[2]Resolution of DF measurements with input reversal.

ACCURACY[3]:
±(0.06% of reading + offset), 0° to 40°C
±(0.12% of reading + offset), -25° to 50°C
±(0.18% of reading + offset),-55° to 85°C(-XT only)

[3]Accuracy does not include sensor and measurement noise. Offsets are defined as:

Offset for DF w/input reversal = 1.5 x Basic Res+1.0 µV
Offset for DF w/o input reversal = 3 x Basic Res+2.0 µV
Offset for SE = 3 x Basic Res + 3.0 µV

ANALOG MEASUREMENT SPEED:

Integration Type Code	Integration Time	Settling Time	----Total Time[5]---- SE w/ No Rev	DF w/ Input Rev
250	250µs	450µs	≈1ms	≈12ms
_60Hz[4]	16.67ms	3ms	≈20ms	≈40ms
_50Hz[4]	20.00ms	3ms	≈25ms	≈50ms

4AC line noise filter
[5]Includes 250 µs for conversion to engineering units

INPUT NOISE VOLTAGE: For DF measurements with input reversal on ±2.5 mV input range (digital resolution dominates for higher ranges).

250 µs Integration: 0.34 µV RMS
50/60 Hz Integration: 0.19 µV RMS

INPUT LIMITS: ±5 Vdc

DC COMMON MODE REJECTION: >100 dB

NORMAL MODE REJECTION: 70 dB @ 60 Hz when using 60 Hz rejection

SUSTAINED INPUT VOLTAGE W/O DAMAGE: ±16 Vdc max.

INPUT CURRENT: ±1 nA typical, ±6 nA max. @ 50°C; ±90 nA @ 85°C

INPUT RESISTANCE: 20 Gohms typical

ACCURACY OF BUILT-IN REFERENCE JUNCTION THERMISTOR (for thermocouple measurements):
±0.3°C, -25° to 50°C
±0.8°C, -55° to 85°C (-XT only)

PERIOD AVERAGE: Any of the 16 SE analog inputs can be used for period averaging. Accuracy is ±(0.01% of reading + resolution), where resolution is 136 ns divided by the specified number of cycles to be measured.

Input amplitude and frequency:

Voltage Gain	± Input Range mV	Signal Peak-Peak[6] Min mV	Max V	Min Pulse Width µs	Max[7] Freq kHz
1	250	500	10	2.5	200
10	25	10	2	10	50
33	7.5	5	2	62	8
100	2.5	2	2	100	5

6With signal centered at CR1000 ground.
[7]The maximum frequency = 1/(Twice Minimum Pulse Width) for 50% of duty cycle signals.

ANALOG OUTPUTS (Vx 1-3)
(3) switched voltage outputs sequentially active only during measurement.

RANGES / RESOLUTION:

Chan	Range	Resolution	Current Source / Sink
V_X	±2.5V	0.67mV	±25 mA

spacer
spacer

V_X ACCURACY
±(0.06% of setting + 0.8 mV, 0° to 40°C
±(0.12% of setting + 0.8 mV, -25° to 50°C
±(0.18% of setting + 0.8 mV,-55° to 85°C(-XT only)

V_X FREQUENCY SWEEP FUNCTION: Switched outputs provide a programmable swept frequency, 0 to 2500 mV square waves for exciting vibrating wire transducers.

CURRENT SOURCING/SINKING: ±25 mA

RESISTANCE MEASUREMENTS
MEASUREMENT TYPES: Ratiometric measurements of 4- and 6-wire full bridges, and 2-, 3-, and 4-wire half bridges. Precise, dual polarity excitation for voltage excitation eliminates DC errors. Offset values are reduced by a factor of 2 when excitation reversal is used.

VOLTAGE RATIO ACCURACY[8]: Assuming excitation voltage of at least 1000 mV, not including bridge resistor error:

±(0.04% of reading + offset)/V_X

[8]Accuracy does not include sensor and measurement noise. Offsets are defined as:

Offset for DF w/input reversal = 1.5 x Basic Res + 1.0 µV
Offset for DF w/o input reversal = 3 x Basic Res + 2.0 µV
Offset for SE = 3 x Basic Res + 3.0 µV

PULSE COUNTERS (P 1-2)
(2) inputs individually selectable for switch closure, high frequency pulse, or low-level ac. Independent 24-bit counters for each input.

MAXIMUM COUNTS PER SCAN: 16.7 x 10^6

SWITCH CLOSURE MODE:
Minimum Switch Closed Time: 5 ms
Minimum Switch Open Time: 6 ms
Max. Bounce Time: 1 ms open w/o being counted

HIGH FREQUENCY PULSE MODE:
Maximum Input Frequency: 250 kHz
Maximum Input Voltage: ±20 V
Voltage Thresholds: Count upon transition from below 0.9 V to above 2.2 V after input filter with 1.2 µs time constant.

LOW LEVEL AC MODE: Internal ac coupling removes dc offsets up to ±0.5 Vdc.

Input Hysteresis: 12 mV RMS @ 1 Hz
Maximum ac Input Voltage: ±20 V
Minimum ac Input Voltage:

Sine wave (mV RMS)	Range (Hz)
20	1.0 to 20
200	0.5 to 200
2000	0.3 to 10,000
5000	0.3 to 20,000

DIGITAL I/O PORTS (C 1-8)
(8) ports software selectable as binary inputs or control outputs. Provide edge timing, subroutine interrupts / wake up, switch closure pulse counting, high frequency pulse counting, asynchronous communications (UARTs), SDI-12 communications, and SDM communications

HIGH FREQUENCY MAX: 400 kHz

SWITCH CLOSURE FREQUENCY MAX: 150 Hz

EDGE TIMING RESOLUTION: 540 ns

OUTPUT VOLTAGES (no load): high 5.0 V ±0.1 V; low <0.1

OUTPUT RESISTANCE: 330 ohms

INPUT STATE: high 3.8 to 16 V; low -8.0 to 1.2 V

INPUT HYSTERISIS: 1.4 V

INPUT RESISTANCE:
100 kohms with inputs <6.2 Vdc
220 ohm with inputs ≥ 6.2 Vdc

SERIAL DEVICE/RS-232 SUPPORT: 0 to 5 Vdc UART

SWITCHED 12 Vdc (SW-12)
(1) independent 12 Vdc unregulated source is switched on and off under program control. Thermal fuse hold current = 900 mA @ 20°C, 650 mA @ 50°C, 360 mA @ 85°C.

CE COMPLIANCE
STANDARD(S) TO WHICH CONFORMITY IS DECLARED: IEC61326:2002

COMMUNICATION
RS-232 PORTS:
9-pin: DCE (not electrically isolated) for computer or non-CSI modem connection.
COM1 to COM4: Four independent Tx/Rx pairs on control ports (non-isolated); 0 to 5 Vdc UART
Baud Rate: Selectable from 300 to 115.2 kbps.
Default Format: 8 data bits; 1 stop bits; no parity.
Optional Formats: 7 data bits; 2 stop bits; odd, even parity.

CS I/O PORT: Interface with CSI telecommunications peripherals.

SDI-12: Digital control ports 1, 3, 5 or 7 are individually configurable and meet SDI-12 Standard version 1.3 for datalogger mode. Up to ten SDI-12 sensors are supported per port.

PERIPHERAL PORT: 40-pin interface for attaching CompactFlash or Ethernet peripherals.

PROTOCOLS SUPPORTED: PakBus, Modbus, DNP3, FTP, HTTP, XML, POP3, SMTP, Telnet, NTCIP, NTP, SDI-12, and SDM.

SYSTEM
PROCESSOR: Renesas H8S 2322 (16-bit CPU with 32-bit internal core, running at 7.3 MHz)

MEMORY: 2 Mbytes of Flash for operating system; 4 Mbytes of battery-backed SRAM for CPU usage, program storage and final data storage.

RTC CLOCK ACCURACY: ±3 min. per year. Correction via GPS optional.

RTC CLOCK RESOLUTION: 10 ms

SYSTEM POWER REQUIREMENTS
VOLTAGE: 9.6 to 16 Vdc

EXTERNAL BATTERIES: 12 Vdc nominal (power connection is reverse polarity protected)

INTERNAL BATTERIES: 1200 mAhr lithium battery for clock and SRAM backup typically provides 3 years of back-up.

TYPICAL CURRENT DRAIN: Sleep Mode: ≈0.6 mA
1 Hz Sample Rate (one fast SE meas.): 1 mA
100 Hz Sample Rate (one fast SE meas.): 16.2 mA
100 Hz Sample Rate (one fast SE meas. w/ RS-232 communications): 27.6 mA
optional keyboard display on: add 7 mA to current drain
Backlight on: add 100 mA to current drain

PHYSICAL
DIMENSIONS: 239 x 102 x 61 mm (9.4 x 4.0 x 2.4 in); additional clearance required for cables and leads.

MASS/WEIGHT (datalogger + base):

MASS: 1.0 kg
WEIGHT: 2.1 lbs

WARRANTY
(3) years against defects in materials and workmanship.

Section 4. Measurements

Several features give the CR1000 the flexibility to measure many sensor types. Contact a Campbell Scientific applications engineer if assistance is required in assessing CR1000 compatibility to a specific application or sensor type. Some sensors require precision excitation or a source of power. See *SECTION. Powering Sensors and Devices* (p. 100).

4.1 Time

Measurement of time is an essential function of the CR1000. Time measurement with the on-board clock enables the CR1000 to attach time stamps to data, measure the interval between events, and time the initiation of control functions.

4.1.1 Time Stamps

A measurement without an accurate time reference has little meaning. Data on the CR1000 are stored with time stamps. How closely a time stamp corresponds to the actual time a measurement is taken depends on several factors.

The time stamp in common CRBASIC programs matches the time at the beginning of the current scan as measured by the real time clock in the CR1000. If a scan starts at 15:00:00, data output during that scan will have a time stamp of 15:00:00 regardless of the length of the scan or when in the scan a measurement is made. The possibility exists that a scan will run for some time before a measurement is made. For instance, a scan may start at 15:00:00, execute time consuming code, then make a measurement at 15:00:00.51. The time stamp attached to the measurement, if the CallTable () instruction is called from within the Scan ... NextScan construct, will be 15:00:00, resulting in a time stamp skew of 510 ms.

Time stamp skew is not a problem with most applications because,

- program execution times are usually short, so time stamp skew is only a few milliseconds. Most measurement requirements allow for a few milliseconds of skew.
- data processed into averages, maxima, minima, etc are composites of several measurements. Associated time stamps only reflect the time the last measurement was made and processing calculations were completed, so the significance of the exact time a specific sample was measured diminishes.

Applications measuring and storing sample data wherein exact time stamps are required can be adversely affected by time stamp skew. Skew can be avoided by

- Making measurements early in a scan interval, before time consuming code.

- Programming the CR1000 such that the time stamp reflects the system time rather than the scan time. When CallTable () is executed from within the Scan ... NextScan construct, as is normally done, the time stamp reflects scan time. By executing the CallTable () instruction outside the Scan ... NextScan construct, the time stamp will reflect system time instead of scan time. *CRBASIC EXAMPLE. Time Stamping with System Time* (p. 44) shows the basic code requirements.

CRBASIC EXAMPLE 1. Time Stamping with System Time

```
'Declare Variables
Public value

'Declare Data Table
DataTable(Test,True,1000)
    Sample(1,Value,FP2)
EndTable

SequentialMode

BeginProg
    Scan(1,Sec,10,0)

        'Delay -- in an operational program, delay may be caused by other code
        Delay(1,500,mSec)

        'Measure Value -- can be any analog measurement
        PanelTemp(Value,0)

        'Immediately call SlowSequence to execute CallTable()
        TriggerSequence(1,0)

    NextScan
    'Allow data to be stored 510 ms into the Scan with a s.51 timestamp
    SlowSequence
        Do: WaitTriggerSequence: CallTable(Test): Loop

EndProg
```

Other time processing CRBASIC instructions are governed by these same rules. Consult CRBASIC Editor Help for more information on specific instructions.

4.2 Voltage

The CR1000 incorporates a programmable gain input instrumentation amplifier (PGIA), as illustrated in *FIGURE. PGI Amplifier* (p. 45). The voltage gain of the instrumentation amplifier is determined by the user selected range code associated with voltage measurement instructions. The PGIA can be configured to measure either single-ended (SE) or differential (DIFF) voltages. For SE measurements, the voltage to be measured is connected to the H input while the L input is internally connected to signal ground (⏚). CRBASIC instructions BrHalf (), BrHalf3W (), TCSE (), Therm107 (), Therm108 (), Therm109 (), and VoltSE () perform SE voltage measurements. For DIFF measurements, the voltage to be measured is connected between the H and L inputs on the PGIA. CRBASIC instructions BrFull (), BrFull6W (), BrHalf4W (), TCDiff (), and VoltDiff () instructions perform DIFF voltage measurements.

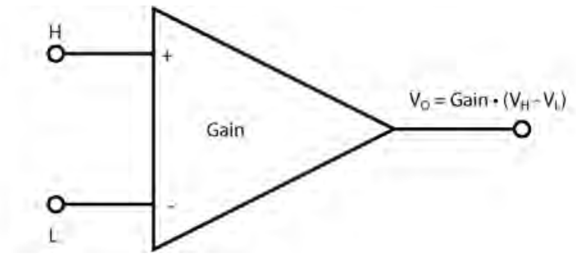


FIGURE 28. PGI Amplifier

A PGIA processes the difference between the H and L inputs, while rejecting voltages that are common to both inputs. *FIGURE. PGIA with Input Signal Decomposition* (p. 45), illustrates the PGIA with the input signal decomposed into a common-mode voltage (V_{cm}) and a DIFF mode voltage (V_{dm}). The common-mode voltage is the average of the voltages on the V_H and V_L inputs, i.e., $V_{cm} = (V_H + V_L)/2$, which can be viewed as the voltage remaining on the H and L inputs with the DIFF voltage (V_{dm}) equal to 0. The total voltage on the H and L inputs is given as $V_H = V_{cm} + V_{dm}/2$, and $V_L = V_{cm} - V_{dm}/2$, respectively.

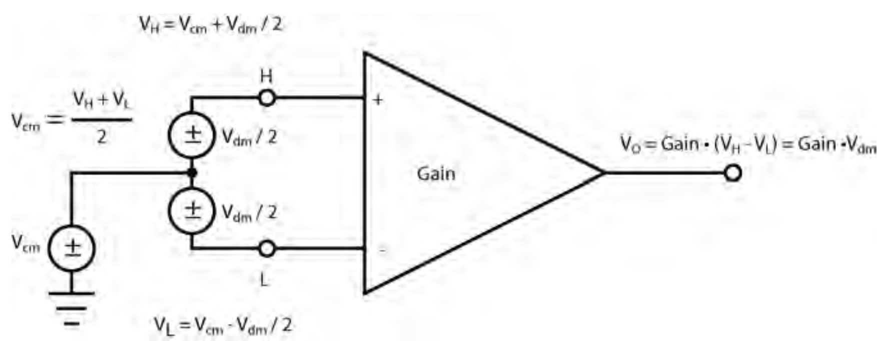


FIGURE 29. PGIA with Input Signal Decomposition

4.2.1 Input Limits

The Input Limits specifies the voltage range, relative to CR1000 ground, which both H and L input voltages must be within to be processed correctly by the PGIA. Input Limits for the CR1000 are ±5 Vdc. Input voltages in which V_H or V_L are beyond the ±5 Vdc Input Limits may suffer from undetected measurement errors. The term "Common-mode Range", which defines the valid range of common-mode voltages, is often used instead of "Input Limits." For DIFF voltages that are small compared to the Input Limits, Common-mode Range is essentially equivalent to Input Limits. Yet from *FIGURE. PGIA with Input Signal Decomposition* (p. 45),

Common-mode Range = ± | Input Limits – $V_{dm}/2$ |, indicating a reduction in Common-mode Range for increasing DIFF signal amplitudes. For example, with a 5000 mV DIFF signal, the Common-mode Range is reduced to ±2.5 Vdc, whereas Input Limits are always ±5 Vdc. Hence for non-negligible DIFF signals, "Input Limits" is more descriptive than "Common-mode Range."

Note Two sets of numbers are assigned to analog channels. For differential measurements, analog channels are numbered 1 - 8. Each differential channel as two inputs: high (H) and low (L). For single-ended measurement, analog channels are numbered 1-16.

Note Sustained voltages in excess of ±16 V input to the analog channels will damage CR1000 circuitry.

4.2.2 Reducing Error

Read More! Consult the following White Papers at *www.campbellsci.com* for in-depth treatment of the advantages of differential and single-ended measurements: "Preventing and Attacking Measurement Noise Problems", "Benefits of Input Reversal and Excitation Reversal for Voltage Measurements", and "Voltage Measurement Accuracy, Self-Calibration, and Ratiometric Measurements.

Deciding whether a differential or single-ended measurement is appropriate for a particular sensor requires sorting through trade-offs of accuracy and precision, available measurement hardware, and fiscal constraints.

In broad terms, analog voltage is best measured differentially because these measurements include noise reduction features, listed below, not included in single-ended measurements.

- Passive Noise Rejection
    - No voltage reference offset
    - Common-mode noise rejection
        - Rejects capacitively coupled noise
- Active Noise Rejection
    - Input reversal
        - Review *SECTION. Input and Excitation Reversal* (p. 53) for details
        - Doubles input reversal signal integration time

Reasons for using single-ended measurements, however, include:

- Sensor is not designed for differential measurement.
- Sensor number exceeds available differential channels.

Sensors with a high signal-to-noise ratio, such as a relative humidity sensor with a full scale output of 0 to 1000 mV, can normally be measured single-ended without a significant reduction in accuracy or precision.

Sensors with low signal-to-noise ratio, such as thermocouples, should normally be measured differentially. However, if the measurement to be made does not require high accuracy or precision, such as thermocouples measuring brush fire temperatures, a single-ended measurement may be appropriate. If sensors require differential measurement, but adequate input channels are not available, an analog multiplexer should be acquired to expand differential input capacity. Refer to *APPENDIX. Analog Multiplexers* (p. 497) for information concerning available multiplexers.

Because a single-ended measurement is referenced to CR1000 ground, any difference in ground potential between the sensor and the CR1000 will result in an error in the measurement. For example, if the measuring junction of a copper-constantan thermocouple being used to measure soil temperature is not insulated, and the potential of earth ground is 1 mV greater at the sensor than at the point where the CR1000 is grounded, the measured voltage will be 1 mV greater than the thermocouple output, or approximately 25°C high. A common problem with ground potential difference occurs in applications wherein external signal conditioning circuitry is powered by the same source as the CR1000, such as an ac mains power receptacle. Despite being tied to the same ground, differences in current drain and lead resistance may result in a different ground potential between the two instruments. Hence, a differential measurement should be made on the analog output from an external signal conditioner. Differential measurements MUST be used when the low input is known to be different from ground.

4.2.3 Measurement Sequence

The CR1000 measures analog voltage by integrating the input signal for a fixed duration, then holding the integrated value during the successive approximation analog-to-digital (A/D) conversion. The CR1000 can make and store measurements from up to 8 differential or 16 single-ended channels at the minimum scan rate of 10 ms (100 Hz) using the burst mode voltage measurement (*SECTION. Burst* (p. 310)). The maximum conversion rate is 2000 per second for measurements made on a single channel.

The timing of CR1000 measurements is precisely controlled. The measurement schedule is determined at compile time and loaded into memory. This schedule sets interrupts that drive the measurement task.

Using two different voltage measurement instructions with the same voltage range takes the same measurement time as using one instruction with two repetitions.

Note This is not the case with legacy CR10(X), 21X, CR23X, and CR7(X) dataloggers. Using multiple measurement "reps" in these dataloggers reduced overall measurement time.

Several parameters in CRBASIC voltage measurement instructions VoltDiff () and VoltSE () vary the sequence and timing of measurements. *TABLE.*

CRBASIC Parameters Varying Measurement Sequence and Timing (p. 48) lists these parameters.

TABLE 4. CRBASIC Parameters Varying Measurement Sequence and T

CRBASIC Parameter	***Description***
MeasOfs	Correct ground offset on single-ended measurements.
RevDiff	Reverse high and low differential inputs.
SettlingTime	Sensor input settling time.
Integ	Duration of input signal integration.
RevEx	Reverse polarity of excitation voltage.

4.2.4 Measurement Accuracy

CR1000 analog measurement error is calculated as

Error = Gain Error (%) + Offset Error

Gain error is expressed as ±% and is a function of input voltage and CR1000 temperature. It is minimized by factory calibration and increases with component temperature and aging. Between 0°C and 40°C, gain error is ±0.06% of input voltage.

Offset error is expressed as

Offset Error = Resolution + 1 µV

where

Resolution = published resolution of the programmed input voltage range (see *SECTION. Specifications* (p. 42)).

FIGURE. Voltage Measurement Accuracy (0° to 40°C) (p. 49) illustrates that as magnitude of input voltage decreases, measurement error decreases.

Note The accuracy specification includes only the CR1000's contribution to measurement error. It does not include the error of sensors.

For example, assume the following (see *SECTION. Specifications* (p. 42)):

- Input Voltage: +2500 mV
- Programmed Input Voltage Range: ±2500 mV
- Programmed Measurement Instruction: VoltDiff()
- Input Measurement Reversal = True
- CR1000 Temperature: Between 0°C and 40°C

Accuracy of the measurement is calculated as follows:

Error = Gain Error + Offset Error,

where

Gain Error = ± (2500 * 0.0006)

= ±1.5 mV

and

Offset Error = Differential (DF) Resolution + 1 μV

= 333 μV + 1 μV

= 334 μV

Therefore,

Error = Gain Error + Offset Error

= ±1.5 mV + 334 μV.

= ±1.834 mV

In contrast, the error for a 500 mV input under the same constraints is ± 0.634 mV.

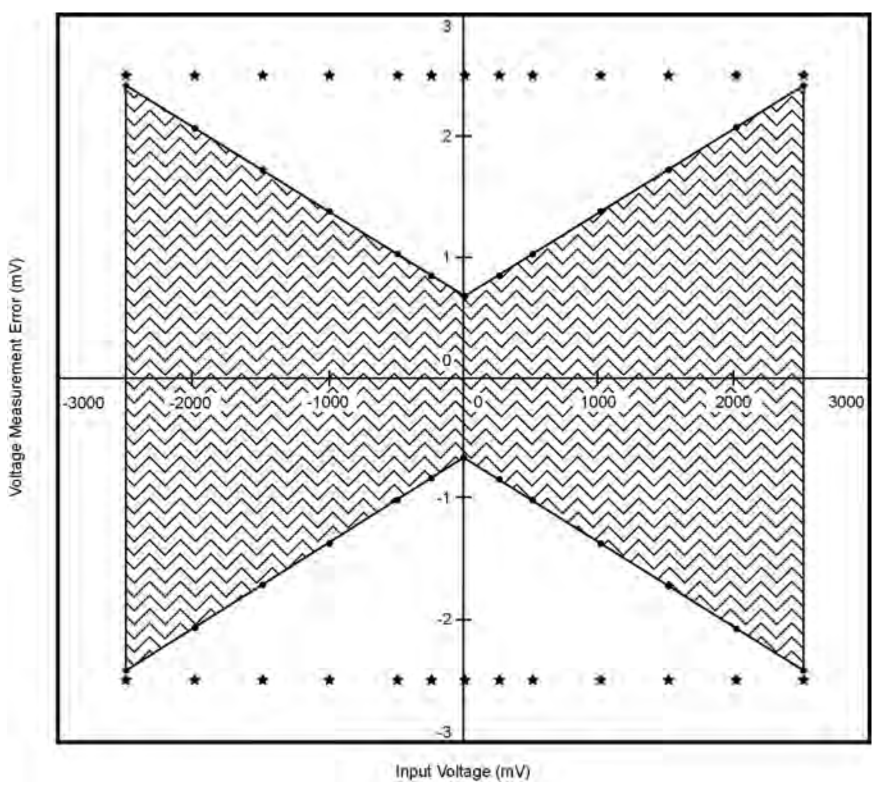


FIGURE 30. Voltage Measurement Accuracy (0° to 40° C)

4.2.5 Voltage Range

In general, a voltage measurement should use the smallest fixed input range that will accommodate the full scale output of the sensor being measured. This results in the best measurement accuracy and resolution. The CR1000 has fixed input ranges for voltage measurements and an auto range to automatically determine the appropriate input voltage range for a given measurement. *TABLE. Analog Voltage Input Ranges with CMN / OID* (p. 50) lists input voltage ranges and range codes.

4.2.5.1 AutoRange

For signals that do not fluctuate too rapidly, AutoRange allows the CR1000 to automatically choose the voltage range to use. AutoRange makes two measurements. The first measurement determines the range to use, and is made with the 250 µs integration on the ±5000 mV range. The second measurement is made using the appropriate range with the integration specified in the instruction. Both measurements use the settling time programmed in the instruction. AutoRange optimizes resolution but takes longer than a measurement on a fixed range, because of the two measurements required.

An AutoRange measurement will return NAN (Not-A-Number) if the voltage exceeds the range picked by the first measurement. To avoid problems with a signal on the edge of a range, AutoRange selects the next larger range when the signal exceeds 90% of a range.

AutoRange is recommended for a signal that occasionally exceeds a particular range, for example, a Type J thermocouple measuring a temperature usually less than 476°C (±25 mV range) but occasionally as high as 500°C (±250 mV range). AutoRange should not be used for rapidly fluctuating signals, particularly signals traversing several voltage ranges rapidly. The possibility exists that the signal can change ranges between the range check and the actual measurement.

TABLE 5. Analog Voltage Input Ranges with Options for Common Mod Input Detect (OID)

Range Code	***Description***
mV5000	measures voltages between ±5000 mV
mV2500[1]	measures voltages between ±2500 mV
mV250[2]	measures voltages between ±250 mV
mV25[2]	measures voltages between ±25 mV
mV7_5[2]	measures voltages between ±7.5 mV
mV2_5[2]	measures voltages between ±2.5 mV
AutoRange[3]	datalogger determines the most suitable range

[1] Append with "C" to enable CMN/OID and set excitation to full-scale DAC (~2700 mV)

[2] Append with "C" to enable CMN/OID

[3] Append with "C" to enable CMN/OID on ranges ≤ ±250 mV, CMN on ranges > ±250 mV

4.2.5.2 Fixed Voltage Ranges

An approximate 9% range overhead exists on fixed input voltage ranges. For example, over-range on the ±2500 mV input range occurs at approximately +2725 mV and -2725 mV. The CR1000 indicates a measurement over-range by returning a NAN (Not-A-Number) for the measurement.

4.2.5.3 Common Mode Null / Open Input Detect

For floating differential sensors such as thermocouples, nulling of any residual common-mode voltage prior to measurement pulls the H and L input amplifier (IA) inputs within the ±5 V Input Limits. Appending a "C" to the range code (i.e. "mV2_5C") enables the nulling of the common-mode voltage prior to a differential measurement on the ±2.5 mV, ±7.5 mV, ±25 mV, and ±250 mV input ranges. Another useful feature for both SE and DIFF measurements is the detection of open inputs due to a broken or disconnected sensor wire, to prevent otherwise undetectable measurement errors. Range codes ending with "C" also enable open detect for all input ranges, except the ±5000 mV input range (See *TABLE. Analog Voltage Input Ranges with CMN / OID* (p. 50)).

On the ±2.5 mV, ±7.5 mV, ±25 mV, and ±250 mV input ranges, the "C" range code option results in a brief 50 microseconds internal connection of the H and L inputs of the IA to 300 mV and ground, respectively, while also connected to the sensor to be measured. The resulting internal common-mode voltage is ±150 mV, which is well within the ±5 V Input Limits. Upon disconnecting the internal 300 mV and ground connections, the associated input is allowed to settle to the desired sensor voltage and the voltage measurement made. If the associated input is open (floating) the input voltages will remain near the 300 mV and ground, resulting in an over range (NAN) on the ±2.5 mV, ±7.5 mV, ±25 mV, and the ±250 mV input range. If the associated sensor is connected and functioning properly, a valid measured voltage will result after the input settling associated with open input detect.

On the ±2500 mV input range the "C" option (i.e. mV2500C) can be used for open input detect with some limitations, as an internal voltage large enough to cause measurement over range is not available. The "C" option for a voltage measurement on the ±2500 mV input range (i.e. mV2500C), results in the H input being briefly connected to a voltage greater than 2500 mV, while the L input is connected to ground. The resulting common-mode voltage is > 1.25 V which is not very helpful in nulling residual common-mode voltage. However, open input detect is still possible by including an If…Then…Else statement in the CRBASIC program to test the measured results. For example, the result of a voltage measurement on the ±2500 mV input range with the "C" option could be tested for > 2500 mV to indicate an open input. For bridge measurements, the returned value X being > 1 would indicate an open input. For example, the BrHalf() instruction returns the value X defined as V1/Vx, where V1 is the measured single-ended voltage and Vx is the user defined excitation voltage having a 2500 mV maximum value. For a BrHalf() measurement utilizing the "C" option on the ±2500 mV input range (i.e. mV2500C), a result of X > 1 indicates an open input for the V1 measurement. The "C" option is not available on the ±5000 mV input range.

Open Input Detect Cautionary Notes

- if the input is not a truly open circuit, such as might occur on a wet cut cable end, the open circuit may not be detected because the input capacitor discharges through external leakage to ground to a normal voltage within the settling time of the measurement. This problem is worse when a long settling time is selected, as more time is given for the input capacitors to discharge to a "normal" level.
- if the open circuit is at the end of a very long cable, the test pulse (300 mV) may not charge the cable (with its high capacitance) up to a voltage that generates NaN or a distinct error voltage. The cable may even act as an aerial and inject noise which also might not read as an error voltage.
- the sensor may "object" to the test pulse being connected to its output, even for 100 microseconds. There is little or no risk of damage, but the sensor output may be kicked into temporary oscillation. Programming a longer settling time in the CRBASIC measurement instruction to allow oscillations to decay before the A/D conversion may mitigate the problem.

4.2.6 Offset Voltage Compensation

Analog measurement circuitry in the CR1000 may introduce a small offset voltage to a measurement. Depending on the magnitude of the signal, this offset voltage may introduce significant error. For example, an offset of 3 μV on a 2500 mV signal introduces an error of only 0.00012%; however, the same offset on a 0.25 mV signal introduces an error of 1.2%.

The primary source of offset voltage is the Seebeck effect, which arises at the junctions of differing metals in electronic circuits. A secondary source of offset voltage are return currents incident to powering external devices through the CR1000. Return currents create voltage drop at the ground terminals that may be used as signal references.

CR1000 measurement instructions incorporate techniques to cancel these unwanted offsets. *TABLE. Analog Measurement Instructions and Offset Voltage Compensation Options* (p. 52) lists available options.

TABLE 6. Analog Measurements and Offset Voltage Compensation

CRBASIC Voltage Measurement Instruction	***Input Reversal (RevDiff = True)***	***Excitation Reversal (RevEx = True)***	***Measure Ground Reference Offset (MeasOff = True)***	***Background Calibration (RevDiff = False) (RevEx = False) (MeasOff = False)***
VoltDiff()	*			*
VoltSe()			*	*
TCDiff()	*			*
TCSe()			*	*
BrHalf()		*		*
BrHalf3W()		*		*
Therm107()		*		*
Therm108()		*		*
Therm109()		*		*
BrHalf4W()	*	*		*
BrFull()	*	*		*
BrFull6W()	*	*		*
AM25T()	*	*		*

4.2.6.1 Input and Excitation Reversal

Reversing inputs (differential measurements) or reversing polarity of excitation voltage (bridge measurements) cancels stray voltage offsets. For example, if there is a +3 μVolt offset in the measurement circuitry, a 5 mV signal is measured as 5.003 mV. When the input or excitation is reversed, the measurement is -4.997 mV. Subtracting the second measurement from the first and dividing by 2 cancels the offset:

$$5.003 \text{ mV} - (-4.997 \text{ mV}) = 10.000 \text{ mV}$$

$$10.000 \text{ mV} / 2 = 5.000 \text{ mV}.$$

When the CR1000 reverses differential inputs or excitation polarity, it delays the same settling time after the reversal as it does before the first measurement. Thus there are two delays per channel when either RevDiff or RevEx is used. If both RevDiff and RevEx are True, four measurements are performed; positive and negative excitations with the inputs one way and positive and negative excitations with the inputs reversed. To illustrate,

- the CR1000 switches to the channel
- sets the excitation, settles, **measures**,
- reverses the excitation, settles, **measures**,
- reverses the excitation, reverses the inputs, settles, **measures**,
- reverses the excitation, settles, **measures.**

There are four delays per channel measured. The CR1000 processes the four sub-measurements into a single reported value. In cases of excitation reversal, excitation "on time" for each polarity is exactly the same to ensure that ionic sensors do not polarize with repetitive measurements.

Read More! A white paper entitled "The Benefits of Input Reversal and Excitation Reversal for Voltage Measurements" is available at *www.campbellsci.com*.

4.2.6.2 Ground Reference Offset Voltage

When MeasOff is enabled (= True), the CR1000 measures the offset voltage of the ground reference prior to each VoltSe () or TCSe () measurement. This offset voltage is subtracted from the subsequent measurement.

4.2.6.3 Background Calibration (RevDiff, RevEx, MeasOff = False)

If RevDiff, RevEx, or MeasOff is disabled (= False) in a measurement instruction, offset voltage compensation is still performed, albeit less effectively, by using measurements from automatic background calibration. Disabling RevDiff, RevEx, or MeasOff speeds up measurement time; however, the increase in speed comes at the cost of accuracy 1) because RevDiff, RevEx, and MeasOff are more effective techniques, and 2) because background calibrations are performed only periodically, so more time skew occurs between the background calibration offsets and the measurements to which they are applied.

Note Disable RevDiff, RevEx and MeasOff when CR1000 module temperature and return currents are slow to change or when measurement duration must be minimal to maximize measurement frequency.

4.2.7 Integration

Read More! See White Paper "Preventing and Attacking Measurement Noise Problems" at *www.campbellsci.com*.

The CR1000 incorporates circuitry to perform an analog integration on voltages to be measured prior to the A/D conversion. The magnitude of the frequency response of an analog integrator is a SIN(x) / x shape, which has notches (transmission zeros) occurring at 1 / (integer multiples) of the integration duration. Consequently, noise at 1 / (integer multiples) of the integration duration is effectively rejected by an analog integrator. *TABLE. Measurement Integration Times and Codes* (p. 55) lists three integration durations available in the CR1000 and associated CRBASIC codes. If reversing the differential inputs or reversing the excitation is specified, there are two separate integrations per measurement; if both reversals are specified, there are four separate integrations.

TABLE 7. CRBASIC Measurement Integration Times and Codes		
Integration Time (ms)	*CRBASIC Code*	*Comments*
250 µs	250	Fast integration
16.667 ms	_60Hz	filters 60 Hz noise
20 ms	_50Hz	filters 50 Hz noise

4.2.7.1 ac Power Line Noise Rejection

Grid or mains power (50 or 60 Hz, 230 or 120 Vac) can induce electrical noise at integer multiples of 50 or 60 Hz. Small analog voltage signals, such as thermocouples and pyranometers, are particularly susceptible. CR1000 voltage measurements can be programmed to reject (filter) 50 or 60 Hz related noise.

4.2.7.1.1 ac Noise Rejection on Small Signals

The CR1000 rejects ac power line noise on all voltage ranges except mV5000 and mV2500 by integrating the measurement over exactly one ac cycle before A/D conversion as illustrated in *TABLE. ac Noise Rejection on Small Signals* (p. 55) and the full cycle technique of *FIGURE. ac Power Line Noise Rejection* (p. 55).

TABLE 8. ac Noise Rejection on Small Signals		
Applies to all analog input voltage ranges except mV2500 and mV5000.		
ac Power Line Frequency	*Measurement Integration Duration*	*CRBASIC Integration Code*
60 Hz	16.667 ms	_60Hz
50 Hz	20 ms	_50Hz

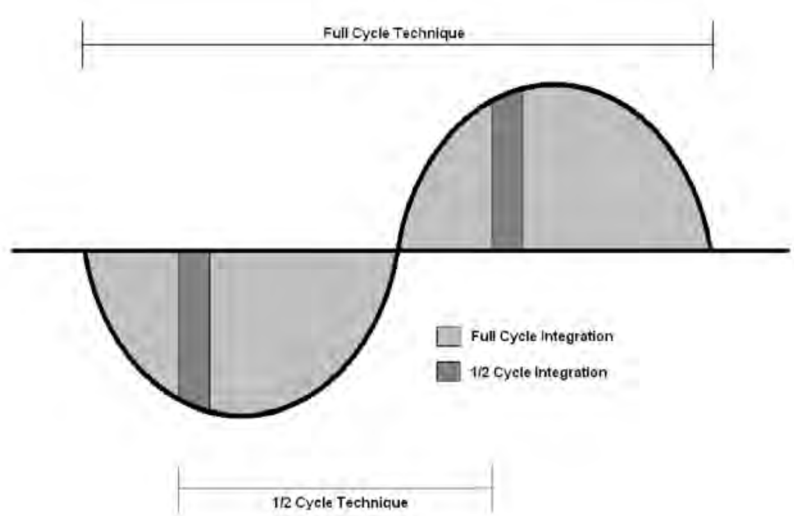


FIGURE 31. ac Power Line Noise Rejection Techniques

4.2.7.1.2 ac Noise Rejection on Large Signals

When rejecting ac noise on the 2500 mV and 5000 mV ranges, the CR1000 makes two fast measurements separated in time by ½ line cycle, as illustrated in *FIGURE. ac Power Line Noise Rejection Techniques* (p. 55). For 60 Hz rejection, ½ line cycle = 8333 µs, meaning that the 2nd measurement must start 8333 µs after the integration for the first measurement was started. The A/D conversion time is approximately 170 µs, leaving a maximum input settling time of approximately 8333 µs - 170 µs = 8160 µs before the 2nd measurement is delayed too long to result in a rejection notch at 60 Hz. For 50 Hz rejection on the mV5000 and mV2500 input ranges, the maximum input settling time of approximately 10,000 - 170 µs = 9830 µs before the 2nd measurement is delayed too long to result in a rejection notch at 50 Hz. The CR1000 does not prevent or warn against setting the settling time beyond the ½ cycle limit. *TABLE. ac Noise Rejection on Large Signals* (p. 56) lists details of the ½ line cycle ac power line noise rejection technique.

TABLE 9. ac Noise Rejection on Large Signals

Applies to analog input voltage ranges mV2500 and mV5000.

ac Power Line Frequency	*Measurement Integration Time*	*CRBASIC Integration Code*	*Default Settling Time*	*Maximum Recommended Settling Time**
60 Hz	250 µs x 2	_60Hz	3000 µs	8330 µs
50 Hz	250 µs x 2	_50Hz	3000 µs	10000 µs

*Excitation time equals settling time in measurements requiring excitation. The CR1000 cannot excite VX/EX excitation channels during A/D conversion. The ½ cycle technique with excitation limits the length of recommended excitation / settling time for the first measurement to ½ cycle. The CR1000 does not prevent or warn against setting a settling time beyond the ½ cycle limit. For example, a settling time of up to 50000 microseconds can be programmed, but the CR1000 will execute the measurement as follows:

1. CR1000 turns excitation on, waits 50000 microseconds, then makes the first measurement.
2. During A/D, CR1000 turns off excitation for ≈ 170 microseconds.
3. Excitation is switched on again for ½ cycle, then the second measurement is made.

Restated, when using the ½ cycle 50 Hz or 60 Hz rejection method, a sensor does not see a continuous excitation of the length entered as the settling time before the second measurement if the settling time entered is greater than ½ cycle. Depending on the sensor used, a truncated second excitation may cause measurement errors.

4.2.8 Signal Settling Time

When the CR1000 switches to an analog input channel or activates excitation for a bridge measurement, a settling time is required for the measured voltage to settle to its true value before being measured. The rate at which the signal settles is determined by the input settling time constant which is a function of both the source resistance and input capacitance.

Rise and decay waveforms are exponential. *FIGURE. Input Voltage Rise and Transient Decay* (p. 57) shows rising and decaying waveforms settling to the true signal level, V_{so}.

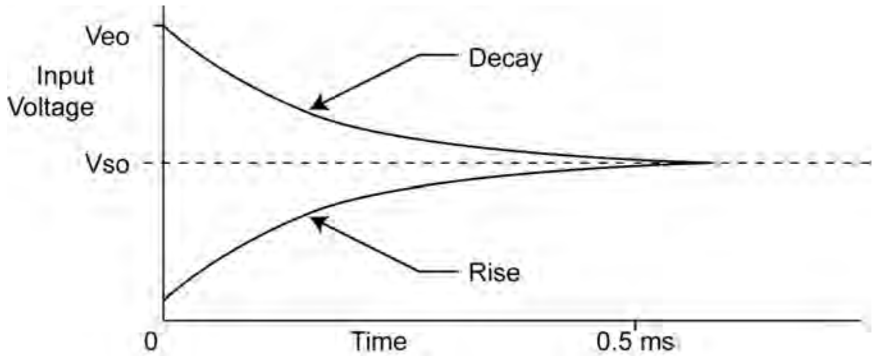


FIGURE 32. Input Voltage Rise and Transient Decay

The CR1000 delays after switching to a channel to allow the input to settle before initiating the measurement. The SettlingTime parameter of the associated measurement instruction is provided to allow the user to tailor measurement instructions settling times with 100 µs resolution up to the maximum settling time of 50000 µs. Default settling times are listed in *TABLE. CRBASIC Measurement Settling Times* (p. 57), and are meant to provide sufficient signal settling in most cases. Additional settling time may be required when measuring high resistance (impedance) sensors and / or sensors connected to the datalogger by long leads. Measurement time of a given instruction increases with increasing settling time. For example, a 1 ms increase in settling time for a bridge instruction with input reversal and excitation reversal results in a 4 ms increase in time for the CR1000 to perform the instruction.

TABLE 10.   CRBASIC Measurement Settling Times

Settling Time Entry	*Input Voltage Range*	*Integration Code*	*Settling Time**
0	All	250 µs	450 µs (default)
0	All	_50Hz	3 ms (default)
0	All	_60Hz	3 ms (default)
>100	All	All	µs entered

*Minimum settling time required to allow the input to settle to CR1000 resolution specifications.

A settling time is required for voltage measurements to minimize the effects of the following sources of error:

- A small switching transient occurs when the CR1000 switches to the single-ended or differential channel to be measured.
- A relatively large transient may be induced on the signal conductor via capacitive coupling during a bridge measurement from an adjacent excitation conductor.

- 50 or 60 Hz integrations require a relatively long reset time of the internal integration capacitor before the next measurement due to dielectric absorption.

4.2.8.1 Minimizing Settling Errors

When long lead lengths are required the following general practices can be used to minimize or measure settling errors:

1. DO NOT USE WIRE WITH PVC INSULATED CONDUCTORS. PVC has a high dielectric which extends input settling time.

2. Where possible, run excitation leads and signal leads in separate shields to minimize transients.

3. When measurement speed is not a prime consideration, additional time can be used to ensure ample settling time. The settling time required can be measured with the CR1000.

4.2.8.2 Measuring the Necessary Settling Time

Settling time for a particular sensor and cable can be measured with the CR1000. Programming a series of measurements with increasing settling times will yield data that indicates at what settling time a further increase results in negligible change in the measured voltage. The programmed settling time at this point indicates the true settling time for the sensor and cable combination.

CRBASIC EXAMPLE. Measuring Settling Time (p. 59) presents CRBASIC code to help determine settling time for a pressure transducer utilizing a high capacitance semi-conductor. The code consists of a series of full-bridge measurements (BrFull ()) with increasing settling times. The pressure transducer is placed in steady-state conditions so changes in measured voltage are attributable to settling time rather than changes in the measured pressure. Reviewing *SECTION. Programming* (p. 129) may help in understanding the CRBASIC code in the example.

The first six measurements are shown in *TABLE. First Six Values of Settling Time Data* (p. 60). Each trace in *FIGURE. Settling Time for Pressure Transducer* (p. 59) contains all 20 PT() values for a given record number, along with an average value showing the measurements as percent of final reading. The reading has settled to 99.5% of the final value by the fourteenth measurement, PT(14). This is a suitable accuracy for the application, so a settling time of 1400 µs is determined to be adequate.

CRBASIC EXAMPLE 2. Measuring Settling Time

```
'Program to measure the settling time of a sensor measured with a differential
'voltage measurement

Public PT(20)                                   'Variable to hold the measurements

DataTable(Settle,True,100)
    Sample(20,PT(),IEEE4)
EndTable

BeginProg
    Scan(1,Sec,3,0)

        BrFull(PT(1),1,mV7.5,1,Vx1,1,2500,True,True,100,250,1.0,0)
        BrFull(PT(2),1,mV7.5,1,Vx1,1,2500,True,True,200,250,1.0,0)
        BrFull(PT(3),1,mV7.5,1,Vx1,1,2500,True,True,300,250,1.0,0)
        BrFull(PT(4),1,mV7.5,1,Vx1,1,2500,True,True,400,250,1.0,0)
        BrFull(PT(5),1,mV7.5,1,Vx1,1,2500,True,True,500,250,1.0,0)
        BrFull(PT(6),1,mV7.5,1,Vx1,1,2500,True,True,600,250,1.0,0)
        BrFull(PT(7),1,mV7.5,1,Vx1,1,2500,True,True,700,250,1.0,0)
        BrFull(PT(8),1,mV7.5,1,Vx1,1,2500,True,True,800,250,1.0,0)
        BrFull(PT(9),1,mV7.5,1,Vx1,1,2500,True,True,900,250,1.0,0)
        BrFull(PT(10),1,mV7.5,1,Vx1,1,2500,True,True,1000,250,1.0,0)
        BrFull(PT(11),1,mV7.5,1,Vx1,1,2500,True,True,1100,250,1.0,0)
        BrFull(PT(12),1,mV7.5,1,Vx1,1,2500,True,True,1200,250,1.0,0)
        BrFull(PT(13),1,mV7.5,1,Vx1,1,2500,True,True,1300,250,1.0,0)
        BrFull(PT(14),1,mV7.5,1,Vx1,1,2500,True,True,1400,250,1.0,0)
        BrFull(PT(15),1,mV7.5,1,Vx1,1,2500,True,True,1500,250,1.0,0)
        BrFull(PT(16),1,mV7.5,1,Vx1,1,2500,True,True,1600,250,1.0,0)
        BrFull(PT(17),1,mV7.5,1,Vx1,1,2500,True,True,1700,250,1.0,0)
        BrFull(PT(18),1,mV7.5,1,Vx1,1,2500,True,True,1800,250,1.0,0)
        BrFull(PT(19),1,mV7.5,1,Vx1,1,2500,True,True,1900,250,1.0,0)
        BrFull(PT(20),1,mV7.5,1,Vx1,1,2500,True,True,2000,250,1.0,0)

        CallTable Settle

    NextScan
EndProg
```

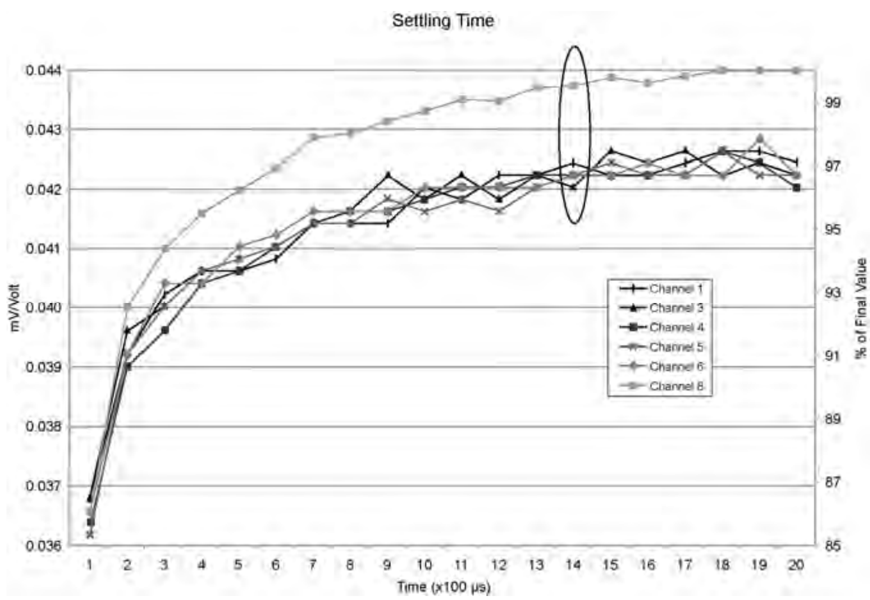


FIGURE 33. Settling Time for Pressure Transducer

TABLE 11. First Six Values of Settling Time Data

TIMESTAMP	*REC*	*PT(1)*	*PT(2)*	*PT(3)*	*PT(4)*	*PT(5)*	*PT(6)*
		Smp	*Smp*	*Smp*	*Smp*	*Smp*	*Smp*
1/3/2000 23:34	0	0.03638599	0.03901386	0.04022673	0.04042887	0.04103531	0.04123745
1/3/2000 23:34	1	0.03658813	0.03921601	0.04002459	0.04042887	0.04103531	0.0414396
1/3/2000 23:34	2	0.03638599	0.03941815	0.04002459	0.04063102	0.04042887	0.04123745
1/3/2000 23:34	3	0.03658813	0.03941815	0.03982244	0.04042887	0.04103531	0.04103531
1/3/2000 23:34	4	0.03679027	0.03921601	0.04022673	0.04063102	0.04063102	0.04083316

4.2.9 Self-Calibration

Read More! Related topics can be found in *SECTION. Offset Voltage Compensation* (p. 52)

The CR1000 self-calibrates to compensate for changes induced by fluctuating operating temperatures and aging. Without self-calibration, measurement accuracy over the operational temperature range is worse by about a factor of 10. That is, over the extended temperature range of -40°C to 85°C, the accuracy specification of ±0.12% of reading can degrade to ±1% of reading with self-calibration disabled. If the temperature of the CR1000 remains the same, there is little calibration drift with self-calibration disabled.

Note -- Self-calibration requires the CR1000 to have an internal voltage standard. The internal voltage standard should periodically be calibrated by Campbell Scientific. When high accuracy voltage measurements are required, a two year calibration cycle is recommended.

Unless a Calibrate() instruction is present in the running CRBASIC program, the CR1000 automatically performs self-calibration during spare time in the background as an automatic *slow sequence* (p. 160), with a segment of the calibration occurring every 4 seconds. If there is insufficient time to do the background calibration because of a scan consuming user program, the CR1000 will display the following warning at compile time: "Warning when Fast Scan x is running background calibration is disabled".

The composite transfer function of the instrumentation amplifier, integrator, and analog-to-digital converter of the CR1000 is described by the following equation:

```
COUNTS = G * Vin + B
```

where COUNTS is the result from an analog-to-digital conversion, G is the voltage gain for a given input range, and B is the internally measured offset voltage.

Automatic self-calibration only calibrates the G and B values necessary to run a given CRBASIC program, resulting in a program dependent number of self-calibration segments ranging from at least 6 to a maximum of 91. A typical number of segments required in self-calibration is 20 for analog ranges and 1 segment for the panel temperature measurement, totaling 21 segments. So, (21 segments) * (4 s / segment) = 84 s per complete self-calibration. The worst-case is (91 segments) * (4 s / segment) = 364 s per complete self-calibration.

During instrument power-up, the CR1000 computes calibration coefficients by averaging 10 complete sets of self-calibration measurements. After power up, newly determined G and B values are low-pass filtered as followed: **Next_Value** = (1/5) * **New** + (4/5) * **Old**. For a step change of the **New** value, the low-pass filter **Next_Value** = (1/5) * **New** + (4/5) * **Old** results in 20% settling for 1 **New** value, 49% settling for 3 **New** values, 67% settling for 5 **New** values, 89% settling for 10 **New** values, and 96% settling for 14 **New** values. If this rate of update for measurement channels is too slow, a user can utilize the Calibrate() instruction. The Calibrate() instruction computes the necessary G and B values every scan without any low-pass filtering.

For a VoltSe() instruction, B is determined as part of self-calibration only if the parameter **MeasOff** = 0. An exception is B for VoltSe () on the ±2500 mV input range with 250 µs integration, which is always determined in self-calibration for use internally. For a VoltDiff () instruction, B is determined as part of self-calibration only if the parameter **RevDiff** = 0.

VoltSe() and VoltDiff() instructions on a given input range with the same integration durations, utilize the same G, but different B values. The 6 input voltage ranges (±5000 mV, ±2500 mV, ±250 mV, ±25 mV, ±7.5 mV, ±2.5 mV) along with the 3 different integration durations (250 µs, _50Hz, and _60Hz) result in a maximum of 18 different gains (G), and 18 offsets for VoltSe() measurements (B), and 18 offsets for VoltDiff() measurements (B) to be determined during CR1000 self-calibration (maximum of 54 values). These values can be viewed in the Status Table, with entries identified as listed in *TABLE. Status Table Calibration Entries* (p. 62).

Automatic self-calibration can be overridden with the Calibrate() instruction, which forces a calibration for each execution, and does not employ any low-pass filtering on the newly determined G and B values. There are two parameters associated with the Calibrate instruction; Dest and CalRange. The CalRange parameter determines whether to calibrate only the necessary input ranges for a given CRBASIC program (Value = 0) or to calibrate all input ranges (Value ≠ 0). The Dest parameter should be of sufficient dimension for all the returned G and B values, which is 2 minimum for the automatic self-calibration of VoltSE () including B (offset) for the ±2500 mV input range with first 250 µs integration, and 54 maximum for all possible integration durations and input voltage ranges chosen.

An example use of the Calibrate() instruction to calibrate all input ranges is given as

```
Calibrate(cal(1),true)
```

where Dest is an array of 54 variables, and Range ≠ 0 to calibrate all input ranges. Results of this command are listed in *TABLE. Calibrate () Instruction Results* (p. 63).

TABLE 12. Status Table Calibration Entries

Status Table Element	Descriptions of Status Table Elements			
	Differential (Diff) Single-Ended (SE)	*Offset or Gain*	*±mV Input Range*	*Integration*
CalGain(1)		Gain	5000	250 ms
CalGain(2)		Gain	2500	250 ms
CalGain(3)		Gain	250	250 ms
CalGain(4)		Gain	25	250 ms
CalGain(5)		Gain	7.5	250 ms
CalGain(6)		Gain	2.5	250 ms
CalGain(7)		Gain	5000	60 Hz Rejections
CalGain(8)		Gain	2500	60 Hz Rejection
CalGain(9)		Gain	250	60 Hz Rejection
CalGain(10)		Gain	25	60 Hz Rejection
CalGain(11)		Gain	7.5	60 Hz Rejection
CalGain(12)		Gain	2.5	60 Hz Rejection
CalGain(13)		Gain	5000	50 Hz Rejection
CalGain(14)		Gain	2500	50 Hz Rejection
CalGain(15)		Gain	250	50 Hz Rejection
CalGain(16)		Gain	25	50 Hz Rejection
CalGain(17)		Gain	7.5	50 Hz Rejection
CalGain(18)		Gain	2.5	50 Hz Rejection
CalSeOffset(1)	SE	Offset	5000	250 ms
CalSeOffset(2)	SE	Offset	2500	250 ms
CalSeOffset(3)	SE	Offset	250	250 ms
CalSeOffset(4)	SE	Offset	25	250 ms
CalSeOffset(5)	SE	Offset	7.5	250 ms

TABLE 12. Status Table Calibration Entries

Status Table Element	*Descriptions of Status Table Elements*			
	Differential (Diff) Single-Ended (SE)	*Offset or Gain*	*±mV Input Range*	*Integration*
CalSeOffset(6)	SE	Offset	2.5	250 ms
CalSeOffset(7)	SE	Offset	5000	60 Hz Rejection
CalSeOffset(8)	SE	Offset	2500	60 Hz Rejection
CalSeOffset(9)	SE	Offset	250	60 Hz Rejection
CalSeOffset(10)	SE	Offset	25	60 Hz Rejection
CalSeOffset(11)	SE	Offset	7.5	60 Hz Rejection
CalSeOffset(12)	SE	Offset	2.5	60 Hz Rejection
CalSeOffset(13)	SE	Offset	5000	50 Hz Rejection
CalSeOffset(14)	SE	Offset	2500	50 Hz Rejection
CalSeOffset(15)	SE	Offset	250	50 Hz Rejection
CalSeOffset(16)	SE	Offset	25	50 Hz Rejection
CalSeOffset(17)	SE	Offset	7.5	50 Hz Rejection
CalSeOffset(18)	SE	Offset	2.5	50 Hz Rejection
CalDiffOffset(1)	Diff	Offset	5000	250 ms
CalDiffOffset(2)	Diff	Offset	2500	250 ms
CalDiffOffset(3)	Diff	Offset	250	250 ms
CalDiffOffset(4)	Diff	Offset	25	250 ms
CalDiffOffset(5)	Diff	Offset	7.5	250 ms
CalDiffOffset(6)	Diff	Offset	2.5	250 ms
CalDiffOffset(7)	Diff	Offset	5000	60 Hz Rejection
CalDiffOffset(8)	Diff	Offset	2500	60 Hz Rejection
CalDiffOffset(9)	Diff	Offset	250	60 Hz Rejection
CalDiffOffset(10)	Diff	Offset	25	60 Hz Rejection
CalDiffOffset(11)	Diff	Offset	7.5	60 Hz Rejection
CalDiffOffset(12)	Diff	Offset	2.5	60 Hz Rejection
CalDiffOffset(13)	Diff	Offset	5000	50 Hz Rejection
CalDiffOffset(14)	Diff	Offset	2500	50 Hz Rejection
CalDiffOffset(15)	Diff	Offset	250	50 Hz Rejection
CalDiffOffset(16)	Diff	Offset	25	50 Hz Rejection
CalDiffOffset(17)	Diff	Offset	7.5	50 Hz Rejection
CalDiffOffset(18)	Diff	Offset	2.5	50 Hz Rejection

TABLE 13. Calibrate() Instruction Results

Array Cal() Element	Descriptions of Array Elements				Typical Value
	Differential (Diff) Single-Ended (SE)	Offset or Gain	±mV Input Range	Integration	
1	SE	Offset	5000	250 ms	±5 LSB
2	Diff	Offset	5000	250 ms	±5 LSB
3		Gain	5000	250 ms	-1.34 mV/LSB
4	SE	Offset	2500	250 ms	±5 LSB
5	Diff	Offset	2500	250 ms	±5 LSB
6		Gain	2500	250 ms	-0.67 mV/LSB
7	SE	Offset	250	250 ms	±5 LSB
8	Diff	Offset	250	250 ms	±5 LSB
9		Gain	250	250 ms	-0.067 mV/LSB
10	SE	Offset	25	250 ms	±5 LSB
11	Diff	Offset	25	250 ms	±5 LSB
12		Gain	25	250 ms	-0.0067 mV/LSB
13	SE	Offset	7.5	250 ms	±10 LSB
14	Diff	Offset	7.5	250 ms	±10 LSB
15		Gain	7.5	250 ms	-0.002 mV/LSB
16	SE	Offset	2.5	250 ms	±20 LSB
17	Diff	Offset	2.5	250 ms	±20 LSB
18		Gain	2.5	250 ms	-0.00067 mV/LSB
19	SE	Offset	5000	60 Hz Rejection	±5 LSB
20	Diff	Offset	5000	60 Hz Rejection	±5 LSB
21		Gain	5000	60 Hz Rejection	-0.67 mV/LSB
22	SE	Offset	2500	60 Hz Rejection	±5 LSB
23	Diff	Offset	2500	60 Hz Rejection	±5 LSB
24		Gain	2500	60 Hz Rejection	-0.34 mV/LSB
25	SE	Offset	250	60 Hz Rejection	±5 LSB
26	Diff	Offset	250	60 Hz Rejection	±5 LSB
27		Gain	250	60 Hz Rejection	-0.067 mV/LSB
28	SE	Offset	25	60 Hz Rejection	±5 LSB
29	Diff	Offset	25	60 Hz Rejection	±5 LSB
30		Gain	25	60 Hz Rejection	-0.0067 mV/LSB
31	SE	Offset	7.5	60 Hz Rejection	±10 LSB
32	Diff	Offset	7.5	60 Hz Rejection	±10 LSB
33		Gain	7.5	60 Hz Rejection	-0.002 mV/LSB
34	SE	Offset	2.5	60 Hz Rejection	±20 LSB
35	Diff	Offset	2.5	60 Hz Rejection	±20 LSB
36		Gain	2.5	60 Hz Rejection	-0.00067 mV/LSB

TABLE 13. Calibrate() Instruction Results

Array Cal() Element	Descriptions of Array Elements				Typical Value
	Differential (Diff) Single-Ended (SE)	Offset or Gain	±mV Input Range	Integration	
37	SE	Offset	5000	50 Hz Rejection	±5 LSB
38	Diff	Offset	5000	50 Hz Rejection	±5 LSB
39		Gain	5000	50 Hz Rejection	-0.67 mV/LSB
40	SE	Offset	2500	50 Hz Rejection	±5 LSB
41	Diff	Offset	2500	50 Hz Rejection	±5 LSB
42		Gain	2500	50 Hz Rejection	-0.34 mV/LSB
43	SE	Offset	250	50 Hz Rejection	±5 LSB
44	Diff	Offset	250	50 Hz Rejection	±5 LSB
45		Gain	250	50 Hz Rejection	-0.067 mV/LSB
46	SE	Offset	25	50 Hz Rejection	±5 LSB
47	Diff	Offset	25	50 Hz Rejection	±5 LSB
48		Gain	25	50 Hz Rejection	-0.0067 mV/LSB
49	SE	Offset	7.5	50 Hz Rejection	±10 LSB
50	Diff	Offset	7.5	50 Hz Rejection	±10 LSB
51		Gain	7.5	50 Hz Rejection	-0.002 mV/LSB
52	SE	Offset	2.5	50 Hz Rejection	±20 LSB
53	Diff	Offset	2.5	50 Hz Rejection	±20 LSB
54		Gain	2.5	50 Hz Rejection	-0.00067 mV/LSB

4.2.10 Time Skew Between Measurements

Time skew between consecutive voltage measurements is a function of settling and integration times, A/D conversion, and the number of reps entered into the VoltDiff() or VoltSE() instruction. The relationship is:

Time Skew = Settling Time + Integration Time + A-D Conversion + Reps/NoReps*

*Reps/No Reps -- If Reps > 1(i.e., multiple measurements by a single instruction), no additional time is required. If Reps = 1 in consecutive voltage instructions, add 15uSec per instruction.

4.3 Bridge Resistance

Many sensors detect phenomena by way of change in a resistive circuit. Thermistors, strain gages, and position potentiometers are examples. Resistance measurements are special case voltage measurements. By supplying a precise, known voltage to a resistive circuit, then measuring the returning voltage, resistance can be calculated.

Read More! Available resistive bridge completion modules are listed in *APPENDIX. Signal Conditioners* (p. 500).

Five bridge measurement instructions are features of the CR1000. *TABLE. Resistive Bridge Circuits -- Voltage Excitation* (p. 66) show circuits that are typically measured with these instructions. In the diagrams, resistors labeled R_s are normally the sensors and those labeled R_f are normally precision fixed (static) resistors. Circuits other than those diagrammed can be measured, provided the excitation and type of measurements are appropriate. Program Code *CRBASIC EXAMPLE. 4 Wire Full Bridge Measurement* (p. 68) shows CR1000 code for measuring and processing four wire full bridge circuits.

All bridge measurements have the option (**RevEx**) to make one set of measurements with the excitation as programmed and another set of measurements with the excitation polarity reversed. The offset error in the two measurements due to thermal EMFs can then be accounted for in the processing of the measurement instruction. The excitation channel maintains the excitation voltage or current until the hold for the analog to digital conversion is completed. When more than one measurement per sensor is necessary (four wire half bridge, three wire half bridge, six wire full bridge), excitation is applied separately for each measurement. For example, in the four-wire half-bridge, when the excitation is reversed, the differential measurement of the voltage drop across the sensor is made with the excitation at both polarities and then excitation is again applied and reversed for the measurement of the voltage drop across the fixed resistor.

Calculating the resistance of a sensor that is one of the legs of a resistive bridge requires additional processing following the bridge measurement instruction. *TABLE. Resistive Bridge Circuits -- Voltage Excitation* (p. 66) lists the schematics of bridge configurations and related resistance equations.

TABLE 14. Resistive Bridge Circuits -- Voltage Excitation

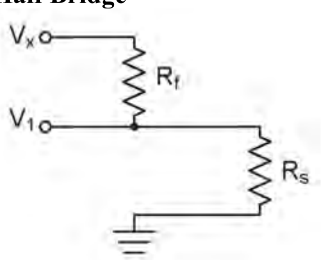
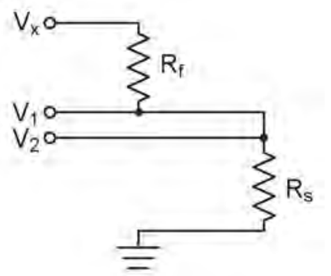
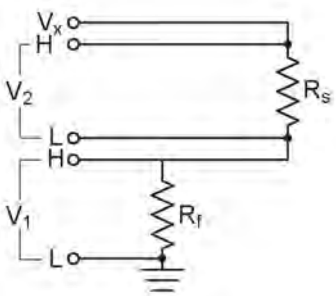
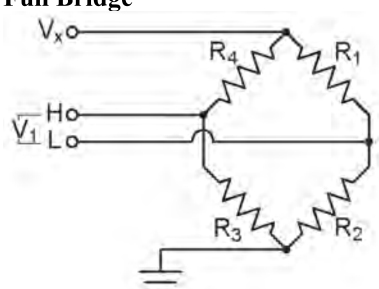
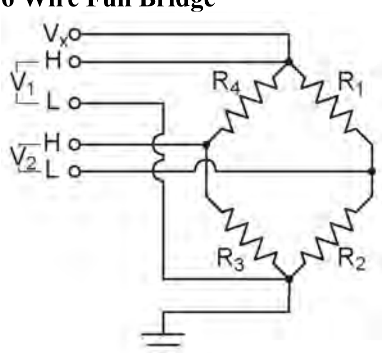
Resistive Bridge Type and Circuit Diagram	*CRBASIC Instruction and Fundamental Relationship*	*Relationships*
Half Bridge[1]  	CRBASIC Instruction: **BrHalf()** Fundamental Relationship[2]: $X = \frac{V_1}{V_x} = \frac{R_s}{R_s + R_f}$	$R_s = R_f \frac{X}{1-X}$ $R_f = \frac{R_s(1-X)}{X}$
3 Wire Half Bridge[1,3]	CRBASIC Instruction: **BrHalf3W()** Fundamental Relationship[2]: $X = \frac{2V_2 - V_1}{V_x - V_1} = \frac{R_s}{R_f}$	$R_f = R_s / X$ $R_s = R_f X$

TABLE 14. Resistive Bridge Circuits -- Voltage Excitation

Resistive Bridge Type and Circuit Diagram	*CRBASIC Instruction and Fundamental Relationship*	*Relationships*
		
4 Wire Half Bridge[1,3] 	CRBASIC Instruction: **BrHalf4W()** Fundamental Relationship[2]: $X = \frac{V_2}{V_1} = \frac{R_s}{R_f}$	$R_s = R_f X$ $R_f = R_s / X$
Full Bridge[1,3] 	CRBASIC Instruction: **BrFull()** Fundamental Relationship[2]: $X = 1000\frac{V_1}{V_x}$ $= 1000\left(\frac{R_3}{R_3+R_4} - \frac{R_2}{R_1+R_2}\right)$	These relationships apply to BrFull() and BrFull6W(). $X_1 = \frac{-X}{1000} + \frac{R_3}{R_3+R_4}$ $R_1 = \frac{R_2(1-X_1)}{X_1}$ $R_2 = \frac{R_1 X_1}{1-X_1}$
6 Wire Full Bridge[1] 	CRBASIC Instruction: **BrFull6W()** Fundamental Relationship[2]: $X = 1000\frac{V_2}{V_1}$ $= 1000\left(\frac{R_3}{R_3+R_4} - \frac{R_2}{R_1+R_2}\right)$	$X_2 = \frac{X}{1000} + \frac{R_2}{R_1+R_2}$ $R_3 = \frac{R_4 X_2}{1-X_2}$ $R_4 = \frac{R_3(1-X_2)}{X_2}$

[1]Key: V_x = excitation voltage; V_1, V_2 = sensor return voltages; R_f = "fixed", "bridge" or "completion" resistor; R_s = "variable" or "sensing" resistor.
[2]Where X = result of the CRBASIC bridge measurement instruction with a multiplier of 1 and an offset of 0.
[3]See *APPENDIX. Resistive Bridge Modules* (p. 500) for a list of available terminal input modules to facilitate this measurement.

CRBASIC EXAMPLE 3. 4 Wire Full Bridge Measurement and Processing

```
'Declare Variables
Public X
Public X1
Public R1
Public R2
Public R3
Public R4

Main Program
BeginProg
    R2 = 1000                                'Resistance of R2
    R3 = 1000                                'Resistance of R3
    R4 = 1000                                'Resistance of R4

    Scan(500,mSec,1,0)

        'Full Bridge Measurement:
        BrFull(X,1,mV2500,1,1,1,2500,True,True,0,_60Hz,1.0,0.0)
        X1 = ((-1 * X) / 1000) + (R3 / (R3 + R4))
        R1 = (R2 * (1 - X1)) / X1

    NextScan
EndProg
```

4.3.1 Measurements Requiring ac Excitation

Some resistive sensors require ac excitation. These include electrolytic tilt sensors, soil moisture blocks, water conductivity sensors and wetness sensing grids. The use of dc excitation with these sensors can result in polarization, which will cause erroneous measurement, shift calibration, or lead to rapid sensor decay.

Other sensors, e.g., LVDTs (Linear Variable Differential Transformers), require an ac excitation because they rely on inductive coupling to provide a signal. dc excitation will provide no output.

CR1000 bridge measurements can reverse excitation polarity to provide ac excitation and avoid ion polarization.

Note Sensors requiring ac excitation require techniques to minimize or eliminate ground loops. See *SECTION. Ground Looping in Ionic Measurements* (p. 109).

4.3.2 Strain Calculations

Read More! FieldCalStrain in *SECTION. FieldCa () Demonstration Programs* (p. 230).

A principal use of the four wire full bridge is the measurement of strain gages in structural stress analysis. StrainCalc () calculates microstrain, με, from an appropriate formula for the particular strain bridge configuration used. All strain gages supported by StrainCalc () use the full bridge electronic configuration. In strain gage parlance, "quarter bridge", "half bridge" and "full bridge" refer to the number of active elements in the full bridge, i.e., 1, 2, or 4 active elements respectively.

StrainCalc() requires a bridge configuration code. *TABLE. StrainCalc() Instruction Equations* (p. 69) shows the equation used by each configuration code. Each code can be preceded by a negative sign (-). Use a positive code when the bridge is configured so the output decreases with increasing strain. Use a negative code when the bridge is configured so the output increases with increasing strain. In the equations in *TABLE. StrainCalc() Instruction Equations* (p. 69), a negative code sets the polarity of V_r to negative (-).

TABLE 15. StrainCalc() Instruction Equations

StrainCalc() BrConfig *Code*	*Configuration*
1	Quarter bridge strain gage: $\mu\varepsilon = \frac{-4 * 10^6 V_r}{GF(1+2V_r)}$
2	Half bridge strain gage. One gage parallel to strain, the other at 90° to strain. $\mu\varepsilon = \frac{-4 * 10^6 V_r}{GF[(1+\nu) - 2V_r(\nu-1)]}$
3	Half bridge strain gage. One gage parallel to $+\varepsilon$, the other parallel to $-\varepsilon$: $\mu\varepsilon = \frac{-2 * 10^6 V_r}{GF}$
4	Full bridge strain gage. Two gages parallel to $+\varepsilon$, the other two parallel to $-\varepsilon$: $\mu\varepsilon = \frac{-10^6 V_r}{GF}$
5	Full bridge strain gage. Half the bridge has to gages parallel to $+\varepsilon$ and $-\varepsilon$, and the other half to $+\nu\varepsilon$ and $-\nu\varepsilon$: $\mu\varepsilon = \frac{-2 * 10^6 V_r}{GF(\nu+1)}$
6	Full bridge strain gage. Half the bridge has two gages parallel to $+\varepsilon$ and $-\nu\varepsilon$, and the other half to $-\nu\varepsilon$ and $+\varepsilon$: $\mu\varepsilon = \frac{-2 * 10^6 V_r}{GF[(\nu+1) - V_r(\nu-1)]}$

where:

- ν: Poisson Ratio (0 if not applicable)
- **GF**: Gage Factor
- $\mathbf{V_r}$: 0.001 (Source-Zero) if BRConfig code is positive (+)
- $\mathbf{V_r}$: -0.001 (Source-Zero) if BRConfig code is negative (-)

where:

- "source": the result of the full Wheatstone bridge measurement ($X = 1000 * V_1 / V_x$) when multiplier = 1 and offset = 0.
- "zero": gage offset to establish an arbitrary zero (see FieldCalStrain in *FieldCal () Demonstration Programs* (p. 230)).

StrainCalc Example: See *SECTION. FieldCalStrain() Demonstration Program* (p. 237)

4.4 Thermocouple

Note Thermocouples are easy to use with the CR1000. They are also inexpensive. However, they pose several challenges to the acquisition of accurate temperature data, particularly when using external reference junctions. Campbell Scientific **strongly encourages** any user of thermocouples to carefully evaluate *SECTION. Error Analysis* (p. 71). An introduction to thermocouple measurements is located in *SECTION. Hands-on Exercise - Measuring a Thermocouple* (p. 13).

The micro-volt resolution and low-noise voltage measurement capability of the CR1000 is well suited for measuring thermocouples. A thermocouple consists of two wires, each of a different metal or alloy, joined at one end to form the measurement junction. At the opposite end, each lead connects to terminals of a voltage measurement device, such as the CR1000. These connections form the reference junction. If the two junctions (measurement and reference) are at different temperatures, a voltage proportional to the difference is induced in the wires. This phenomenon is known as the Seebeck effect. Measurement of the voltage between the positive and negative terminals of the voltage measurement device provides a direct measure of the temperature difference between the measurement and reference junctions. A third metal (e.g., solder or CR1000 terminals) between the two dissimilar metal wires form parasitic thermocouple junctions, the effects of which cancel if the two wires are at the same temperature. Consequently, the two wires at the reference junction are placed in close proximity so they remain at the same temperature. Knowledge of the reference junction temperature provides the determination of a reference junction compensation voltage, corresponding to the temperature difference between the reference junction and 0°C. This compensation voltage, combined with the measured thermocouple voltage, can be used to compute the absolute temperature of the thermocouple junction. To facilitate thermocouple measurements, a thermistor is integrated into the CR1000 wiring panel for measurement of the reference junction temperature by means of the PanelTemp() instruction.

TCDiff() and TCSe() thermocouple instructions determine thermocouple temperatures using the following sequence. First, the temperature (°C) of the reference junction is determined. A reference junction compensation voltage is next computed based on the temperature difference between the reference junction and 0 °C. If the reference junction is the CR1000 analog input terminals, the temperature is conveniently measured with the PanelTemp() instruction. The actual thermocouple voltage is measured and combined with the reference junction compensation voltage. It is then used to determine the thermocouple junction temperature based on a polynomial approximation of NIST thermocouple calibrations.

4.4.1 Error Analysis

The error in the measurement of a thermocouple temperature is the sum of the errors in the reference junction temperature measurement plus the temperature-to-voltage polynomial fit error, the non-ideality of the thermocouple (deviation from standards published in NIST Monograph 175), the thermocouple voltage measurement accuracy, and the voltage-to-temperature polynomial fit error (difference between NIST standard and CR1000 polynomial approximations). The discussion of errors that follows is limited to these errors in calibration and measurement and does not include errors in installation or matching the sensor and thermocouple type to the environment being measured.

4.4.1.1 Panel Temperature Error

The panel temperature thermistor (Betatherm 10K3A1A) is just under the panel in the center of the two rows of analog input terminals. It has an interchangeability specification of 0.1°C for temperatures between 0 and 70°C. Below freezing and at higher temperatures, this specification is degraded. Combined with possible errors in the completion resistor measurement and the Steinhart and Hart equation used to calculate the temperature from resistance, the accuracy of panel temperature is estimated in *FIGURE. Panel Temperature Error Summary* (p. 72). In summary, error is estimated at ± 0.1°C over -0 to 40°C, ± 0.3°C from -25 to 50°C, and ± 0.8°C from -55 to 85°C.

The error in the reference temperature measurement is a combination of the error in the thermistor temperature and the difference in temperature between the panel thermistor and the terminals the thermocouple is connected to. The terminal strip cover should always be used when making thermocouple measurements. It insulates the terminals from drafts and rapid fluctuations in temperature as well as conducting heat to reduce temperature gradients. In a typical installation where the CR1000 is in a weather tight enclosure not subject to violent swings in temperature or uneven solar radiation loading, the temperature difference between the terminals and the thermistor is likely to be less than 0.2°C.

With an external driving gradient, the temperature gradients on the input panel can be much worse. For example, the CR1000 was placed in a controlled temperature chamber. Thermocouples in channels at the ends and middle of each analog terminal strip measured the temperature of an insulated aluminum bar outside the chamber. The temperature of this bar was also measured by another datalogger. Differences between the temperature measured by one of the thermocouples and the actual temperature of the bar are due to the temperature difference between the terminals the thermocouple is connected to and the thermistor reference (the figures have been corrected for thermistor errors). *FIGURE. Panel Temperature Gradients (Low Temperature to High)* (p. 72) shows the errors when the chamber was changed from low temperature to high in approximately 15 minutes. *FIGURE. Panel Temperature Gradients (High Temperature to Low)* (p. 72) shows the results when going from high temperature to low. During rapid temperature changes, the panel thermistor will tend to lag behind terminal temperature because it is mounted deeper in the CR1000.

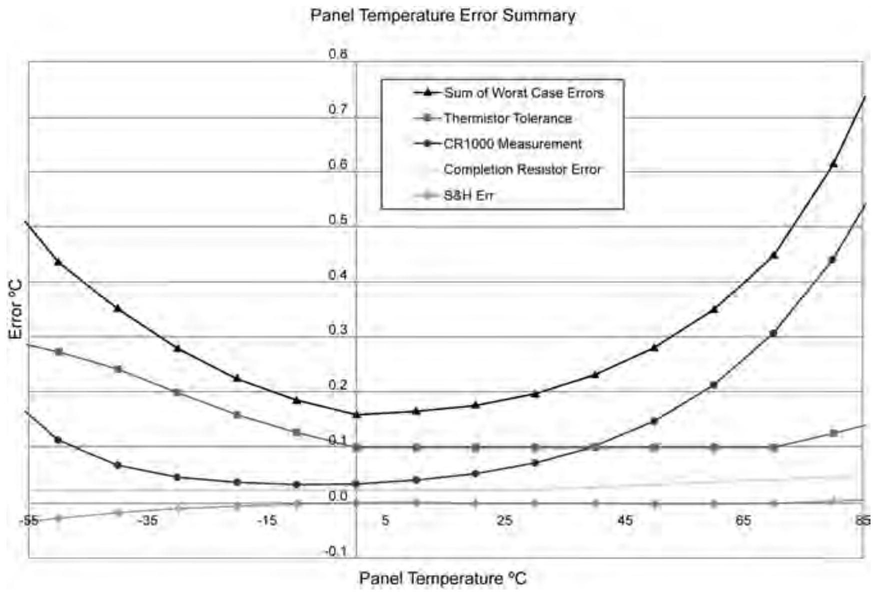


FIGURE 34. Panel Temperature Error Summary

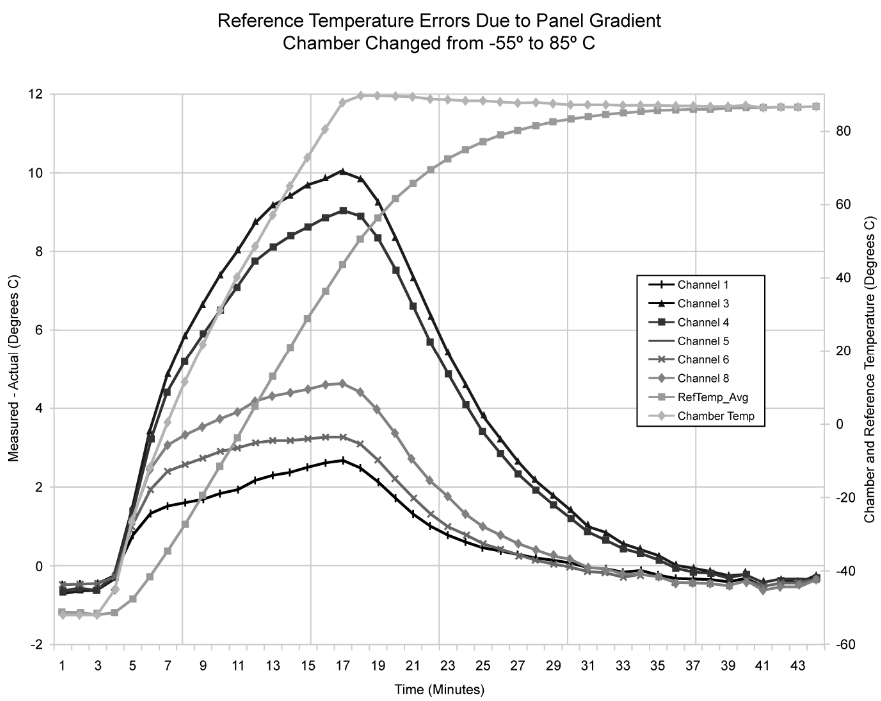


FIGURE 35. Panel Temperature Gradients (Low Temperature to High)

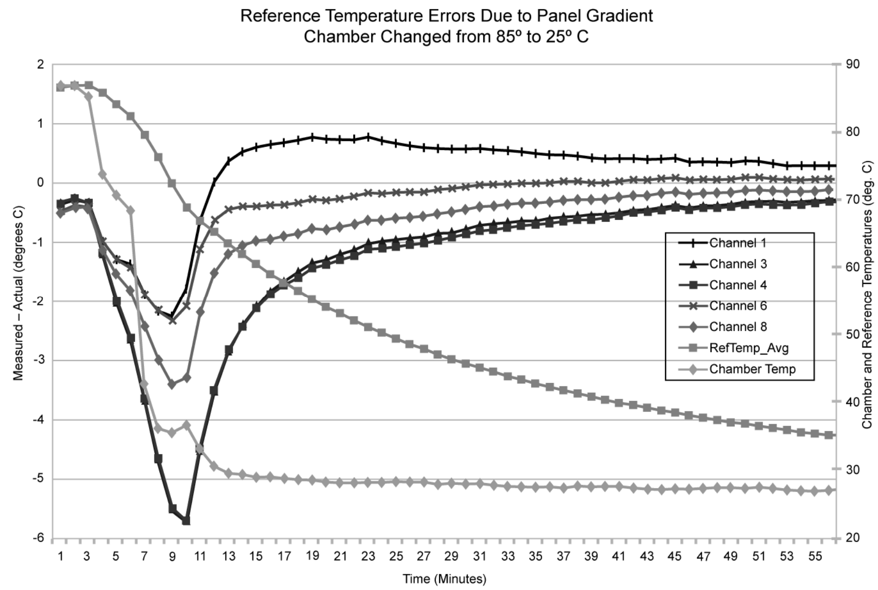


FIGURE 36. Panel Temperature Gradients (High Temperature to Low)

4.4.1.2 Thermocouple Limits of Error

The standard reference that lists thermocouple output voltage as a function of temperature (reference junction at 0°C) is the NIST (National Institute of Standards and Technology) Monograph 175 (1993). ANSI (American National Standards Institute) has established limits of error on thermocouple wire which is accepted as an industry standard (ANSI MC 96.1, 1975). *TABLE. Limits of Error for Thermocouple Wire* (p. 74) gives the ANSI limits of error for standard and special grade thermocouple wire of the types accommodated by the CR1000.

When both junctions of a thermocouple are at the same temperature there is no voltage produced (law of intermediate metals). A consequence of this is that a thermocouple cannot have an offset error; any deviation from a standard (assuming the wires are each homogeneous and no secondary junctions exist) is due to a deviation in slope. In light of this, the fixed temperature limits of error (e.g., ±1.0°C for type T as opposed to the slope error of 0.75% of the temperature) in the table above are probably greater than one would experience when considering temperatures in the environmental range (i.e., the reference junction, at 0°C, is relatively close to the temperature being measured, so the absolute error - the product of the temperature difference and the slope error - should be closer to the percentage error than the fixed error). Likewise, because thermocouple calibration error is a slope error, accuracy can be increased when the reference junction temperature is close to the measurement temperature. For the same reason differential temperature measurements, over a small temperature gradient, can be extremely accurate.

To quantitatively evaluate thermocouple error when the reference junction is not fixed at 0°C limits of error for the Seebeck coefficient (slope of thermocouple voltage vs. temperature curve) are needed for the various thermocouples. Lacking this information, a reasonable approach is to apply the percentage errors, with perhaps 0.25% added on, to the difference in temperature being measured by the thermocouple.

TABLE 16. Limits of Error for Thermocouple Wire (Reference Junction a			
Thermocouple	*Temperature*	*Limits of Error (Whichever is greater)*	
Type	*Range°C*	*Standard*	*Special*
T	-200 to 0	± 1.0°C or 1.5%	
	0 to 350	± 1.0°C or 0.75%	± 0.5°C or 0.4%
J	0 to 750	± 2.2°C or 0.75%	± 1.1°C or 0.4%
E	-200 to 0	± 1.7°C or 1.0%	
	0 to 900	± 1.7°C or 0.5%	± 1.0°C or 0.4%
K	-200 to 0	± 2.2°C or 2.0%	
	0 to 1250	± 2.2°C or 0.75%	± 1.1°C or 0.4%
R or S	0 to 1450	± 1.5°C or 0.25%	± 0.6°C or 0.1%
B	800 to 1700	± 0.5%	Not Established.

4.4.1.3 Thermocouple Voltage Measurement Error

Thermocouple outputs are extremely small -- 10 to 70 µV per °C. Unless high resolution input ranges are used when programming the CR1000, accuracy and sensitivity are compromised. *TABLE. Voltage Range for Maximum Thermocouple Resolution* (p. 74) lists high resolution ranges available for various thermocouple types and temperature ranges. The following four example calculations of thermocouple input error demonstrate how the selected input voltage range impacts the accuracy of measurements. *FIGURE. Input Error Calculation* (p. 75) shows from where various values are drawn to complete the calculations. See *SECTION. Measurement Accuracy* (p. 48) for more information on measurement accuracy and accuracy calculations.

When the thermocouple measurement junction is in electrical contact with the object being measured (or has the possibility of making contact) a differential measurement should be made to avoid ground looping.

TABLE 17. Voltage Range for Maximum Thermocouple Resolution (with refe 20°C)

TC Type and Temperature Range (°C)	*Tem-perature Range (°C) for ±2.5 mV Input Range*	*Tem-perature Range (°C) for ±7.5 mV Input Range*	*Tem-perature Range (°C) for ±25 mV Input Range*	*Tem-perature Range (°C) for ±250 mV Input Range*
T: -270 to 400	-45 to 75	-270 to 180	-270 to 400	not used
E: -270 to 1000	-20 to 60	-120 to 130	-270 to 365	>365
K: -270 to 1372	-40 to 80	-270 to 200	-270 to 620	>620
J: -210 to 1200	-25 to 65	-145 to 155	-210 to 475	>475
B: -0 to 1820	0 to 710	0 to 1265	0 to 1820	not used
R: -50 to 1768	-50 to 320	-50 to 770	-50 to 1768	not used
S: -50 to 1768	-50 to 330	-50 to 820	-50 to 1768	not used
N: -270 to 1300	-80 to 105	-270 to 260	-270 to 725	>725

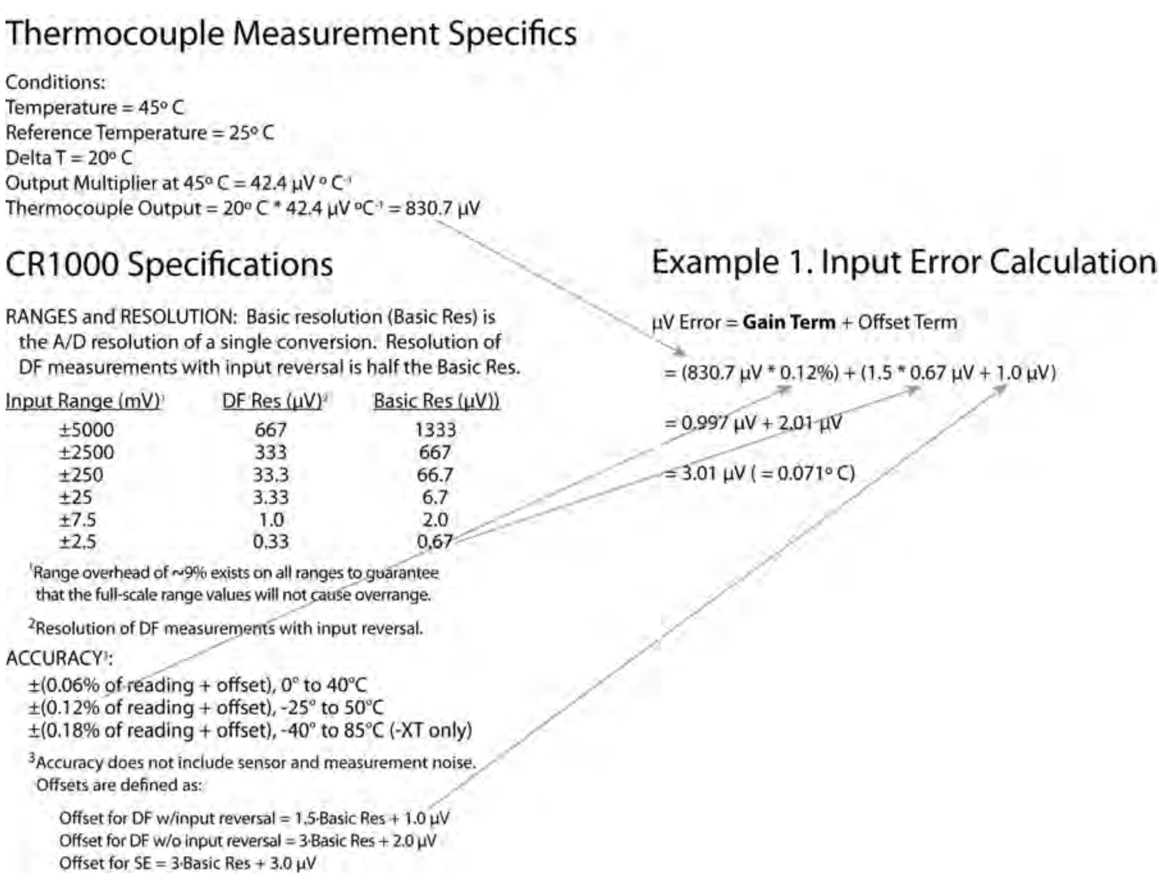


FIGURE 37. Input Error Calculation

4.4.1.3.1 Input Error Examples: Type T Thermocouple @ 45°C

These examples demonstrate that in the environmental temperature range, input offset error is much greater than input gain error because a small input range is used.

Conditions:

CR1000 module temperature between -25 to 50°C

Temperature = 45°C

Reference Temperature = 25°C

Delta T = 20°C

Thermocouple Output Multiplier at 45°C = 42.4 μV $°C^{-1}$

Thermocouple Output = 20°C * 42.4 μV $°C^{-1}$ = 830.7 μV

Input Range = ±2.5 mV

Error Calculations with Input Reversal = True

μV Error = Gain Term + Offset Term

= (830.7 μV * 0.12%) + (1.5 * 0.67 μV + 1.0 μV)

= 0.997 μV + 2.01 μV

= 3.01 μV (= 0.071 °C)

Error Calculations with Input Reversal = False

μV Error = Gain Term + Offset Term

= (830.7 μV * 0.12%) + (3 * 0.67 μV + 2.0 μV)

= 0.997 μV + 4.01 μV

= 5.01 μV (= 0.12 °C)

4.4.1.3.2 Input Error Examples: Type K Thermocouple @ 1300°C

Error in the temperature due to inaccuracy in the measurement of the thermocouple voltage increases at temperature extremes, particularly when the temperature and thermocouple type require using the ±200|250 mV range. For example, assume type K (chromel-alumel) thermocouples are used to measure temperatures around 1300°C.

These examples demonstrate that at temperature extremes, input offset error is much less than input gain error because the use of a larger input range is required.

Conditions

CR1000 module temperature between -25 to 50°C

Temperature = 1300°C

Reference Temperature = 25°C

Delta T = 1275°C

Thermocouple Output Multiplier at 1300°C = 34.9 µV °C^{-1}

Thermocouple Output = 1275°C * 34.9 µV °C^{-1} = 44500 µV

Input Range = ±250 mV

Error Calculations with Input Reversal = True

µV Error = Gain Term + Offset Term

= (44500 µV * 0.12%) + (1.5 * 66.7 µV + 1.0 µV)

= 53.4 µV + 101.0 µV

= 154 µV (= 4.41 °C)

Error Calculations with Input Reversal = False

µV Error = Gain Term + Offset Term

= (44500 µV * 0.12%) + (3 * 66.7 µV + 2.0 µV)

= 53.4 µV + 200 µV

= 7.25 µV (= 7.25 °C)

4.4.1.4 Ground Looping Error

When the thermocouple measurement junction is in electrical contact with the object being measured (or has the possibility of making contact) a differential measurement should be made to avoid ground looping.

4.4.1.5 Noise Error

The typical input noise on the ±2.5 mV range for a differential measurement with 16.67 ms integration and input reversal is 0.19 µV RMS. On a type T thermocouple (approximately 40 µV/°C), this is 0.005°C. Note that this is an RMS value; some individual readings will vary by greater than this.

4.4.1.6 Thermocouple Polynomial Error

NIST Monograph 175 gives high order polynomials for computing the output voltage of a given thermocouple type over a broad range of temperatures. To speed processing and accommodate the CR1000's math and storage capabilities, four separate 6th order polynomials are used to convert from volts to temperature over the range covered by each thermocouple type. *TABLE. Limits of Error on CR1000 Thermocouple Polynomials* (p. 78) gives error limits for the thermocouple polynomials.

TABLE 18. Limits of Error on CR1000 Thermocouple Polynomials

TC Type	*Range °C*			*Limits of Error °C Relative to NIST Standards*
T	**-270**	**to**	**400**	
	-270	to	-200	+18 @ -270
	-200	to	-100	±0.08
	-100	to	100	±0.001
	100	to	400	±0.015
J	**-150**	**to**	**760**	±0.008
	-100	to	300	±0.002
E	**-240**	**to**	**1000**	
	-240	to	-130	±0.4
	-130	to	200	±0.005
	200	to	1000	±0.02
K	**-50**	**to**	**1372**	
	-50	to	950	±0.01
	950	to	1372	±0.04

4.4.1.7 Reference Junction Error

Thermocouple instructions TCDiff () and TCSe () include the parameter TRef to incorporate the reference junction temperature into the measurement. A reference junction compensation voltage is computed from TRef as part of the thermocouple instruction, based on the temperature difference between the reference junction and 0°C. The polynomials used to determine the reference junction compensation voltage do not cover the entire thermocouple range, as illustrated in *TABLE. Limits of Error on CR1000 Thermocouple Polynomials* (p. 78) and *TABLE. Reference Temperature Compensation Range and Polynomial Error* (p. 79). Substantial errors in the reference junction compensation voltage will result if the reference junction temperature is outside of the polynomial fit ranges given.

The reference junction temperature measurement can come from a PanelTemp () instruction, or from any other temperature measurement of the reference junction. The standard and extended (-XT) operating ranges for the CR1000 are

-25 to +50 °C and -55 to 85 °C, respectively. These ranges also apply to the reference junction temperature measurement using PanelTemp ().

Two sources of error arise when the reference temperature is out of the polynomial fit range. The most significant error is in the calculated compensation voltage; however a small error is also created by non-linearities in the Seebeck coefficient.

TABLE 19. Reference Temperature Compensation Range and Polynomia Standards

TC Type	*Range °C*	*Limits of Error °C*
T	-100 to 100	± 0.001
J	-150 to 296	± 0.005
E	-150 to 206	± 0.005
K	-50 to 100	± 0.01

4.4.1.8 Thermocouple Error Summary

The magnitude of the errors described in *SECTION. Error Analysis* (p. 71) illustrate that the greatest sources of error in a thermocouple temperature measurement are likely due to the limits of error on the thermocouple wire and in the reference temperature. Errors in the thermocouple and reference temperature linearizations are extremely small, and error in the voltage measurement is negligible.

TABLE. Example of Errors in Thermocouple Temperature (p. 79) illustrates the relative magnitude of these errors in the environmental range. It shows a worst case situation where all errors are maximum and additive. A temperature of 45°C is measured with a type T (copper-constantan) thermocouple, using the ±2.5 mV range. The reference thermistor measures 25.1 °C, The terminal the thermocouple is connected to is 0.05°C cooler than the reference thermistor (0.15°C error).

TABLE 20. Example of Errors in Thermocouple Temperature				
	Error: °C : % of Total Error			
	Single Differential 250 µs Integration		*Reversing Differential 50/60 Hz Rejection Integration*	
Source	*ANSI TC Error (1°C)*	*TC Error 1% Slope*	*ANSI TC Error (1°C)*	*TC Error 1% Slope*
Reference Temp.	0.15°:11.5%	0.15°:29.9%	0.15°:12.2%	0.15°:34.7%
TC Output	1.0°:76.8%	0.2°:39.8%	1.0°:81.1%	0.2°:46.3%
Voltage Measurement	0.12°:9.2%	0.12°:23.9%	0.07°:5.7%	0.07°:16.2%
Noise	0.03°:2.3%	0.03°:6.2%	0.01°:0.8%	0.01°:2.3%
Reference Linearization	0.001°:0.1%	0.001°:0.2%	0.001°:0.1%	0.001°:0.25%
Output Linearization	0.001°:0.1%	0.001°:0.2%	0.001°:0.1%	0.001°:0.25%
Total Error	1.302°:100%	0.502°:100%	1.232°:100%	0.432°:100%

4.4.2 Use of External Reference Junction

An external junction in an insulated box is often used to facilitate thermocouple connections. It can reduce the expense of thermocouple wire when measurements are made long distances from the CR1000. Making the external junction the reference junction, which is preferable in most applications, is accomplished by running copper wire from the junction to the CR1000. Alternatively, the junction box can be used to couple extension grade thermocouple wire to the thermocouples, with the PanelTemp () instruction used to determine the reference junction temperature.

Extension grade thermocouple wire has a smaller temperature range than standard thermocouple wire, but meets the same limits of error within that range. One situation in which thermocouple extension wire is advantageous is when the junction box temperature is outside the range of reference junction compensation provided by the CR1000. This is only a factor when using type K thermocouples, since the upper limit of the reference compensation polynomial fit range is 100°C and the upper limit of the extension grade wire is 200°C. With the other types of thermocouples the reference compensation polynomial fit range equals or is greater than the extension wire range. In any case, errors can arise if temperature gradients exist within the junction box.

FIGURE. Diagram of Junction Box (p. 81) illustrates a typical junction box wherein the reference junction is the CR1000. Terminal strips are a different metal than the thermocouple wire. Thus, if a temperature gradient exists between A and A' or B and B', the junction box will act as another thermocouple in series, creating an error in the voltage measured by the CR1000. This thermoelectric offset voltage is also a factor when the junction box is used as the reference junction. This offset can be minimized by making the thermal conduction between the two points large and the distance small. The best solution in the case where extension grade wire is being connected to thermocouple wire is to use connectors which clamp the two wires in contact with each other.

When an external junction box is also the reference junction, the points A, A', B, and B' need to be very close in temperature (isothermal) to measure a valid reference temperature, and to avoid thermoelectric offset voltages. The box should contain elements of high thermal conductivity, which will act to rapidly equilibrate any thermal gradients to which the box is subjected. It is not necessary to design a constant temperature box. It is desirable that the box respond slowly to external temperature fluctuations. Radiation shielding must be provided when a junction box is installed in the field. Care must also be taken that a thermal gradient is not induced by conduction through the incoming wires. The CR1000 can be used to measure the temperature gradients within the junction box.

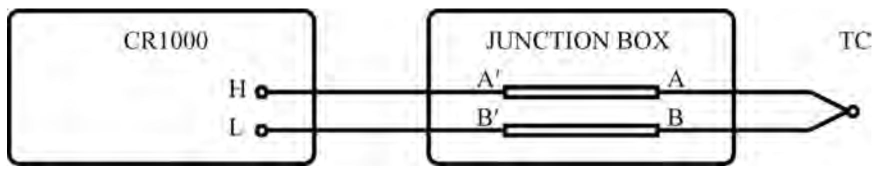


FIGURE 38. Diagram of a Thermocouple Junction Box

4.5 Pulse

FIGURE. Pulse Input Types (p. 9) illustrates pulse input types measured by the CR1000. *FIGURE. Switch Closure Pulse Sensor* (p. 82) is a generalized schematic showing connection of a pulse sensor to the CR1000. The CR1000 features two dedicated pulse input channels, P1 through P2, and eight digital I/O channels, C1 through C8, for measuring frequency or pulse output sensors.

As shown in *TABLE. Pulse Input Channels and Measurements* (p. 9), all CR1000 pulse input channels can be measured with CRBASIC instruction PulseCount (). PulseCount () has various parameters to customize it to specific applications. Digital I/O ports C1 through C8 can also be measured with the TimerIO () instruction. PulseCount () instruction functions include returning counts or frequency on frequency or switch closure signals. TimerIO () instruction has additional capabilities. Its primary function is to measure the time between state transitions.

Note Consult CRBASIC Editor Help for more information on PulseCount () and TimerIO () instructions.

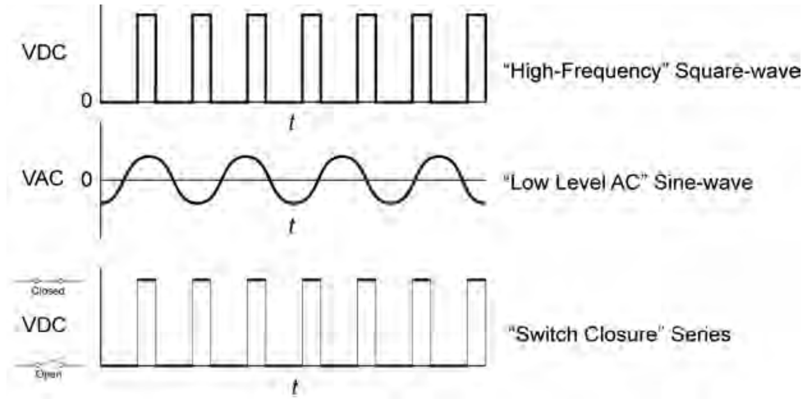


FIGURE 39. Pulse Sensor Output Signal Types

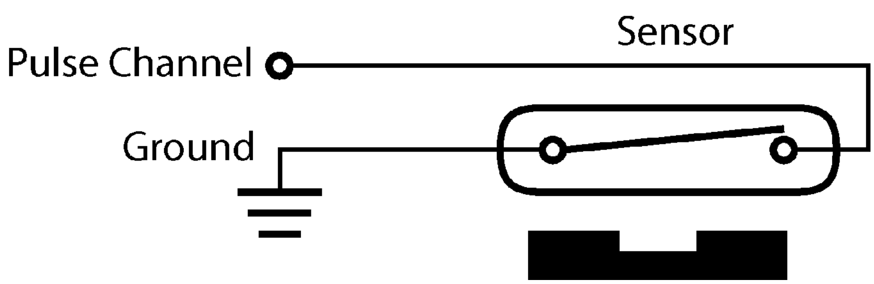


FIGURE 40. Switch Closure Pulse Sensor

TABLE 21. Pulse Input Channels and Measurements

Channels Available for Pulse Input	***Input Types***	***Data Option***	***CRBASIC Instruction***
P1, P2	High Frequency Low-Level ac Switch Closure	Counts Frequency Run Avg of Freq	PulseCount ()
C1, C2, C3, C4, C5, C6, C7, C8	High Frequency Switch Closure Low-Level ac (with LLAC4 Low-Level AC Conversion Module)	Counts Frequency Run Avg of Freq Interval Period State	PulseCount () TimerIO ()

4.5.1 Pulse Input Channels (P1 - P2)

Read More! Review pulse counter specifications at *SECTION. Specifications* (p. 42). Review pulse counter programming in CRBASIC Editor Help for the PulseCount () instruction.

Dedicated pulse input channels (P1 through P2), as shown in *FIGURE. Pulse Input Channels* (p. 83), can be configured to read high- frequency pulses, low-level ac signals, or switch closures.

Note Input channel expansion devices for all input types are available from Campbell Scientific. Refer to Sensors and Peripherals for more information.

Caution Maximum input voltage on pulse channels P1 through P2 is ±20 V. If pulse inputs of higher than ±20 V need to be measured, third party external signal conditioners should be employed. Contact a Campbell Scientific applications engineer if assistance is needed. Under no circumstances should voltages greater than ±50 V be measured.

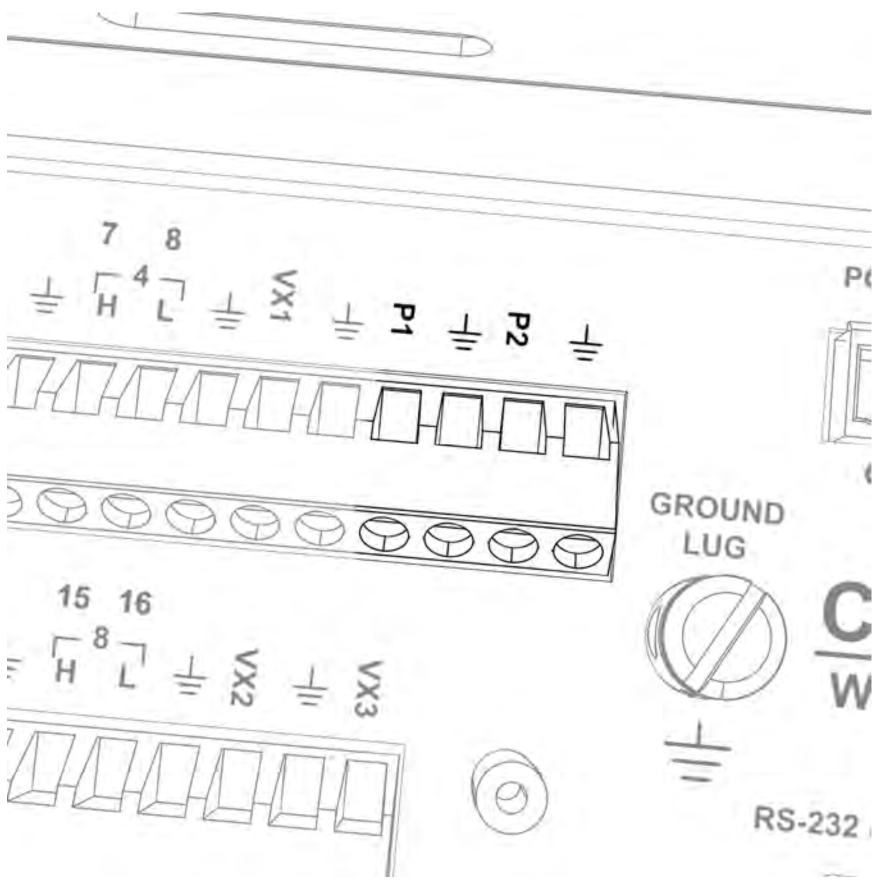


FIGURE 41. Pulse Input Channels

4.5.1.1 High-frequency Pulse (P1 - P2)

High-frequency pulse inputs are routed to an inverting CMOS input buffer with input hysteresis. The CMOS input buffer is an output 0 level with its input ≥ 2.2 V, and an output 1 with its input ≤ 0.9 V. When a pulse channel is configured for high-frequency pulse, an internal 100 kΩ pull-up resistor to 5 Vdc on the P1 or P2 input is automatically employed. This pull-up resistor accommodates open-collector (open-drain) output devices for high-frequency input.

4.5.1.2 Low-Level ac (P1 - P2)

Rotating magnetic pickup sensors commonly generate AC output voltages ranging from milliVolts at low rotational speeds to several volts at high rotational speeds. Pulse channels contain internal signal conditioning hardware for measuring low-level AC output sensors. When configured for low-level AC, P1 through P2 measure signals ranging from 20 mV RMS (±28 mV peak) to 14 V RMS (±20 V peak). Internal AC coupling is incorporated in the low-level AC hardware to eliminate dc offset voltages of up to ±0.5 Vdc.

4.5.1.3 Switch Closure (P1 - P2)

Switch-closure mode measures switch closure events, such as occur with a common tipping bucket rain gage. An internal 100 kΩ pull-up resistor pulls an input to 5 Vdc with the switch open, whereas a switch closure to ground pulls the input to 0 V. An internal 3.3 ms time constant RC debounce filter eliminates multiple counts from a single switch closure event.

4.5.2 Pulse Input on Digital I/O Channels C1 - C8

Read More! Review digital I/O channel specifications in *SECTION. Specifications* (p. 42). Review pulse counter programming with PulseCount () in CRBASIC Help.

Digital I/O channels C1 - C8 can be configured for edge timing or to measure high-frequency or switch closure signals. Input voltage must range between -8.0 and +16 Vdc.

Caution Contact Campbell Scientific for signal conditioning information if a pulse input < -8.0 or > +16 Vdc is to be measured. Under no circumstances should voltages greater than ±50 V be connected to channels C1 - C8.

Low-level ac signals cannot be measured directly by digital I/O channels C1 - C8. Refer to *APPENDIX. Pulse / Frequency Input Expansion Modules* (p. 498) for information on peripheral modules available to convert low-level ac signals to high-frequency square-wave.

4.5.2.1 High-frequency (C1 - C8)

Digital I/O channels C1 - C8 have a small 25 ns input RC filter time constant between the terminal block and the CMOS input buffer, which allows for higher frequency operation (400 kHz maximum) when compared with pulse input channels P1 through P2 (250 kHz maximum).

When configured for input, signals connected to C1 - C8 each go into a digital CMOS input buffer that recognizes inputs ≥ 3.8 V as high and inputs ≤ 1.2 V as low.

Open collector (bipolar transistors) or open drain (MOSFET) sensors are typically measured as high frequency sensors. Condition channels C1 - C8 for open collector or open drain with an external pull-up resistor as shown in *FIGURE. Connecting Switch Closures to Digital IO* (p. 86). The pull-up resistor counteracts an internal 100 kΩ pull-down resistor, allowing inputs to be pulled to > 3.8 V for reliable measurements.

4.5.2.2 Switch Closure (C1 - C8)

Two schemes are available for connecting switch closure sensors to the CR1000. If the switch closes to ground, an external pull-up resistor is used as shown in *FIGURE. Connecting Switch Closures to Digital I/O* (p. 86). If the switch is to close directly to the control port, connect the sensor to the CR1000 as diagramed.

Mechanical switch closures have a tendency to bounce before solidly closing. Bouncing can cause multiple counts. The CR1000 incorporates software switch debounce in switch-closure mode for channels C1 - C8.

Note Maximum switch closure frequency measured is 150 kHz.

4.5.2.3 Edge Timing (C1 - C8)

Time between pulse edges can be measured. Results can be expressed in terms of microseconds or hertz. To read more concerning edge timing, refer to CRBASIC Help for the TimerIO() instruction. Edge timing resolution is 540 ns.

4.5.3 Pulse Measurement Tips

- Activated by the PulseCount() instruction, dedicated 24-bit counters on channels P1 through P2 and C1 through C8 accumulate all counts over the user specified scan interval. Counters are read at the beginning of each scan and cleared. Counters overflow, resulting in erroneous measurements, if accumulated counts exceed 16,777,216.
- Execution of PulseCount() within a scan involves determining the accumulated counts in each dedicated 24-bit counter since execution of the last PulseCount(). Counts are the preferred output option for measuring number of tips from a tipping bucket rain gage, or the number of times a door opens. Many pulse sensors, such as anemometers and flow meters, are

calibrated in terms of frequency (Hz or counts / second), and are usually measured with the frequency option.

- Accuracy of PulseCount() is limited by a small scan interval error of ±(3 ppm of scan interval + 10 µs) plus the measurement resolution error of ± 1 Hz. The sum is essentially ± 1 Hz.
- Use the LLAC4 module to convert non-TTL level signals, including low-level ac signals, to TTL levels for input into digital I/O channels C1 through C8.
- When digital I/O channels C1 through C8 measure switch closure inputs, pull-up resistors may be required. *FIGURE. Connecting Switch Closures to Digital I/O* (p. 86) show how pull-up resistors can be incorporated into a wiring scheme.
- As shown *FIGURE. Connecting Switch Closures to Digital I/O* (p. 86), digital I/O inputs, with regard to the 6.2 V Zener diode, have an input resistance of 100 kohms with input voltages < 6.2 Vdc. **For input voltages ≥ 6.2 Vdc, the inputs have an input resistance of only 220 ohms.**

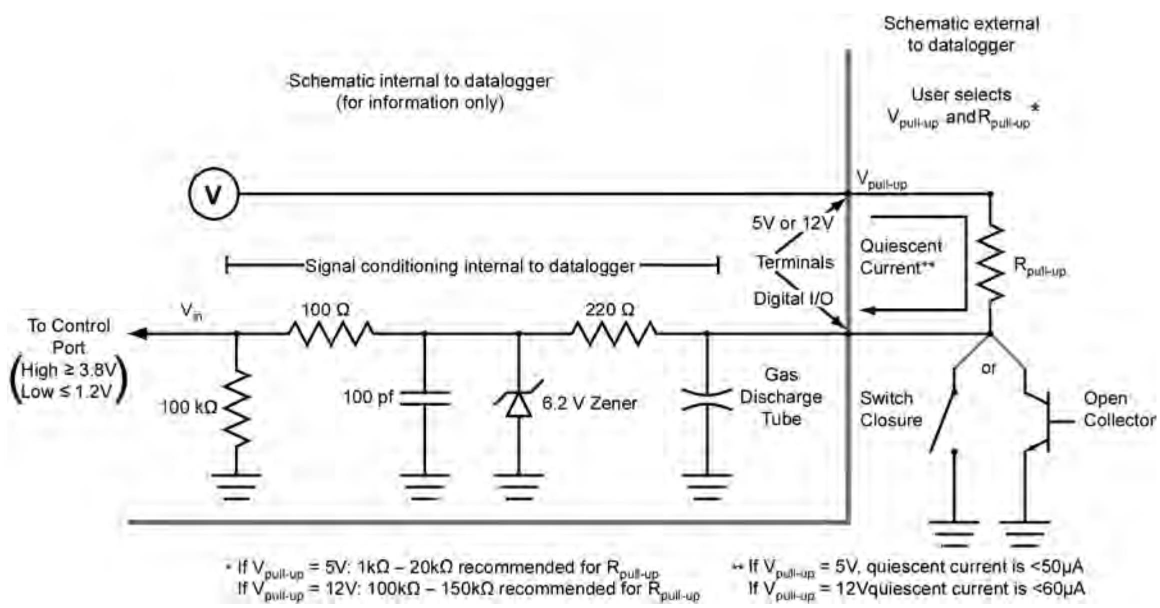


FIGURE 42. Connecting Switch Closures to Digital I/O

4.5.3.1 Frequency Resolution

Resolution of the 24-bit pulse counters is one count. Frequency resolution of a PulseCount () frequency measurement is

$$FR = \frac{1}{S}$$

where:

FR = Resolution of the frequency measurement (Hz)

S = Scan Interval of CRBASIC Program

Resolution of TimerIO () instruction is:

$$FR = \frac{R/E}{P * (P+(R/E))}$$

where:

FR = Frequency resolution of the measurement (Hz)

R = Timing resolution of the period measurement = 540 ns

P = Period of input signal (seconds) = 1 / 1000 Hz = 0.001 s

E = Rising edges per scan = 500 in 0.5 s scan, 5000 in 5.0 s scan)

TimerIO () instruction measures frequencies of ≤ 1 kHz with higher frequency resolution over short (sub-second) intervals. In contrast, sub-second frequency measurement with PulseCount () produce measurements of lower resolution. Consider a 1 kHz input. *TABLE. Frequency Resolution* (p. 87) lists frequency resolution to be expected for a 1 kHz signal measured by TimerIO () and PulseCount() at 0.5 s and 5.0 s scan intervals.

Increasing a 1 s measurement interval to 10 s, either by increasing the scan interval (when using PulseCount()) or by averaging (when using PulseCount() or TimerIO()), improves the resulting frequency resolution from 1 Hz to 0.1 Hz. Averaging can be accomplished by the Average(), AvgRun(), and AvgSpa() instructions. Also, PulseCount() has the option of entering a number greater than 1 in the POption parameter. Doing so enters an averaging interval in milliseconds for a direct running average computation. However, use caution when averaging, Averaging of any measurement reduces the certainty that the result truly represents a real aspect of the phenomenon being measured.

TABLE 22. Frequency Resolution Comparison

	0.5 s Scan	***5.0 s Scan***
PulseCount(), POption 1	FR= 2 Hz	FR = 0.2 Hz
TimerIO(), Function 2	FR = 0.0011 Hz	FR = 0.00011 Hz

4.5.4 Pulse Measurement Problems

4.5.4.1 Pay Attention to Specifications

TABLE. Example of Differing Specifications for Pulse Input Channels (p. 87) compares specifications for pulse input channels to emphasize the need for matching the proper device to application. Take time to understand signals to be measured and compatible channels.

TABLE 23. Example of Differing Specifications for Pulse Input Channels		
	Pulse Channels P1, P2	***Digital I/O Channels C1, C2, C3, C4, C5, C6, C7, C8***
High Frequency Max (kHz)	250	1
Max Input Voltage (Vdc)	20	16
State Transition Thresholds (Vdc)	Count upon transition from <0.9 to >2.2.	Count upon transition from <1.2 to >3.8.

4.5.4.2 Input Filters and Signal Attenuation

Pulse input channels are equipped with input filters to reduce spurious noise that can cause false counts. The higher the time constant (τ) of the filter, the tighter the filter. *TABLE. Time Constants* (p. 88) lists τ values for pulse input channels. So, while TimerIO () frequency measurement may be superior for clean signals, a pulse channel filter (much higher τ) may be required to get a measurement on a dirty signal.

Input filters, however, attenuate the amplitude (voltage) of the signal. The amount of attenuation is a function of the frequency passing through the filter. Higher frequency signals are attenuated more. If a signal is attenuated enough, it may not pass the state transition thresholds (thresholds are listed in *TABLE. Pulse Input Channels and Measurements* (p. 9)) required by the detection device. To avoid over attenuation, sensor output voltage must be increased at higher frequencies. As an example, *TABLE. Filter Attenuation of Frequency Signals* (p. 88) lists low-level ac frequencies and the voltages required to overcome filter attenuation.

For pulse input channels P1 - P2, an RC input filter with an approximate 1 µs time constant precedes the inverting CMOS input buffer. The resulting amplitude reduction is illustrated in *FIGURE. Amplitude Reduction of Pulse-Count Waveform.* (p. 89) For a 0 to 5 Vdc square wave applied to a pulse channel, the maximum frequency that can be counted in high-frequency mode is approximately 250 kHz.

TABLE 24. Time Constants (τ)	
Measurement	*τ*
Pulse Channel, High Frequency Mode	1.2
Pulse Channel, Switch Closure Mode	3300
Pulse Channel, Low-level AC Mode	See *TABLE. Filter Attenuation of Frequency Signals* (p. 88) footnote
Digital I/O, High Frequency Mode	0.025
Digital I/O, Switch Closure Mode	0.025

TABLE 25. Filter Attenuation of Frequency Signals.	
As shown for low-level ac inputs, increasing voltage is required at increasing frequencies to overcome filter attenuation on pulse input channels*.	
ac mV (RMS)	***Maximum Frequency***
20 200 2000 5000	20 200 10,000 20,000
*8.5 ms time constant filter (19 Hz 3 dB frequency) for low-amplitude signals. 1 ms time constant (159 Hz 3 dB frequency) for larger (> 0.7 V) amplitude signals.	

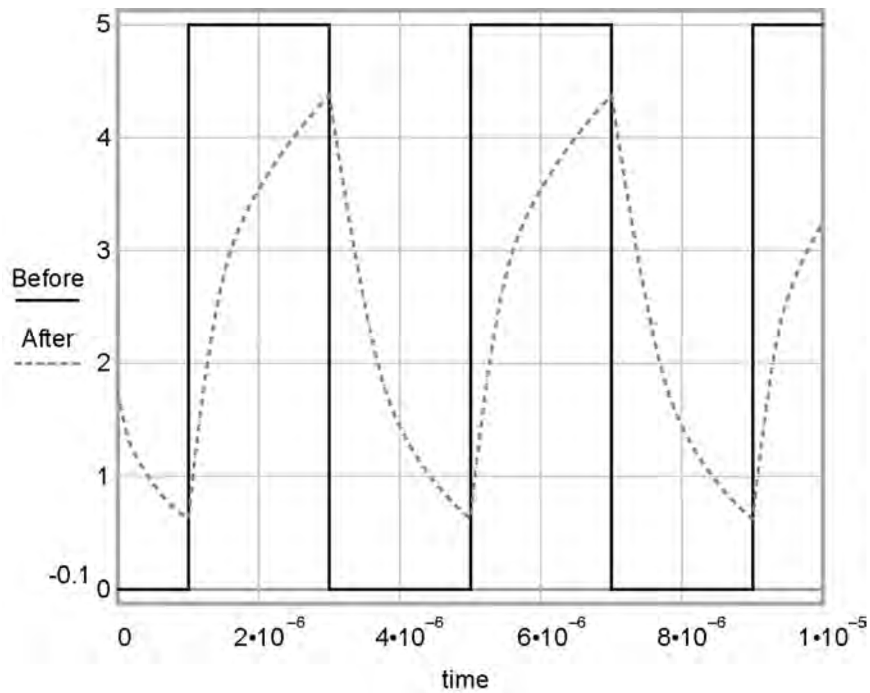


FIGURE 43. Amplitude Reduction of Pulse-Count Waveform (before and after 1 µs time constant filter)

4.6 Period Averaging

The CR1000 can measure the period of a signal on any single-ended analog input channel (SE 1 - 16). The specified number of cycles are timed with a resolution of 136 ns, making the resolution of the period measurement 136 ns divided by the number of cycles chosen.

Low-level signals are amplified prior to a voltage comparator. The internal voltage comparator is referenced to the user-entered threshold. The threshold parameter allows a user to reference the internal voltage comparator to voltages other than 0 V. For example, a threshold of 2500 mV allows a 0 to 5 Vdc digital signal to be sensed by the internal comparator without the need of any additional input conditioning circuitry. The threshold allows direct connection of standard digital signals, but is not recommended for small amplitude sensor signals. For sensor amplitudes less than 20 mV peak-to-peak, a dc blocking capacitor is recommended to center the signal at CR1000 ground (threshold = 0) because of offset voltage drift along with limited accuracy (± 10 mV) and resolution (1.2 mV) of a threshold other than 0. *FIGURE. Input Conditioning Circuit for Period Averaging* (p. 90) shows an example circuit.

The minimum pulse width requirements increase (maximum frequency decreases) with increasing gain. Signals larger than the specified maximum for a range will saturate the gain stages and prevent operation up to the maximum specified frequency. As shown back-to-back diodes are recommended to limit large amplitude signals to within the input signal ranges.

Caution Noisy signals with slow transitions through the voltage threshold have the potential for extra counts around the comparator switch point. A voltage comparator with 20 mV of hysteresis follows the voltage gain stages. The effective input referred hysteresis equals 20 mV divided by the selected voltage gain. The effective input referred hysteresis on the ± 25 mV range is 2 mV; consequently, 2 mV of noise on the input signal could cause extraneous counts. For best results, select the largest input range (smallest gain) that meets the minimum input signal requirements.

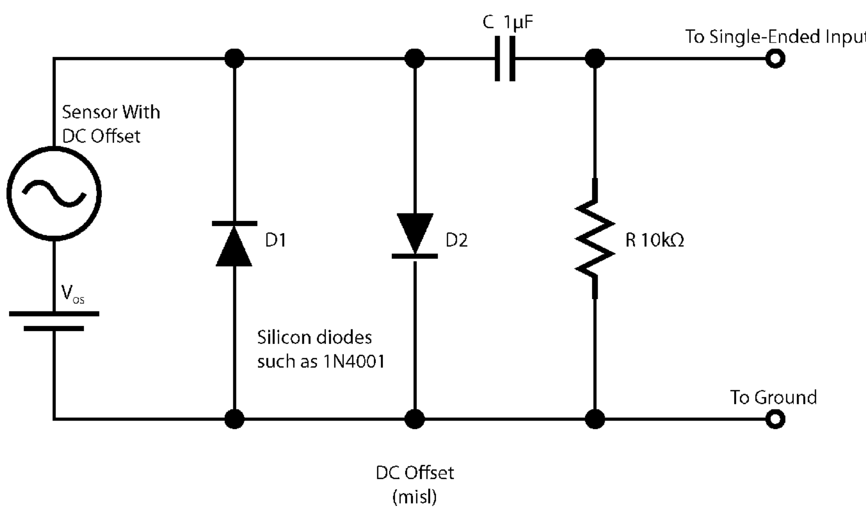


FIGURE 44. Input Conditioning Circuit for Period Averaging

4.7 SDI-12 Recording

Read More! *SECTION. SDI-12 Sensor Support* (p. 249) and *SECTION. Serial Input / Output* (p. 209).

SDI-12 is a communications protocol developed to transmit digital data from smart sensors to data acquisition units. It is a simple protocol, requiring only a single communication wire. Typically, the data acquisition unit also supplies power (12 Vdc and ground) to the SDI-12 sensor. The CR1000 is equipped with 4 SDI-12 channels (C1, C3, C5, C7) and an SDI12Recorder () CRBASIC instruction.

4.8 RS-232 and TTL Recording

Read More! *SECTION. Serial Input / Output* (p. 209) and *SECTION. Serial I/O* (p. 279).

The CR1000 can usually receive and record RS-232 and 0-5V logic data from sensors designed to transmit via these protocols. Data are received through the CS I/O port with the proper interface (*APPENDIX. CS I/O Serial Interfaces* (p. 499)), the RS-232 port, or the digital I/O communication ports (C1 & C2, C3 & C4, C5 & C6, C7 & C8). If additional serial inputs are required, serial input expansion modules (*APPENDIX. Serial Input Expansion Modules* (p. 499)) can be connected to increase the number of serial ports. Serial data are usually captured as strings, which are then parsed (split up) as defined in the user entered program.

Note Digital I/O communication ports (control ports) only transmit 0-5V logic. However, they read most true RS-232 input signals. When connecting serial sensors to an RX control port, the sensor power consumption may increase by a few milliamps due to voltage clamps. An external resistor may need to be added in series to the RX line to limit the current drain, although this is not advisable at very high baud rates. *FIGURE. Circuit to Limit Control Port Input to 5 Volts* (p. 91) shows a circuit that limits voltage input on a control port to 5 Vdc.

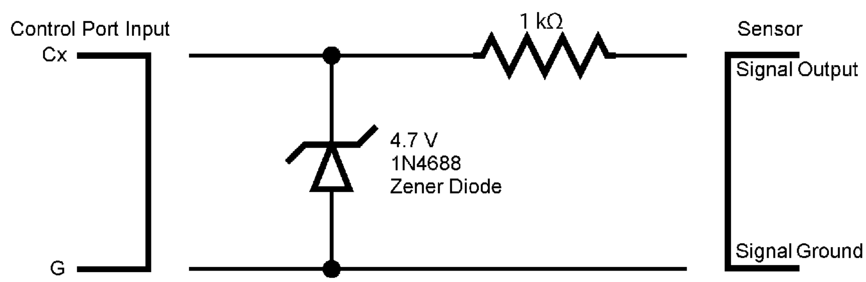


FIGURE 45. Circuit to Limit Control Port Input to 5 Volts

4.9 Field Calibration of Linear Sensor

Read More! *SECTION. Field Calibration of Linear Sensors (FieldCal)* (p. 227) has complete FieldCal information.

Calibration increases accuracy of a measurement device by adjusting its output, or the measurement of its output, to match independently verified quantities. Adjusting a sensor output directly is preferred, but not always possible or practical. By adding FieldCal() or FieldCalStrain() instructions to the CR1000 program, a user can easily adjust the measured output of a linear sensors by modifying multipliers and offsets.

4.10 Cabling Effects

Sensor cabling can have significant effects on sensor response and accuracy. This is usually only a concern with sensors acquired from manufacturers other than Campbell Scientific. Campbell Scientific sensors are engineered for optimal performance with factory installed cables.

4.10.1 Analog Sensor Cables

Cable length in analog sensors is most likely to affect the signal settling time. For more information, see *SECTION. Signal Settling Time* (p. 56).

4.10.2 Pulse Sensors

Because of the long interval between switch closures in tipping bucket rain gages, appreciable capacitance can build up between wires in long cables. A built up charge can cause arcing when the switch closes, shortening switch life. As shown in *FIGURE. Current Limiting Resistor in a Rain Gage Circuit* (p. 92), a 100 ohm resistor is connected in series at the switch to prevents arcing. This resistor is installed on all rain gages currently sold by Campbell Scientific.

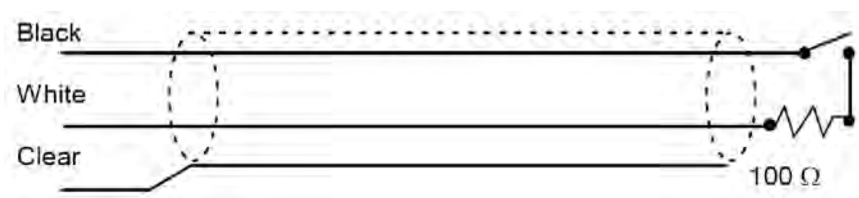


FIGURE 46. Current Limiting Resistor in a Rain Gage Circuit

4.10.3 RS-232 Sensors

RS-232 sensors cable lengths should be limited to 50 feet.

4.10.4 SDI-12 Sensors

The SDI-12 standard allows cable lengths of up to 200 feet. Campbell Scientific does not recommend SDI-12 sensor lead lengths greater than 200 feet; however, longer lead lengths can sometimes be accommodated by increasing the wire gage and/or powering the sensor with a second 12 Vdc power supply placed near the sensor.

4.11 Synchronizing Sensor Measurements

Timing of a measurement is usually controlled relative to the CR1000 clock. When sensors in a sensor network are measured by a single CR1000, measurement times are synchronized, often within a few milliseconds, depending on sensor number and measurement type. Large numbers of sensors, cable length restrictions, or long distances between measurement sites may require use of multiple CR1000s. Techniques outlined below enable network administrators to synchronize CR1000 clocks and measurements in a CR1000 network.

Care should be taken when a clock change operation is planned. Any time the CR1000 clock is changed, the deviation of the new time from the old time may be sufficient to cause a skipped record in data tables. Any command used to synchronize clocks should be executed after any CallTable() instructions and timed so as to execute well clear of data output intervals.

Time Synchronization Techniques:

1. LoggerNet Utility – When reliable telecommunications are common to all CR1000s in a network, LoggerNet's Automated Clock Check provides a simple time synchronization function. Accuracy is limited by the system clock on the PC running the LoggerNet server. Precision is limited by network transmission latencies. LoggerNet compensates for latencies in many telecommunications systems and can achieve synchronies within <100 ms deviation. Errors of 2 – 3 second may be seen on very busy RF connections or long distance internet connections.

Note Common PC clocks are notoriously inaccurate. An easy way to keep a PC clock accurate is to utilize public domain software available at http://tf.nist.gov/service/its.htm.

2. Digital Trigger – A digital trigger, rather than a clock, can provide the synchronization signal. When cabling can be run from CR1000 to CR1000, each CR1000 can catch the rising edge of a digital pulse from the Master CR1000 and synchronize measurements or other functions, using the WaitDigTrig() instructions, independent of CR1000 clocks or data time stamps. When programs are running in pipeline mode, measurements can be synchronized with a few microseconds.

3. PakBus Commands – The CR1000 is a PakBus device, so it is capable of being a node in a PakBus network.. Node clocks in a PakBus network are synchronized using the SendGetVariable(), ClockReport(), or PakBusClock() commands. The CR1000 clock has a resolution of 10 ms, which is the resolution used by PakBus clock sync functions. In networks without routers, repeaters, or retries, the communication time will cause an additional error (typically a few 10s of milliseconds). PakBus clock commands set the time at the end of a scan to minimize the chance of skipping a record to a data table.

An RF401 radio network has an advantage over Ethernet in that ClockReport() can be broadcast to all dataloggers within reach and set their clocks with a single PakBus broadcast from the master. Each datalogger in the network must be programmed with a PakBusClock() instruction.

Note Use of PakBus clock functions re-synchronizes the Scan() instruction. Use should not exceed once per minute. CR1000 clocks drift at a slow enough rate that a ClockReport() once per minute should be sufficient to keep clocks within 30 ms of each other.

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4. GPS – Clocks in CR1000s can be synchronized to within about 10 ms of each other using the GPS () instruction. CR1000s built since October of 2008 (serial numbers >= 20409) can be synchronized within a few microseconds of each other and within ≈ 200 µs of UTC. While a GPS signal is available, the CR1000 essentially uses the GPS as its continuous clock source, so the chance of jumps in system time and skipped records is minimized.

5. Ethernet – Any CR1000 with a network connection (internet, GPRS, private network) can synchronize its clock relative to Coordinated Universal Time (UTC) using the NetworkTimeProtocol () instruction. Precisions are usually maintained to within 10 ms.

Section 6. Power Sources

Reliable power is the foundation of a reliable data acquisition system. When designing a power supply, consideration should be made regarding worst-case power requirements and environmental extremes.

Excessive switching noise or AC ripple present on a DC power supply can increase measurement noise. Noise sources include power transformers, regulators, and grid or mains power inclusively. Using high quality power regulators reduces noise due to power regulation. Utilizing 50 Hz or 60 Hz integration times for voltage measurements (see *SECTION. Sensor Support* (p. 43)) improves rejection of power supply induced noise. The CRBASIC standard deviation instruction, SDEV() can be used to evaluate measurement noise.

Contact Campbell Scientific if assistance in selecting a power supply is needed, particularly with applications in extreme environments.

6.1 Power Requirement

The CR1000 operates on dc voltage ranging from 9.6 to 16 V. It is internally protected against accidental polarity reversal. A transient voltage suppressor (TVS) diode on the 12 Vdc power input terminal provides transient protection by clamping voltages in the range of 19 to 21 V. Sustained input voltages in excess of 19 V can damage the TVS diode.

Caution The 12V and SW-12 terminals on the wiring panel are not regulated by the CR1000; they obtain the same power as that provided by the CR1000 primary power supply. When using the CR1000 wiring panel to source power to other 12 Vdc devices, be sure the power supply regulates the voltage within a the range specified by the manufacturer of the connected device.

6.2 Calculating Power Consumption

Read More! *SECTION. Power Requirements* (p. 32).

System operating time for batteries can be determined by dividing the battery capacity (ampere-hours) by the average system current drain (amperes). The CR1000 typically has a quiescent current draw of 0.5 mA (with display off), 0.6 mA with a 1 Hz sample rate, and >10 mA with a 100 Hz sample rate. With the optional keyboard display on, an additional 7 mA is added to the current drain while enabling the back light for the display adds 100 mA to the current drain.

6.3 Power Supplies

APPENDIX. Power Supplies (p. 495) lists external power supplies available from Campbell Scientific, including alkaline and solar options. Complete power supply information is available in manual or brochure form at *www.campbellsci.com*.

6.3.1 External Batteries

When connecting external power to the CR1000, remove the green POWER IN connector from the CR1000 front panel. Insert the positive 12 Vdc lead into the terminal marked "12V". Insert the ground lead in the terminal marked "G" (ground). The CR1000 is internally protected against, but will not function with, reversed external power polarity.

6.4 Vehicle Power Connections

If a CR1000 is powered by a motor vehicle supply, a second supply may be needed. When starting the motor of the vehicle, the battery voltage may drop below 9.6 V. This causes the CR1000 to stop measurements until the voltage again equals or exceeds 9.6 V. A second supply can be provided to prevent measurement lapses during vehicle starting. *FIGURE. Connecting CR1000 to Vehicle Power Supply* (p. 100) illustrate how a second power supply should be connected to the CR1000. The diode OR connection causes the supply with the largest voltage to power the CR1000 and prevents the second backup supply from attempting to power the vehicle.

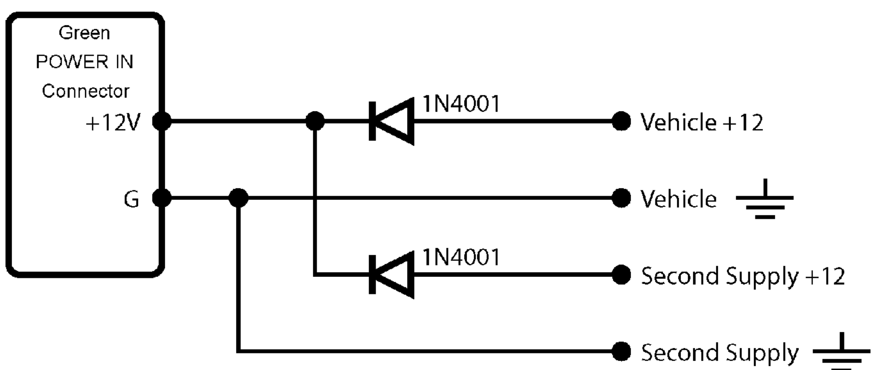

FIGURE 50. Connecting to Vehicle Power Supply

6.5 Powering Sensors and Devices

Read More! See *SECTION. CR1000 Power Supply* (p. 99).

The CR1000 is a convenient distributor of power for sensors and peripherals requiring a 5 or 12 Vdc source. It has 2 continuous 12 Vdc terminals (12V), one program-controlled switched 12 Vdc terminal (SW-12), and one continuous 5 Vdc terminal (5V). SW-12, 12V, and 5V terminals limit current internally for protection against accidental short circuits. Voltage on the 12V and SW-12 terminals will change with the dc supply used to power the CR1000. The 5V terminal is internally regulated to within ±4%, which is typically not adequate accuracy for bridge sensor excitation. *TABLE. Current Sourcing Limits* (p. 102) lists the current limits of 12V and 5V. Greatly reduced output voltages associated with 12V, SW-12, and 5V due to current limiting may occur if the current limits given in the table are exceeded. Information concerning digital I/O control ports is available in *SECTION. Digital I/O Ports* (p. 96).

6.5.1 Switched Excitation

Switched Voltage Excitation

Three switched analog output (excitation) terminals (VX1 - VX3) operate under program control to provide -2500 mV to +2500 mV excitation. Check the accuracy specification of these channels in *SECTION. Specifications* (p. 42) to understand their limitations. Specifications are only applicable for loads not exceeding ±25 mA. CRBASIC instructions that control excitation channels include:

- BrFull ()
- BrFull6W ()
- BrHalf ()
- BrHalf3W ()
- BrHalf4W ()
- ExciteV ()

Note Excitation channels can be configured through the RevEx parameter of bridge instructions to provide a square wave ac excitation for use with polarizing bridge sensors.

6.5.2 Continuous Regulated (5 Volt)

The 5V terminal is regulated and remains near 5 Vdc (±4%) so long as the CR1000 supply voltage remains above 9.6 Vdc. Measurement of the output from 5V (by means of jumpering to an analog input on the same CR1000) enables an accurate bridge measurement if the 5V terminal must be used for excitation.

6.5.3 Continuous Unregulated (Nominal 12 Volt)

Voltage on the 12V terminals will change with CR1000 supply voltage.

6.5.4 Switched Unregulated (Nominal 12 Volt)

SW-12 is often used to control low power devices such as sensors that require 12 Vdc during measurement. Current sourcing must be limited to 900 mA or less at 20°C. See *TABLE. Current Sourcing Limits* (p. 102). Voltage on a SW-12 terminal will change with CR1000 supply voltage. Two CRBASIC instructions, SW12 () and PortSet (), control a SW-12 terminal. Each is handled differently by the CR1000. SW12 () is a processing task instruction. Use it when controlling power to SDI-12 and serial sensors, which use SDI12Recorder () or SerialIn () instructions respectively. CRBASIC programming using IF THEN constructs to control SW-12, such as when used for cell phone control, should also use the SW12 () instruction. PortSet () is a measurement task instruction. Use it when powering analog input sensors that need to be powered just prior to measurement.

A 12 Vdc switching circuit, driven by a digital I/O port, is also available from Campbell Scientific.

Note The SW-12 supply is unregulated and can supply up to 900 mA at 20°C. See *TABLE. Current Sourcing Limits* (p. 102). A resettable polymeric fuse protects against over-current. Reset is accomplished by removing the load or turning off the SW-12 for several seconds.

TABLE 26. Current Source (+) & Sink (-) Limits

Terminal	***Limit***
Voltage Excitation (VX, EX)[1]	±25 mA Maximum
SW-12[2]	< +900 mA @ 20°C < +630 mA @ 50°C < +450 mA @ 70°C
12V + SW-12 (Combined)[3]	< +3.00 A @ 20°C < +2.34 A @ 50°C < +1.80 A @ 70°C < +1.50 A @ 85°C
5V + CSI/O (Combined)[4]	< +200 mA

[1] Greater magnitude current than stated limits will cause voltage to become unstable. Voltage should stabilize once current is again established under maximum magnitude.

[2] Polyfuse is used to limit power. Result of overload is a voltage drop. To reset, disconnect and allow circuit to cool. Operating at the current limit is OK so long a a little fluctuation can be tolerated.

[3] Polyfuse protected. See 2.

[4] Maximum current is maintained by a current limiting circuit, which holds the current at the maximum by dropping the voltage when the load is too great.

Section 12. Memory and Final Data Storage

12.1 Storage Media

CR1000 memory consists of four non-volatile storage media:

- Internal battery backed SRAM
- Internal Flash
- Internal Serial Flash
- External Flash (optional CSI Flash drive)
- External CompactFlash® (*optional module* (p. 503))

TABLE. CR1000 Memory Allocation (p. 349) and *TABLE. CR1000 SRAM Memory* (p. 350) illustrate how CR1000 memory is structured around these media. The CR1000 utilizes and maintains most memory features automatically. However, users should periodically review areas of memory wherein data files, CRBASIC program files, and image files reside. Review and management of memory are accomplished with LoggerNet / PC400 / RTDAQ / PC200W File Control feature.

TABLE 72. CR1000 Memory Allocation

Memory Sector	Comments
Internal battery-backed SRAM[1] 4 Mbytes*	See *TABLE. CR1000 SRAM Memory* (p. 350) for detail.
Internal Flash[2] 2 Mbytes	Operating system
Internal Serial Flash[3] 12 kbytes: Device Settings 500 kbytes: CPU: drive	Device Settings: A backup of settings such as PakBus Address, Station Name, Beacon Intervals, Neighbor lists, etc. Rebuilt when a setting changes. CPU: Drive: Holds program files, field calibration files, and other files not over written frequently. Slower than SRAM. When a program is compiled and run, it is copied here automatically for loading on subsequent power-ups. Files accumulate until deleted with File Control or the FilesManage() instruction. Use USR: drive to store other file types. Available CPU: memory is reported in Status Table field "CPUDriveFree."

External Flash (Optional) 2 Gbytes: USB: drive	USB: drive: Holds program files. Holds a copy of final storage table data as files when TableFile() instruction is used. USB: data can be retrieved from the storage device with Windows Explorer. Can facilitate use of Powerup.ini.
External CompactFlash (Optional) <= 2 Gbytes: CRD: drive	CRD: drive: Holds program files. Holds a copy of final storage table data as files when CardOut() instruction is used. When data are requested by a PC, data first are provided from SRAM. If the requested records have been overwritten in SRAM, data are sent from CRD:. Alternatively, CRD: data can be retrieved in a binary format using File Control. Binary files are converted using CardConvert software. 10% or 80 kbytes of CF memory (whichever is smaller) is reserved for program storage. Can facilitate use of Powerup.ini.

[1]SRAM

·CR800 series changed from 2 to 4 Mbytes SRAM in Sept 2007. SNs >= 3605 are 4 Mbytes

·CR1000 changed from 2 to 4 Mbytes SRAM in Sept 2007. SNs >= 11832 are 4 Mbytes

·CR3000 has always shipped with a 4 Mbytes SRAM.

[2]Flash is rated for > 1 million overwrites.

[3]Serial Flash is rated for 100,000 overwrites (50,000 overwrites on 128 kbyte units). Care should be taken in programs that do overwrites to use the CRD: or USR: drives so as not to wear-out the CPU: drive.

·The CR800 series changed from 128 to 512 kbytes Serial Flash in May 2007. SNs >=2787 are 512 kbytes

·The CR1000 changed from 128 to 512 kbytes Serial Flash in May 2007. SNs >= 9452 are 512 kbytes

·The CR3000 changed from 128 512 kbytes Serial Flash in May 2007. SNs > 1948 are 512 kbytes

TABLE 73. CR1000 SRAM Memory

Use	*Comments*
Static Memory	Operational memory used by the operating system regardless of the user program. This sector is rebuilt at power-up, program re-compile, and watchdog events.
Operating Settings and Properties	"Keep" memory. Stores settings such as PakBus address, station name, beacon intervals, neighbor lists, etc. Also stores dynamic properties such as the routing table, communications timeouts, etc.
CRBASIC Program Operating Memory	Stores the currently compiled and running user program. This sector is rebuilt on power-up, recompile, and watchdog events.
Variables & Constants	Stores variables in the user program. These values may persist through power-up, recompile, and watchdog events if the PreserveVariables instruction is in the running program.
Final Storage Data Tables Final Storage is given lowest priority in SRAM memory allocation.	Stores data resulting from CR1000 measurements. This memory is termed "Final Storage." Fills memory remaining after all other demands are satisfied. Configurable as ring or fill and stop memory. Compile error occurs if insufficient memory is available for user allocated data tables.
Communications Memory 1	Construction and temporary storage of PakBus® packets.
Communications Memory 2	Constructed Routing Table: list of known nodes and routes to nodes. Routers use more space than leaf nodes because routes to neighbors must be remembered. Increasing the PakBusNodes field in the Status Table will increase this allocation.
USR: drive <= 3.6 Mbytes (4 Mbyte Mem) <= 1.5 Mbytes (2 Mbyte Mem) Less on older units with more limited memory.	Optionally allocated. Holds image files. Holds a copy of Final Storage when TableFile() instruction used. Provides memory for FileRead / FileWrite operations. Managed in File Control. Status reported in Status Table fields "USRDriveSize" and "USRDriveFree."

12.1.1 Data Storage

Data table SRAM and the CPU: drive are automatically partitioned for use in the CR1000. The USR: drive can be optionally partitioned at programmer discretion.

The USB: drive is automatically partitioned when a CS mass storage device is connected.

TABLE 74. Data Storage Drives

Drive	*Recommended File Types*
CPU:	CR1, .CAL
USR:	.DAT, .JPG
USB:	.DAT
CRD:	Principal use is to expand *Final Storage* (p. 442), but also used to store .JPG, CR1, and .DAT files.

The CRD: drive is automatically partitioned when a CF card is installed.

12.1.1.1 Data Table SRAM

Primary storage for measurement data are those areas in SRAM allocated to data tables as detailed in *FIGURE. CR1000 SRAM Memory* (p. 350). Measurement data can be also be stored as discrete files on USR:, or USB: by using TableFile() instruction.

The CR1000 can be programmed to store each measurement or, more commonly, to store processed values such as averages, maxima, minima, histograms, FFTs, etc. Data are stored periodically or conditionally in data tables in SRAM as directed by the CRBASIC program (see *SECTION. Structure* (p. 133)). The DataTable () instruction allows the user to set the size of a data table. Discrete data files are normally created only on a PC when data are retrieved using *datalogger support software* (p. 439, p. 490).

Data are usually erased from this area when a program is sent to the CR1000. However, options are available in *datalogger support software* (p. 439, p. 490) File Control and CRBASIC Editor to preserve data when downloading programs.

12.1.1.2 CPU: Drive

CPU: is the default drive to which programs and calibration files are stored. Do not store data on CPU: or premature failure of CPU: memory may result.

12.1.1.3 USR: Drive

SRAM can be partitioned to create a FAT32 USR: drive, analogous to partitioning a second drive on a PC hard disk. Certain types of files are stored to USR: to reserve limited CPU: memory for datalogger programs and calibration files. Partitioning also helps prevent interference from data table SRAM. USR: is configured using DevConfig settings or SetStatus() instruction in a CRBASIC program. Partition USR: drive to at least 11264 bytes in 512 byte increments. If the value entered is not a multiple of 512 bytes, the size is rounded up. Maximum size of USR: is the total RAM size less 400 Kbytes; i.e., for a CR1000 with 4 Megabyte memory, the maximum size of USR: is about 3.6 Megabytes.

USR: is not affected by program recompilation or formatting of other drives. It will only be reset if the USR: drive is formatted, a new operating system is loaded, or the size of USR: is changed. USR: size is changed manually using the optional keyboard display or by loading a program with a different USR: size entered in a SetStatus() instruction.

Measurement data can be stored on USR: as discrete files by using the TableFile() instruction. *TABLE. TableFile() Instruction Data File Formats* (p. 355) describes available data file formats.

Note Placing an optional USR: size setting in the user program over-rides manual changes to USR: size. When USR: size is changed manually, the user program restarts and the programmed size for USR: takes immediate effect.

The USR: drive holds any file type within the constraints of the size of the drive and the limitations on filenames. Files typically stored include image files from cameras (see *APPENDIX. Cameras* (p. 504)), certain configuration files, files written for ftp retrieval, html files for viewing via web access, and files created with the TableFile() instruction. Files can be collected by ftp using *datalogger support software* (p. 439, p. 490) File Control utility, or automatically using the LNCMD program supplied exclusively with top-level *datalogger support software* (p. 439, p. 490).

Monitor use of available USR: memory to ensure adequate space to store new files. FileManage() command is used within the CR1000 user program to remove files. Files also can be removed using *datalogger support software* (p. 439, p. 490) File Control utility.

Two status table registers monitor use and size of the USR: drive. Bytes remaining are indicated in register "USRDriveFree." Total size is indicated in register "USRDriveSize." Memory allocated to USR: drive, less overhead for directory use, is shown in *datalogger support software* (p. 439, p. 490) File Control.

12.1.1.4 USB: Drive

USB: drive uses Flash memory on a CS mass storage device (see *APPENDIX. Mass Storage Devices* (p. 504)). Its primary purpose is the storage of ASCII data files. Measurement data can be stored on USB: as discrete files by using the TableFile() instruction. *TABLE. TableFile() Instruction Data File Formats* (p. 355) describes available data file formats.

Caution When removing mass storage devices, do so when the LED is not flashing or lit.

Removing a mass storage device from the CR1000 while the storage device is active can cause data corruption.

CS mass storage devices connect to the CR1000 via the CS I/O port.

CS mass storage devices should be formatted as FAT32.

12.1.1.5 CRD: Drive

CRD: drive uses CompactFlash® memory exclusively. Its primary purpose is the storage of binary data files.

Caution When installing or removing card storage modules, first turn off CR1000 power.

Removing a card from the module while the CF card is active can cause data corruption and may damage the card. Always press the removal button to disable the card and wait for the green LED before removing the card or switching off power prior to removal of the card.

To prevent losing data, collect data from the CF card before sending a program to the datalogger. When a program is sent to the datalogger all data on the CF card may be erased.

CSI CF card modules connect to the CR1000 peripheral port. Each has a slot for Type I or Type II CF cards. A maximum of 30 data tables can be created on a CF card. Refer to *APPENDIX. Card Storage Modules* (p. 503) for information on available CF card modules.

Note CardConvert software, included with mid- and top-level *datalogger support software* (p. 439, p. 490), converts binary card data to the standard Campbell Scientific data format.

When a data table is sent to a CF card, a data table of the same name in SRAM is used as a buffer for transferring data to the card. When the card is present, the status table will show the size of the table on the card. If the card is removed, the size of the table in SRAM is shown.

When a new program is compiled that sends data to the CF card, the CR1000 checks if a card is present and if the card has adequate space for the data tables. If no card is present, or if space is inadequate, the CR1000 will warn that the card is not being used. However, the user program is run and data stored to SRAM. When a card is later inserted, accumulated data is copied to the card.

The CR1000 accepts cards formatted as FAT or FAT32; however, **FAT32 is recommended**. Otherwise, some functionality, such as the ability to manage large numbers of files (>254) is lost. Older CR1000 operating systems formatted cards as FAT or FAT32. Newer operating systems always format cards as FAT32.

See *SECTION. File System Errors* (p. 366) for explanation of error codes associated with CRD: use.

12.1.1.6 Data File Formats

TableFile() instruction data file formats contain time series data and may have an option to include header, timestamp and record number. *TABLE. TableFile() Instruction Data File Formats* (p. 355) lists available formats. For a format to be compatible with *datalogger support software* (p. 439, p. 490) graphing and reporting tools, header, timestamps, and record numbers are usually required. Fully compatible formats are indicated with an asterisk. A more detailed discussion of data file formats is available in the Campbell Scientific publication "LoggerNet Instruction Manual" available at www.campbellsci.com.

TABLE 75. TableFile() Instruction Data File Formats

TableFile() Format Option	*Base File Format*	*Elements Included*		
		Header Information	*Time Stamp*	*Record Number*
0*	TOB1	X	X	X
1	TOB1	X	X	
2	TOB1	X		X
3	TOB1	X		
4	TOB1		X	X
5	TOB1		X	
6	TOB1			X
7	TOB1			
8*	TOA5	X	X	X
9	TOA5	X	X	
10	TOA5	X		X
11	TOA5	X		
12	TOA5		X	X
13	TOA5		X	
14	TOA5			X
15	TOA5			
16*	CSIXML	X	X	X
17	CSIXML	X	X	
18	CSIXML	X		X
19	CSIXML	X		
32*	CSIJSON	X	X	X
33	CSIJSON	X	X	
34	CSIJSON	X		X
35	CSIJSON	X		

*Formats compatible with *datalogger support software* (p. 439, p. 490) data viewing and graphing utilities

12.1.1.6.1 Data File Format Examples

TOB1

TOB1 files may contain an ASCII header and binary data. The last line in the example contains cryptic text which represents binary data.

Example:

```
"TOB1","11467","CR1000","11467","CR1000.Std.20","CPU:file
    format.CR1","61449","Test"
"SECONDS","NANOSECONDS","RECORD","battfivoltfiMin","PTemp"
"SECONDS","NANOSECONDS","RN","",""
"","","","Min","Smp"
"ULONG","ULONG","ULONG","FP2","FP2"
}Ÿp'    E1HŒŸp'    E1H›Ÿp'    E1HªŸp'    E1H¹Ÿp'       E1H
```

TOA5

TOA5 files contain ASCII (American Standard Code for Information Interchange) header and comma separated data.

Example:

```
"TOA5","11467","CR1000","11467","CR1000.Std.20","CPU:file
    format.CR1","26243","Test"
"TIMESTAMP","RECORD","battfivoltfiMin","PTemp"
"TS","RN","",""
"","","Min","Smp"
"2010-12-20 11:31:30",7,13.29,20.77
"2010-12-20 11:31:45",8,13.26,20.77
"2010-12-20 11:32:00",9,13.29,20.8
```

CSIXML

CSIXML files contain header information and data in an XML (eXtensible Markup Language) format.

Example:

```
<?xml version="1.0" standalone="yes"?>
<csixml version="1.0">
<head>
    <environment>
        <station-name>11467</station-name>
        <table-name>Test</table-name>
        <model>CR1000</model>
        <serial-no>11467</serial-no>
        <os-version>CR1000.Std.20</os-version>
        <dld-name>CPU:file format.CR1</dld-name>
    </environment>
    <fields>
        <field name="battfivoltfiMin" type="xsd:float"
            process="Min"/>
        <field name="PTemp" type="xsd:float" process="Smp"/>
    </fields>
</head>
    <data>
        <r time="2010-12-20T11:37:45"
            no="10"><v1>13.29</v1><v2>21.04</v2></r>
        <r time="2010-12-20T11:38:00"
            no="11"><v1>13.29</v1><v2>21.04</v2></r>
```

```
        <r time="2010-12-20T11:38:15"
            no="12"><v1>13.29</v1><v2>21.04</v2></r>
    </data>
</csixml>
```

CSIJSON

CSIJSON files contain header information and data in a JSON (Java Script Object Notation) format.

Example:


```
"signature": 38611,"environment":  {"stationfiname":
    "11467","tablefiname":  "Test","model":
    "CR1000","serialfino":  "11467",
"osfiversion":  "CR1000.Std.21.03","progfiname":  "CPU:file
    format.CR1"},"fields":  [{"name":
    "battfivoltfiMin","type":  "xsd:float",
"process":  "Min"},{"name":  "PTemp","type":
    "xsd:float","process":  "Smp"}]},
"data": [{"time":  "2011-01-06T15:04:15","no":  0,"vals":
    [13.28,21.29]},
{"time":  "2011-01-06T15:04:30","no":  1,"vals":
    [13.28,21.29]},
{"time":  "2011-01-06T15:04:45","no":  2,"vals":
    [13.28,21.29]},
{"time":  "2011-01-06T15:05:00","no":  3,"vals":
    [13.28,21.29]}]}
```


12.1.1.6.2 Data File Format Elements

HEADER

File headers provide metadata that describe the data in the file. A TOA5 header contains the metadata described below. Other data formats contain similar information unless a non-header format option is selected in the TableFile() instruction in the CR1000 CRBASIC program.

Line 1 – Data Origins

Includes the following metadata series: file type, station name, CR1000 model name, CR1000 serial number, OS version, CRBASIC program name, program signature, data table name.

Line 2 – Data Field Names

Lists the name of individual data fields. If the field is an element of an array, the name will be followed by a comma separated list of subscripts within parentheses that identifies the array index. For example, a variable named “values” that is declared as a two by two array, i.e.,

```
Public Values(2,2)
```

will be represented by four field names: “values(1,1)”, “values(1,2)”, “values(2,1)”, and “values(2,2)”. Scalar (non-array) variables will not have subscripts.

Line 3 – Data Units

Includes the units associated with each field in the record. If no units are programmed in the CR1000 CRBASIC program, an empty string is entered for that field.

Line 4 – Data Processing Descriptors

Entries describe what type of processing was performed in the CR1000 to produce corresponding data, e.g., Smp indicates samples, Min indicates minima. If there is no recognized processing for a field, it is assigned an empty string. There will be one descriptor for each field name given on Header Line 2.

TIMESTAMP

Data without timestamps are usually meaningless. Nevertheless, the TableFile() instruction optionally includes timestamps in some formats.

RECORD NUMBER

Record numbers are optionally provided in some formats as a means to ensure data integrity and provide an upcount data field for graphing operations.

12.2 Memory Conservation

One or more of the following memory saving techniques can be used on the rare occasions when a program reaches memory limits:

- Declare variables as DIM instead of Public. DIM variables do not require buffer memory for data retrieval.
- Reduce arrays to the minimum size needed. Each variable, whether or not part of an array, requires about the same amount of memory. Approximately 192000 (4 kbyte memory) or 87000 (2 kbyte memory) variables will fill available memory.
- Use variable arrays with aliases instead of individual variables with unique names. Aliases consume less memory than unique variable names.
- Confine string concatenation to DIM variables.
- Dimension string variables only to the size required.

Read More! More information on string variable memory use and conservation is available in *SECTION. String Operations* (p. 317).

12.3 Memory Reset

Four features are available for complete or selective reset of CR1000 memory.

12.3.1 Full Memory Reset

Full memory reset occurs when an operating system is sent to the CR1000 using DevConfig or when entering "98765" in the status table field "FullMemReset." A full memory reset does the following:

- Clears and Formats CPU: drive (all program files erased)
- Clears SRAM data tables
- Clears Status Table Elements
- Restores settings to default
- Initializes system variables
- Clears communications memory

Full memory reset does not affect the CRD: drive directly. Subsequent user program uploads, however, can affect CRD:.

Operating systems can also be sent using the Program Send feature in *datalogger support software* (p. 439). Beginning with operating system version 16, settings and status are preserved when sending a subsequent OS by this method; data tables are erased. Rely on this feature with caution, however, when sending an OS to CR1000s in remote and difficult to access locations.

12.3.2 Program Send Reset

Final Storage (p. 442) data are erased when user programs are uploaded, unless preserve / erase data options are used. Preserve / erase data options are presented when sending programs from *datalogger support software* (p. 439, p. 490) File Control and CRBASIC Editor Compile | Save | Send. See *SECTION. Preserving Data at Program Send* (p. 131) for a more detailed discussion of preserve / erase data at program send.

12.3.3 Manual Data Table Reset

Data table memory is selectively reset from

- *datalogger support software* (p. 439) Station Status option
- optional keyboard display: Data | Reset Data Tables

12.3.4 Formatting Drives

CPU:, USR:, USB:, and CRD: drives can be formatted individually. Formatting a drive erases all files on that drive. If the currently running user program is found on the drive to be formatted, the program will cease running and any SRAM data associated with the program is erased. Drive formatting is performed through datalogger support software File Control.

12.4 File Management

Files in CR1000 memory (program, data, CAL, image) can be managed or controlled with Campbell Scientific support software as summarized in *TABLE. File Control Functions* (p. 360).

TABLE 76. File Control Functions

File Control Functions	*Accessed Through*
Sending programs to the CR1000.	**Send**[1], File Control[2], DevConfig[3], keyboard with CompactFlash card (CRD: drive) or CS mass storage media (USB: drive)[4], power-up with CompactFlash card (CRD: drive) or CS mass storage media (USB: drive).[5]
Setting file attributes. See *File Attributes* (p. 361).	File Control[2], power-up with CompactFlash card (CRD: drive) or CS mass storage media (USB: drive)[5], FileManage() instruction[6].
Sending an OS to the CR1000. Reset settings.	DevConfig[3], automatic with CompactFlash card (CRD: drive) or CS mass storage media (USB: drive).[5]
Sending an OS to the CR1000. Preserve settings.	**Send**[1], power-up with CompactFlash card (CRD: drive) or CS mass storage media (USB: drive) with default.CR1 file.[5]
Formatting CR1000 memory drives.	File Control[2], power-up with CompactFlash card (CRD: drive) or CS mass storage media (USB: drive).[5]
Retrieving programs from the CR1000.	Connect[7], File Control[2], keyboard with CompactFlash card (CRD: drive) or CS mass storage media (USB: drive).[4]
Setting disposition of old CompactFlash card (CRD: drive) or CS mass storage media (USB: drive) files	File Control[2], power-up with CompactFlash card (CRD: drive) or CS mass storage media (USB: drive).[5]
Deleting files from memory drives.	File Control[2], power-up with CompactFlash card (CRD: drive) or CS mass storage media (USB: drive).[5]
Stopping program execution.	File Control[2].
Renaming a file.	FileRename()[6]
Time stamping a file.	FileTime()[6]
List files.	File Control[2], FileList()[6]

TABLE 76. File Control Functions	
File Control Functions	*Accessed Through*
Create a data file from a data table	TableFile()[6]
JPEG files manager	optional keyboard display , LoggerNet | PakBusGraph

[1]*Datalogger support software* (p. 439, p. 490) Program Send Button. See software Help.

[2]*Datalogger support software* (p. 439, p. 490) File Control. See software Help.

[3]Device Configuration Utility (DevConfig). See DevConfig Help.

[4]Manual with CompactFlash card (CRD: drive) or CS mass storage media (USB: drive). See *Data Storage* (p. 352).

[5]Automatic with CompactFlash card (CRD: drive) or CS mass storage media (USB: drive) and Powerup.ini. See *Power-up* (p. 363).

[6]CRBASIC commands. See *Data Table Declarations* (p. 177) and *File Management* (p. 215) and CRBASIC Editor Help.

[7]*Datalogger support software* (p. 439, p. 490) Retrieve button. See software Help.

12.4.1 File Attributes

A feature of program files is the file attribute. *TABLE. CR1000 File Attributes* (p. 361) lists available file attributes, their functions, and when attributes are typically used. For example, a program file sent via the **Send** option in *datalogger support software* (p. 439), runs a) immediately ("Run Now") and b) when power is cycled on the CR1000 ("Run on Power-up). This functionality is invoked because **Send** sets two CR1000 file attributes on the program file, i.e., "Run Now" and "Run on Power-up." When together, "Run Now" and "Run on Power-up" are tagged as "Run Always."

Note Activation of the Run on Power-up file can be prevented by holding down the Del key on the optional keyboard display while the CR1000 is being powered up.

TABLE 77. CR1000 File Attributes		
Attribute	*Function*	*Attribute for Programs Sent to CR1000 with:*
Run Always (Run on Power-up + Run Now)	Runs now and on power-up	a) **Send**[1] b) File Control[2] with Run Now & Run on Power-up checked. c) CompactFlash card (CRD: drive) or CS mass storage media (USB: drive) power-up[3] using commands 1 & 13 (see *TABLE. Powerup.ini Commands* (p. 364)).
Run on Power-up	Runs only on power-up	a) File Control[2] with Run on Power-up checked. b) CompactFlash card (CRD: drive) or CS mass storage media (USB: drive) power-up[3] using command 2 (see *TABLE. Powerup.ini Commands* (p. 364)).

TABLE 77. CR1000 File Attributes

Attribute	Function	Attribute for Programs Sent to CR1000 with:
Run Now	Runs only when file sent to CR1000	a) File Control[2] with Run Now checked. b) CompactFlash card (CRD: drive) or CS mass storage media (USB: drive) power-up[3] using commands 6 & 14 (see *TABLE. Powerup.ini Commands* (p. 364)). But, if CompactFlash card (CRD: drive) or CS mass storage media (USB: drive) is left in, program loads again from CompactFlash card (CRD: drive) or CS mass storage media (USB: drive).

[1]*Datalogger support software* (p. 439, p. 490) Program Send Button. See software Help.

[2]*Datalogger support software* (p. 439, p. 490) | File Control. See software Help & *Preserving Data at Program Send* (p. 131).

[3]Automatic on power-up of CR1000 with CompactFlash card (CRD: drive) or CS mass storage media (USB: drive) and Powerup.ini. See *Power-up* (p. 363).

12.4.2 Data Preservation

Associated with file attributes is the option to preserve data in CR1000 memory when a program is sent. This option applies to data table SRAM, CompactFlash(R), and datalogger support software cache data. Depending on the application, retention of data files when a program is downloaded may be desirable. When sending a program to the CR1000 with the datalogger support software Send, data are always deleted before the program runs. When the program is sent using datalogger support software File Control or CRBASIC Editor "Compile, Save, and Send," options to preserve (do not erase) or not preserve (erase) data are presented. The logic in *TABLE. Data Preserve Options* (p. 362) summarizes the disposition of CR1000 data depending on the data preservation option selected.

TABLE 78. Data Preserve Options

```
if "Preserve data if no table changed"
    keep CF data from overwritten program
    if current program = overwritten program
        keep CPU data
        keep cache data
    else
        erase CPU data
        erase cache data
    end if
end if

if "erase CF data"
    erase CF data from overwritten program
    erase CPU data
    erase cache data
end if
```

12.4.3 External Memory Power-up

Uploading a CR1000 operating system file or user program file in the field can be challenging, particularly during weather extremes. Heat, cold, snow, rain, altitude, blowing sand, and distance to hike influence how easily programming with a laptop or palm PC may be. An alternative is to carry the file to field on a light weight external memory device such as a *USB:* (p. 504) or *CRD:* (p. 503) drive. Including a powerup.ini file with the OS / program file on an external drive, connecting the external device to the CR1000, and then cycling power, will result in the file automatically uploading to the CR1000 and running. Powerup.ini options also allows final data storage management comparable to the *datalogger support software* (p. 489) File Control feature. CRD: drive has precedence over USB: drive.

Caution Test Power-up options in the lab before going to the field. Always carry a laptop or palm PC into difficult or expensive to access places.

Power-up functions include

1. Sending programs to the CR1000
2. Setting attributes of CR1000 program files
3. Setting disposition of old CompactFlash card (CRD: drive) or CS mass storage media (USB: drive) files
4. Sending an OS to the CR1000
5. Formatting memory drives
6. Deleting data files

Note Back in the old days of volatile RAM, life was simple. Lost power meant lost programs, variables, and data. The advent of non-volatile memory has saved a lot of frustration in the field, but it requires thought in some applications. For instance, if the CR1000 loses power, do you want it to power back up with the same program, or another one? with variables intact or erased? with data intact or erased?

The powerup.ini file enables the power-up function. The powerup.ini file usually resides on an external drive. It contains a list of one or more command lines. At power-up, the CR1000 searches for a powerup.ini file on a drive and executes the command line(s) prior to compiling a program. Powerup.ini performs three operations:

1. Copies the specified program file to a specified memory drive.
2. Sets a file attribute on the program file.
3. Optionally deletes data left in memory from a just previous, and now overwritten, program.

A powerup.ini file takes precedence during power-up. Although it sets file attributes for the programs it uploads, its presence on a drive does not allow those file attributes to control the power-up process. To avoid confusion, either remove the external drive on which the powerup.ini file resides or delete the file after the powerup.ini operation is complete.

12.4.3.1 Creating and Editing Powerup.ini

A powerup.ini file is created with a text editor on a PC, then saved as "powerup.ini" on a memory drive of the CR1000. The file is saved to the memory drive, along with the operating system or user program file, using the File Control | Send function in *datalogger support software* (p. 489).

Note Some text editors (such as MicroSoft® WordPad®) will attach header information to the powerup.ini file causing it to abort. Check the text of a powerup.ini file in the CR1000 with the optional keyboard display to see what the CR1000 actually sees.

Comments can be added to the file by preceding them with a single-quote character ('). All text after the comment mark on the same line is ignored.

12.4.3.1.1 Syntax

```
Command,File,Device
```

where

- Command = one of the numeric commands in *TABLE. Powerup.ini Commands* (p. 364).
- File = accompanying operating system or user program file. Name can be up to 22 characters.
- Device: the CR1000 memory drive to which the accompanying operating system or user program file is copied (usually CPU:). If left blank or with an invalid option, default device will be CPU:. Use the same drive designation as the transporting external device if the preference is to not copy the file.

TABLE 79. Powerup.ini Commands

Command	*Description*
1*	Run always, preserve data
2	Run on power-up
5	Format
6*	Run now, preserve data
9	Load OS (File = .obj)
13	Run always, erase data
14	Run now, erase files

*By using PreserveVariables() instruction in the CRBASIC program, with commands 1 & 6, data and variables can be preserved.

12.4.3.1.2 Applications

- Commands 1, 2, 6, 13, and 14 (Run Now and / or Run On Power-up). File is copied to Device.
- Command 1, 2, 13 (Run On Power-up). If the copy (first application, above) succeeds, the new Run On Power-up program is accepted. If the copy fails, no change is made to the Run On Power-up program.
- Commands 1, 6, 13, and 14 (Run Now). The Run Now program is changed whether or not the copy (first application, above) occurs. If the copy does succeed, the Run Now program is opened from the device specified.
- Commands 13 and 14 (Delete Associated Data). Since powerup.ini is only processed at power-up, there is not a compiled program to delete associated data for. The information from the last running program is still available for the CR1000 to delete the files used by that program.

12.4.3.1.3 Program Execution

After File is processed, the following rules determine what CR1000 program to run:

- If the Run Now program is changed then it is the program that runs.
- If no change is made to Run Now program, but Run on Power-up program is changed, the new Run on Power-up program runs.
- If neither Run on Power-up nor Run Now programs are changed, the previous Run on Power-up program runs.

12.4.3.1.4 Example Power-up.ini Files

Powerup.ini Example

Code Form / Syntax

```
'Command = numeric power-up command
'File = file associated with the action
'Device = device to which File is copied. Defaults to CPU:

'Command,File,Device
13,Write2CRD_2.cr1,cpu:
```

Powerup.ini Example

Copy program file pwrup.cr1 from the external drive to CPU:. File will run only when CR1000 powered-up later

```
2,pwrup.cr1,cpu:
```

Powerup.ini Example

Format the USR: drive

```
5,,usr:
```

Powerup.ini Example. Load an operating system (.obj) file into FLASH as the new OS
`9,CR1000.Std.04.obj`

Powerup.ini Example A program file is carried on an external USB: drive. Do not copy program file from USB:. Run program always, erase data.
`13,toobigforcpu.cr1,usb:`

Powerup.ini Example Run a program file always, erase data
`13,pwrup_1.cr1,cpu:`

Powerup.ini Example Run a program file now, erase data now
`14,run.cr1,cpu:`

12.5 File Names

The maximum size of the file name that can be stored, run as a program, or FTP transferred in the CR1000 is 59 characters. If the name is longer than 59 characters an "Invalid Filename" error is displayed. If several files are stored, each with a long filename, memory allocated to the root directory can be exceeded before the actual memory of storing files is exceeded. When this occurs, an "insufficient resources or memory full" error is displayed.

12.6 File System Errors

TABLE. File System Error Codes (p. 366) lists error codes associated with the datalogger file system. Errors can occur when attempting to access files on any of the available drives. All occurrences are rare, but they are most likely to occur when using the CRD: drive.

TABLE 80.   File System Error Codes

Error Code	*Description*
1	Invalid Format
2	Device capabilities error
3	Unable to allocate memory for file operation
4	Max number of available files exceeded
5	No file entry exists in directory
6	Disk change occurred

TABLE 80.   File System Error Codes

Error Code	*Description*
7	Part of the path (subdirectory) was not found
8	File at EOF
9	Bad cluster encountered
10	No file buffer available
11	Filename too long or has bad chars
12	File in path is not a directory
13	Access permission, opening DIR or LABEL as file, or trying to open file as DIR or mkdir existing file
14	Opening read only file for write
15	Disk full (can't allocate new cluster)
16	Root directory is full
17	Bad file ptr (pointer) or device not initialized
18	Device does not support this operation
19	Bad function argument supplied
20	Seek out of file bounds
21	Trying to mkdir an existing dir
22	Bad partition sector signature
23	Unexpected system ID byte in partition entry
24	Path already open
25	Access to uninitialized ram drive
26	Attempted rename across devices
27	Subdirectory is not empty
31	Attempted write to Write Protected disk
32	No response from drive (Door possibly open)
33	Address mark or sector not found
34	Bad sector encountered
35	DMA memory boundary crossing error
36	Miscellaneous I/O error
37	Pipe size of 0 requested
38	Memory release error (relmem)
39	FAT sectors unreadable (all copies)
40	Bad BPB sector
41	Time-out waiting for filesystem available
42	Controller failure error
43	Pathname exceeds _MAX_PATHNAME

Section 18. Care and Maintenance

Temperature and humidity can affect the performance of the CR1000. The internal lithium battery must be replaced periodically.

18.1 Temperature Range

The CR1000 is designed to operate reliably from -25 to +50°C (-40°C to +85°C, optional) in non-condensing environments.

18.2 Moisture Protection

When humidity tolerances are exceeded and condensation occurs, damage to CR1000 electronics can result. Effective humidity control is the responsibility of the user.

Internal CR1000 module moisture is controlled at the factory by sealing the module with a packet of silica gel inside. The desiccant is replaced whenever the CR1000 is repaired at Campbell Scientific. The module should not be opened by the user except to replace the lithium coin cell providing back up power to the clock and SRAM. Repeated disassembly of the CR1000 will degrade the seal, leading to potential moisture problems.

Adequate desiccant should be placed in the instrumentation enclosure to prevent corrosion on the CR1000 wiring panel.

18.3 Enclosures

Illustrated in *FIGURE. Enclosure* (p. 410) is a typical use of an enclosure available from Campbell Scientific for housing a CR1000 and peripherals. This style of enclosures is classified as NEMA 4X (watertight, dust-tight, corrosion-resistant, indoor and outdoor use). Refer to *APPENDIX. Enclosures* (p. 497) for information concerning available enclosures.

FIGURE 127. Enclosure

18.4 Replacing the Internal Battery

Caution Fire, explosion, and severe burn hazard! Misuse or improper installation of the lithium battery can cause severe injury. Do not recharge, disassemble, heat above 100°C (212°F), solder directly to the cell, incinerate, or expose contents to water. Dispose of spent lithium batteries properly.

The CR1000 contains a lithium battery that operates the clock and SRAM when the CR1000 is not powered. The CR1000 does not draw power from the lithium battery while it is powered by a 12 Vdc supply. In a CR1000 stored at room temperature, the lithium battery should last approximately 3 years (less at temperature extremes). In installations where the CR1000 remains powered the lithium cell should last much longer.

While powered from an external source, the CR1000 measures the voltage of the lithium battery daily. This voltage is displayed in the status table (*APPENDIX. Status Table and Settings* (p. 457)). A new battery supplies approximately 3.6 volts. The CR1000 Status Table has a "Lithium Battery" field. This field shows lithium battery voltage. Replace the battery when voltage is approximately 2.7 V. If the lithium cell is removed or allowed to discharge below the safe level, the CR1000 will still operate correctly while powered. Without the lithium battery, the clock will reset and data are lost when power is removed.

- The CR1000 is partially disassembled to replace the lithium cell. See *FIGURE. Loosening Thumbscrews* (p. 411) through *FIGURE. Remove and Replace Battery* (p. 413). When the lithium battery is removed, the user program and most settings are maintained. Items not retained include
  - Run now and run on power-up settings.
  - Routing and communications logs (relearned without user intervention).
  - Time. Clock will need resetting when the battery is replaced.
  - Final storage data tables.

A replacement lithium battery (pn 13519) can be purchased from Campbell Scientific or another supplier. *TABLE. Internal Lithium Battery Specifications* (p. 411) lists battery specifications.

TABLE 88. Internal Lithium Battery Specifications

Manufacturer	*Tadiran*
Model	TL-5902S (3.6 V)
Capacity	1.2 Ah
Self-discharge rate	1%/year @ 20°C
Operating temperature range	-55°C to 85°C

When reassembling the module to the wiring panel, assure that the module is fully seated or connected to the wiring panel by firmly pressing them together by hand.

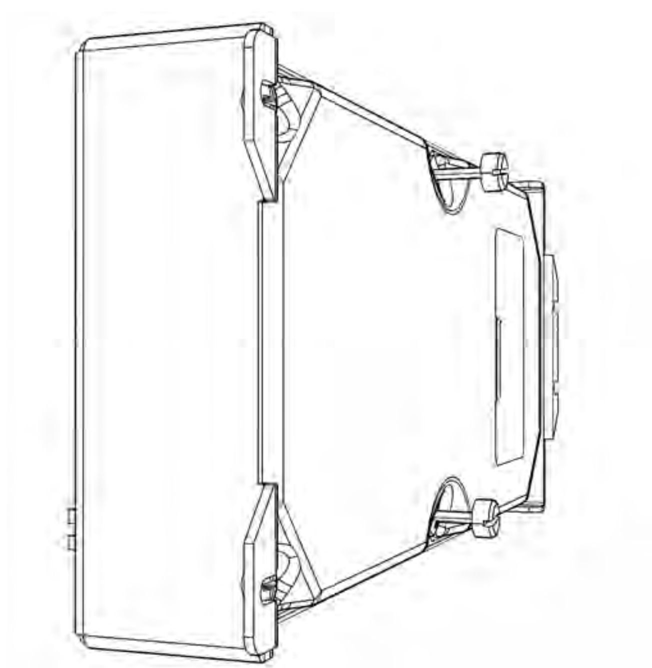

FIGURE 128. Loosening Thumbscrews

Fully loosen the two knurled thumbscrews. Only loosen the screws. They will remain attached to the module.

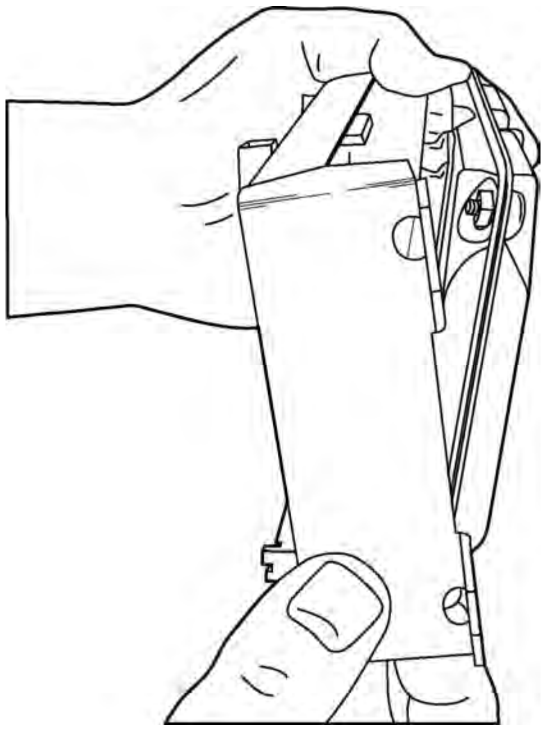

FIGURE 129. Pulling Edge Away from Panel

Pull one edge of the canister away from the wiring panel to loosen it from three connector seatings.

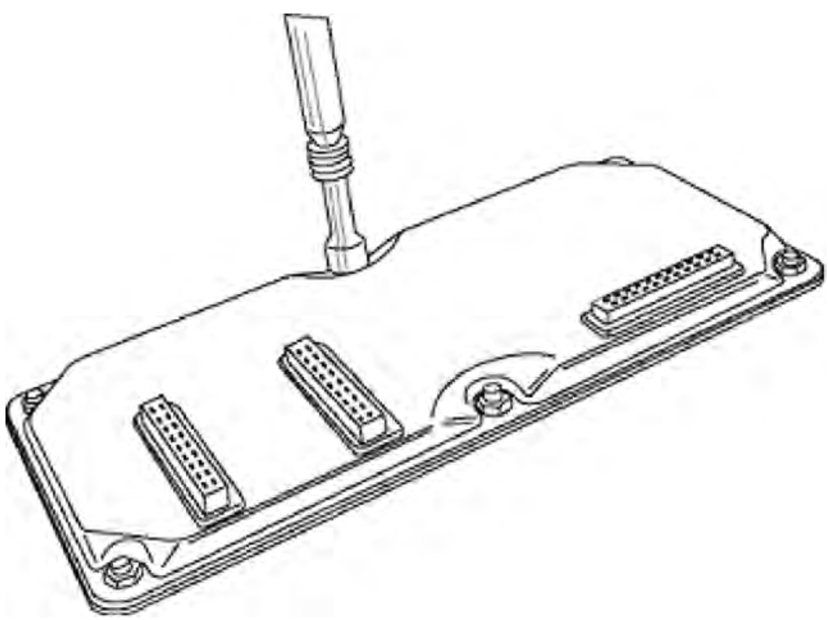

FIGURE 130. Removing Nuts to Disassemble Canister

Remove six nuts, then open the clam shell.

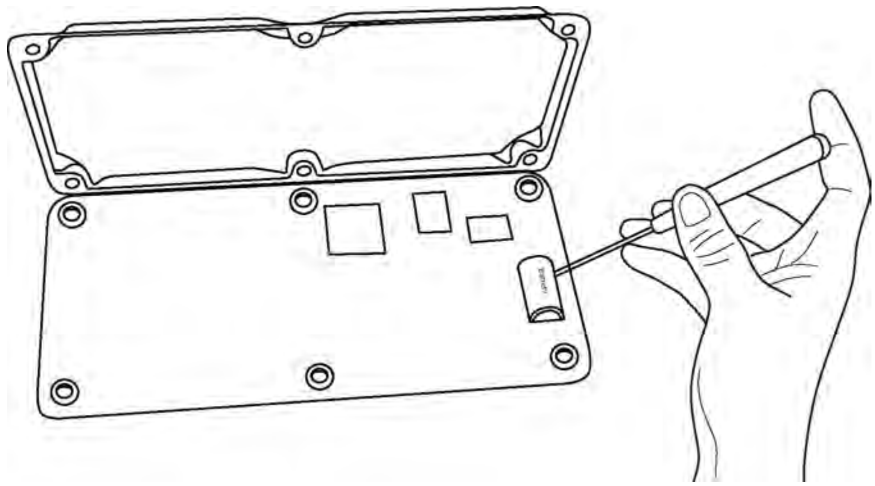

FIGURE 131. Remove and Replace Battery

Remove the lithium battery by gently prying it out with a small flat point screwdriver. Reverse the disassembly procedure to reassemble the CR1000. Take particular care to ensure the canister is reseated tightly into the three connectors.

18.5 Repair

Occasionally, a CR1000 requires repair. Consult with a Campbell Scientific applications engineer before sending any product for repair. Be prepared to perform some troubleshooting procedures while on the phone with the applications engineer. Many problems can be resolved with a telephone conversation. If a repair is warranted, the following procedures should be followed when sending the product.

Products may not be returned without prior authorization. The following contact information is for US and International customers residing in countries served by Campbell Scientific, Inc. directly. Affiliate companies handle repairs for customers within their territories. Please visit *www.campbellsci.com* to determine which Campbell Scientific company serves your country.

To obtain a Returned Materials Authorization (RMA), contact CAMPBELL SCIENTIFIC, INC., phone (435) 753-2342. After an applications engineer determines the nature of the problem, an RMA number will be issued. Please write this number clearly on the outside of the shipping container. Campbell Scientific's shipping address is:

CAMPBELL SCIENTIFIC, INC.
RMA#_____
815 West 1800 North
Logan, Utah 84321-1784

For all returns, the customer must fill out a "Declaration of Hazardous Material and Decontamination" form and comply with the requirements specified in it. The form is available from our web site at *www.campbellsci.com/repair*. A completed form must be either emailed to *repair@campbellsci.com* or faxed to 435-750-9579. Campbell Scientific will not process any returns until we receive this form. If the form is not received within three days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. Campbell Scientific reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.

Appendix A2 - CFM100 CompactFlash Module

INSTRUCTION MANUAL

CFM100 CompactFlash® Module

Revision: 6/12

WARRANTY AND ASSISTANCE

This equipment is warranted by CAMPBELL SCIENTIFIC (CANADA) CORP. ("CSC") to be free from defects in materials and workmanship under normal use and service for **twelve (12) months** from date of shipment unless specified otherwise. ***** **Batteries are not warranted.** ***** CSC's obligation under this warranty is limited to repairing or replacing (at CSC's option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CSC. CSC will return such products by surface carrier prepaid. This warranty shall not apply to any CSC products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CSC is not liable for special, indirect, incidental, or consequential damages.

Products may not be returned without prior authorization. To obtain a Return Merchandise Authorization (RMA), contact CAMPBELL SCIENTIFIC (CANADA) CORP., at (780) 454-2505. An RMA number will be issued in order to facilitate Repair Personnel in identifying an instrument upon arrival. Please write this number clearly on the outside of the shipping container. Include description of symptoms and all pertinent details.

CAMPBELL SCIENTIFIC (CANADA) CORP. does not accept collect calls.

Non-warranty products returned for repair should be accompanied by a purchase order to cover repair costs.

CAMPBELL SCIENTIFIC®

Campbell Scientific (Canada) Corp.
11564 149 Street | Edmonton AB T5M 1W7
780.454.2505 | fax 780.454.2655 | campbellsci.ca

PLEASE READ FIRST

About this manual

Please note that this manual was originally produced by Campbell Scientific Inc. (CSI) primarily for the US market. Some spellings, weights and measures may reflect this origin.

Some useful conversion factors:

Area:	1 in^2 (square inch) = 645 mm^2
Length:	1 in. (inch) = 25.4 mm 1 ft (foot) = 304.8 mm 1 yard = 0.914 m 1 mile = 1.609 km
Mass:	1 oz. (ounce) = 28.35 g 1 lb (pound weight) = 0.454 kg
Pressure:	1 psi (lb/in2) = 68.95 mb
Volume:	1 US gallon = 3.785 litres

In addition, part ordering numbers may vary. For example, the CABLE5CBL is a CSI part number and known as a FIN5COND at Campbell Scientific Canada (CSC). CSC Technical Support will be pleased to assist with any questions.

CFM100 Table of Contents

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Appendix

Figure

Table

CFM100 CompactFlash® Module

1. Introduction

Campbell Scientific's CFM100 CompactFlash® Module stores the datalogger's data on a removable CompactFlash (CF) card. The CFM100 module connects to the datalogger via the 40-pin peripheral port. Currently, only our CR1000 and CR3000 dataloggers have the 40-pin peripheral port; the CFM100 is not compatible with the CR200-series, CR800, CR850, CR5000, and CR9000X dataloggers.

Before using the CFM100, please study:

- Section 2, *Cautionary Statements*
- Section 3, *Initial Inspection*
- Section 4, *Quickstart*

The Quickstart explains how to quickly begin using a CFM100 for straightforward data storage operations. The remainder of the manual is a technical reference which describes in detail such operations as: file formats, datalogger programming and data retrieval.

2. Cautionary Statements

- The CFM100 is rugged, but it should be handled as a precision scientific instrument. There are no user-serviceable parts inside the module.
- The 28033 surge suppressor and/or a shielded 10baseT Ethernet cable should be used for locations susceptible to power surges and for cable length longer than 9 ft.
- Always power down the datalogger before installing or removing the CFM100 to/from the datalogger.
- Removing a CompactFlash card while it is active can cause garbled data and can actually damage the card. **Always** press the control button and wait for a green light before removing card.
- LoggerNet's File Control should not be used to retrieve data from a CompactFlash card. Using File Control to retrieve the data can result in a corrupted data file.

3. Initial Inspection

Upon receipt of the CFM100, inspect the packaging and contents for damage. File damage claims with the shipping company.

4 Quickstart

This section describes the basics of storing and retrieving datalogger data. These operations are discussed in detail in Section 7, *Operation* of this manual.

4.1 Preparation

CAUTION Always power down the datalogger before installing or removing the CFM100 to/from the datalogger.

After powering down the datalogger, plug the CFM100 into the datalogger peripheral port. Restore power to the datalogger. Insert formatted CF card. (For instructions on formatting a CF card, see Appendix A.)

4.2 Programming the Datalogger to Send Data to the CFM100

The **CardOut()** instruction is used in the datalogger program to send data to the CF card. The **CardOut()** instruction must be entered within each **DataTable()** declaration that is to store data to the CF card. The file is saved to the card with the name stationname.tablename and a .DAT extension.

The **CardOut()** instruction has the following parameters:

StopRing: A constant is entered for the *StopRing* parameter to specify whether the **DataTable()** created should be a Ring Mode table (0) or a Fill and Stop table (1).

Size: The *Size* parameter is the minimum number of records that will be included in the **DataTable()**. If –1000 is entered, the size of the file on the card will be the same as the size of the internal table on the datalogger. If any other negative number is entered, the memory that remains after creating any fixed-size tables on the card will be allocated to this table. If multiple DataTables are set to a negative number, the remaining memory will be divided among them. The datalogger attempts to size the tables so that all of them will be full at the same time

In the following example, the minimum batt_voltage and a sample of PTemp is written to the card each time the data table is called. The *StopRing* parameter is 0 for ring mode. This means that once the data table is full, new data will begin overwriting old data. The *size* parameter is –1, so all available space on the card will be allocated to the table.

```
DataTable(Table1,1,-1)
CardOut(0,-1)
    Minimum(1,batt_volt,FP2,0,False)
    Sample(1,PTemp,IEEE4)
EndTable
```

CAUTION To prevent losing data, collect data from the CF card before sending the datalogger a new or modified program. When a program is sent to the datalogger using the Send button in the Connect screen of LoggerNet or PC400, an attribute is sent along with the program that commands the datalogger to erase all data on the CF card from the currently running program.

4.3 Data Retrieval

Data stored on cards can be retrieved through a communication link to the datalogger or by removing the card and carrying it to a computer with a CF adapter. With large files, transferring the CF card to a computer may be faster than collecting the data over a communication link. Data retrieval is discussed in detail in Section 7.3, *Data Retrieval*.

CAUTION Removing a card while it is active can cause garbled data and can actually damage the card. **Always** press the control button and wait for a green light before removing card.

CAUTION LoggerNet's File Control should not be used to retrieve data from a CompactFlash card. Using File Control to retrieve the data can result in a corrupted data file.

5. Overview

The CFM100 connects to a datalogger's peripheral port and has a slot for a Type I or Type II CompactFlash (CF) card (3.3 V, 75 mA). The CFM100/CF card combination can be used to expand the datalogger's memory, transport data/programs from the field site(s) to the office, upload datalogger power up functions, and store JPEG images from the CC640 camera. Data stored on cards can be retrieved through a communication link to the datalogger or by removing the card and carrying it to a computer. The computer can read the CF card either with the CF1 adapter or 17752 Reader/Writer. The CF1 adapter allows the PC's PCMCIA card slot to read the CF card; the 17752 Reader/Writer allows the PC's USB port to read the CF card. User-supplied CF adapters may also be used.

CAUTION LoggerNet's File Control should not be used to retrieve data from a CompactFlash card. Using File Control to retrieve the data can result in a corrupted data file.

FIGURE 5-1. CompactFlash Module

5.1 LEDs/Buttons

There is one red-green-orange LED (light emitting diode) and two buttons: control and eject. The LED indicates the status of the module. The LED will flash red when the CF card is being accessed, solid green when it is OK to remove the card, solid orange to indicate an error, and flashing orange if the card has been removed and has been out long enough that CPU memory has wrapped and data is being overwritten without being stored to the card. The control button must be pressed before removing a card to allow the datalogger to store any buffered data to the card and then power it off.

NOTE The CFM100 will consume more current if a Status LED is continuously on. When a red or green LED is continuously on, add 1 mA to the power consumption. When an orange LED is continuously on, add 2 mA to the power consumption.

5.2 Power

5.2.1 Primary Power

The CompactFlash module is powered by 12 VDC received from the datalogger through the peripheral port.

5.2.2 Backup Power and Data Retention

The CompactFlash (CF) cards do not require power to retain data.

Typically, a CF card can be erased and rewritten a minimum of 100,000 times. Industrial CF cards, graded for 2,000,000 write cycles, are recommended for most applications.

6. Specifications

Storage Capacity:	Depends on card size (up to 2 GB supported)
Dimensions:	10.0 x 8.3 x 6.5 cm (4.0 in x 3.3 in x 2.6 in)
Weight:	132.5 g
Operating Temp. Range:	-35° to +65°C (-55° to +85°C optional)
Typical Access Speed:	200 to 400 kbits s^{-1}
Memory Configuration:	User selectable for either ring style (default) or fill and stop.

6.1 Power

The CFM100 receives 12 V power from the datalogger through the peripheral port. The following currents are for the CR1000 with the CFM100 attached and can vary with the card.

Writing to card with RS-232 port active:	30 mA (avg.)
Reading from card with RS-232 port active:	20 mA (avg.)
Writing to card with RS-232port not active:	20 mA (avg.)
Reading from card with RS-232 port not active:	15 mA (avg.)
Low Power Standby State:	700 to 800 µA
Red or green LED continuously on:	Add 1 mA to current drain
Orange LED continuously on:	Add 2 mA to current drain

7. Operation

7.1 File Formats

This section covers the different types of files stored on the CF card

7.1.1 Data Files

The datalogger stores data on the CF card in TOB3 Format. TOB3 is a binary format that incorporates features to improve reliability of the CF cards. TOB3 allows the accurate determination of each record's time without the space required for individual time stamps.

TOB3 format is different than the data file formats created when data are collected via a communications link. Data files read directly from the CF card generally need to be converted into another format to be used

When TOB3 files are converted to another format, the number of records may be slightly greater or less than the number requested in the data table declaration. There is always some additional memory allocated. When the file is converted this will result in additional records if no lapses occurred. If more lapses occur than were anticipated, there may be fewer records in the file than were allocated.

The CardConvert software included in LoggerNet, PC400, and PC200 will convert data files from one format to another.

7.1.2 Program Files

The CF card can be used to provide extra program storage space for the datalogger. Program files can be copied to the card while it is attached as a drive on the computer. They can also be sent to the card using LoggerNet's File Control. They may also be copied from CPU memory to the card (or from the card to CPU memory) using the keyboard display.

7.1.3 Power-up Files (powerup.ini)

Users can insert a properly-configured CF card into the CFM100, cycle through the datalogger power, and have power up functions automatically performed.

Power-up functions of CompactFlash® cards can include

a) Sending programs to the CR1000 or CR3000
b) Setting attributes of datalogger program files
c) Setting disposition of old CF files
d) Sending an OS to the CR1000 or CR3000
e) Formatting memory drives
f) Deleting data files

CAUTION Test the power-up functions in the office before going into the field to ensure the power-up file is configured correctly.

The key to the CF power-up function is the powerup.ini file, which contains a list of one or more command lines. At power-up, the powerup.ini command line is executed prior to compiling the program. Powerup.ini performs three operations:

1) Copies the specified program file to a specified memory drive.

2) Sets a file attribute on the program file

3) Optionally deletes CF data files from the overwritten (just previous) program.

Powerup.ini takes precedence during power-up. Though it sets file attributes for the programs it uploads, its presence on the CF does not allow those file attributes to control the power-up process. To avoid confusion, either remove the CF card or delete the powerup.ini file after the powerup.ini upload.

7.1.3.1 Creating and Editing Powerup.ini

Powerup.ini is created with a text editor, then saved as "powerup.ini".

NOTE Some text editors (such as WordPad) will attach header information to the powerup.ini file causing it to abort. Check the text of a powerup.ini file with the datalogger keyboard display to see what the datalogger actually sees.

Comments can be added to the file by preceding them with a single-quote character ('). All text after the comment mark on the same line is ignored.

Syntax
Syntax allows functionality comparable to File Control in LoggerNet. Powerup.ini is a text file that contains a list of commands and parameters. The syntax for the file is:

Command,File,Device

where

Command = one of the numeric commands in Table 7.1-1.
File = file on CF associated with the action. Name can be up to 22 characters.
Device = the device to which the associated file will be copied to. Options are CPU:, USR:, and CRD:. If left blank or with invalid option, will default to CPU:.

TABLE 7.1-1. Powerup.ini Commands

Command	Description
1	Run always, preserve CF data files
2	Run on power-up
5	Format
6	Run now, preserve CF data files
9	Load OS (File = .obj)
13	Run always, erase CF data files now
14	Run now, erase CF data files now

By using **PreserveVariables()** instruction in the datalogger CRBasic program, with options 1 and 6, data and variables can be preserved.

EXAMPLE 7.1-1. Powerup.ini code.

```
'Command = numeric power-up command
'File = file on CF associated with the action
'Device = the device to which File will be copied.  Defaults to CPU:

'Command,File,Device
13,Write2CRD_2.cr1,CPU:
```

7.1.3.2 Applications

- Commands 1, 2, 6, 13, and 14 (Run Now and / or Run On Power-up). If a device other than CRD: drive is specified, the file will be copied to that device.

- Command 1, 2, 13 (Run On Power-up). If the copy (first application, above) succeeds, the new Run On Power-up program is accepted. If the copy fails, no change will be made to the Run On Power-up program.

- Commands 1, 6, 13, and 14 (Run Now). The Run Now program is changed whether or not the copy (first application, above) occurs. If the copy does succeed, the Run Now program will be opened from the device specified.

- Commands 13 and 14 (Delete Associated Data). Since CRD:powerup.ini is only processed at power-up, there is not a compiled program to delete associated data for. The information from the last running program is still available for the datalogger to delete the files used by that program.

7.1.3.3 Program Execution

After File is processed, the following rules determine what datalogger program to run:

1) If the Run Now program is changed then it will be the program that runs.
2) If no change is made to Run Now program, but Run on Power-up program is changed, the new Run on Power-up program runs.
3) If neither Run on Power-up nor Run Now programs are changed, the previous Run on Power-up program runs.

7.1.3.4 Example Power-up.ini Files

Example 7.1-2 through Example 7.1-7 are example powerup.ini files.

EXAMPLE 7.1-2. Run Program on Power-up.

```
'Copy pwrup.cr1 to USR:, will run only when powered-up later
2,pwrup.cr1,usr:
```

EXAMPLE 7.1-3. Format the USR: drive.

```
'Format the USR: drive
5,,usr:
```

EXAMPLE 7.1-4. Send OS on Power-up.

```
'Load this file into FLASH as the new OS
9,CR1000.Std.04.obj
```

EXAMPLE 7.1-5. Run Program from CRD: drive.

```
'Leave program on CRD:, run always, erase CRD: data files
13,toobigforcpu.cr1,crd:
```

EXAMPLE 7.1-6. Run Program Always, Erase CF data.

```
'Run always, erase CRD: data files
13,pwrup_1.cr1,crd
```

EXAMPLE 7.1-7. Run Program Now, Erase CF data.

```
'Copy run.cr1 to CPU:, erase CF data, run CPU:run.cr1, but not if later powered-up
14,run.cr1,cpu:
```

7.1.4 Camera Files

JPEG images taken by a digital camera connected to the datalogger can be stored to the CF card rather than CPU memory. This is done by configuring the PakBus setting “Files Manager” for the datalogger. This can be done using the Device Configuration Utility or PakBus Graph.

7.2 Programming

7.2.1 The CardOut() Instruction

The **CardOut()** Instruction is used to send data to a CF card. The **CardOut()** Instruction must be entered within each **DataTable** declaration that is to store data to the CF card. Data is stored to the card when a call is made to the data table.

CardOut(*StopRing, Size***)**

Parameter *& Data Type*	**Enter**
StopRing *Constant*	A code to specify if the Data Table on the CF card is fill and stop or ring (newest data overwrites oldest). **Value** | **Result** 0 | Ring 1 | Fill and Stop
Size *Constant*	The size to make the data table. The number of data sets (records) for which to allocate memory in the CF card. Each time a variable or interval trigger occurs, a line (or row) of data is output with the number of values determined by the Output Instructions within the table. This data is called a record.
	Note Enter –1000 and the size of the table on the card will match the size of the internal table on the datalogger Enter any other negative number and all remaining memory (after creating any fixed size data tables) will be allocated to the table or partitioned among all tables with a negative value for size. The partitioning algorithm attempts to have the tables full at the same time.

7.2.2 Program Examples

7.2.2.1 Ring Mode

The following program outputs the maximum and minimum of the panel temperature to the card once a second. The first parameter of the **CardOut()** instruction is 0, which sets the table on the card to ring mode. The second parameter is negative, so all available memory on the card will be allocated to the data table. Once all available memory is used, new data will begin overwriting the oldest data.

PROGRAM

```
'CR1000

Public temp

DataTable (Table1,1,-1)
    CardOut (0, -1)
    Maximum (1,temp,FP2,False,False)
    Minimum (1,temp,FP2,False,False)
EndTable

BeginProg
    Scan(1,SEC,3,0)
        PanelTemp(temp,250)
        CallTable Table1
    NextScan
EndProg
```

7.2.2.2 Fill and Stop Mode

The following program outputs a sample of the panel temperature to the card once a second. The first parameter of the **CardOut()** instruction is 1, which sets the table on the card to fill and stop mode. The second parameter (1000) is the number of records which will be written before the table is full and data storage stops. Once 1000 records have been stored, data storage will stop.

PROGRAM

```
'CR1000

Public temp

DataTable (Table1,1,1000)
    CardOut (1,1000)
    Sample(1,temp,IEEE4)
EndTable

BeginProg
    Scan(1,SEC,3,0)
        PanelTemp(temp,250)
        CallTable Table1
    NextScan
EndProg
```

To reset a table after a fill and stop table has been filled and stopped, either use the reset button in LoggerNet (LN Connect | Datalogger | View Station Status | Table Fill Times, Reset Tables button) or use the CRBasic **ResetTable** instruction.

7.2.2.3 Mixed Modes

The following program stores four data tables to the card. The first two tables will output samples of the panel temperature and battery voltage to the card once a second. The first parameter of the **CardOut()** instructions is 1, which sets the tables on the card to fill and stop mode. The second parameter is 1000, so 1000 records will be written to each table before stopping.

Tables 3 and 4 will output the maximum and minimum of the panel temperature and battery voltage to the card once every five seconds. (The tables will be called once a second. The **DataInterval()** instruction causes data to only be stored every five seconds.) The first parameter of the **CardOut()** instructions is 0, which sets the tables on the card to ring mode. The second parameter is negative, so all available memory on the card will be allocated to these tables, once space for the fixed-size tables has been allocated. The datalogger will attempt to size the tables so that both of them will be full at the same time.

PROGRAM

```
'CR1000

Public temp
Public batt

DataTable (Table1,1,-1)
      CardOut (1,1000)
      Sample(1,temp,IEEE4)
EndTable

DataTable (Table2,1,-1)
      CardOut (1,1000)
      Sample(1,batt,IEEE4)
EndTable

DataTable (Table3,1,1000)
      DataInterval(0,5,sec,4)
      CardOut (0 ,-1)
      Maximum (1,temp,FP2,False,False)
      Minimum (1,temp,FP2,False,False)
EndTable

DataTable (Table4,1,1000)
      DataInterval(0,5,sec,4)
      CardOut (0 ,-1)
      Maximum (1batt,FP2,False,False)
      Minimum (1,batt,FP2,False,False)
EndTable
```

```
BeginProg
    Scan(1,SEC,3,0)
        PanelTemp(temp,250)
        Battery(Batt)
        CallTable Table1
        CallTable Table2
        CallTable Table3
        CallTable Table4
    NextScan
EndProg
```

7.2.3 Table Size and Mode

The size of each data table in CPU memory is set as part of the **DataTable()** instruction and the size of each data table on the CF card is set with the **CardOut()** instruction. Because they are set independently, they can be different. It is important to note that if the CPU memory is set to fill and stop mode, once a table is full, all data storage to the table will stop. No more records will be stored to the CPU memory or the card.

7.3 Data Retrieval

Data stored on CF cards can be retrieved through a communication link to the datalogger or by removing the card and carrying it to a computer.

7.3.1 Via a Communication Link

Data can be transferred to a computer via a communications link using one of Campbell Scientific's datalogger support software packages (e.g., PC200, PC400, LoggerNet). There is no need to distinguish whether the data is to be collected from the CPU memory or a CF card. The software package will look for data in the CPU memory and then the CF card.

The datalogger manages data on a CF card as final storage table data, accessing the card as needed to fill data collection requests initiated with the Collect button in datalogger support software. If desired, binary data can be collected using the File Control utility in datalogger support software. Before collecting data this way, stop the datalogger program to ensure data are not written to the CF card while data are retrieved. Otherwise, data corruption and confusion will result.

7.3.2 Transporting CF Card to Computer

With large files, transferring the CF card to a computer may be faster than collecting the data over a link.

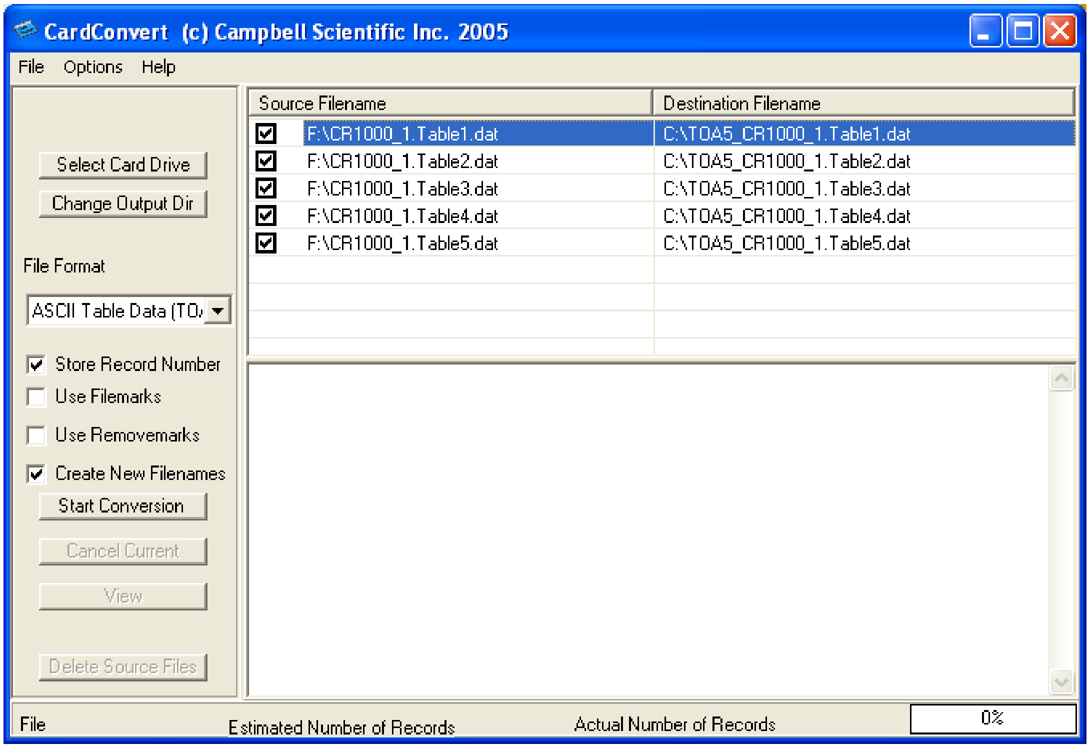
CAUTION Removing a card while it is active can cause garbled data and can actually damage the card. Do not switch off the CR1000 power if a card is present and active.

To remove a card, press the control button on the CFM100. The CR1000 or CR3000 will transfer any buffered data to the card and then power off. The Status LED will turn green when it is OK to remove the card. The card will be reactivated after 20 seconds if it is not removed.

When the CF card is inserted in a computer, the data files can be copied to another drive or used directly from the CF card just as one would from any other disk. In most cases, however, it will be necessary to convert the file format before using the data.

7.3.2.1 Converting File Formats

Files can be converted using LoggerNet's CardConvert. Begin by using "Select Output Drive" to indicate where the files to be converted are stored. Then use "Change Output Dir" to choose where you would like the converted files to be stored. Place check marks next to the files to be converted. A default destination filename is given. It can be changed by right-clicking with the filename highlighted. Use the drop-down to select what file format to convert to. Then press "Start Conversion" to begin converting files. Green checkmarks will appear next to each filename as conversion is complete.



7.3.2.2 Reinserting the Card

If the same card is inserted again into the CFM100, the datalogger will store all data to the card that has been generated since the card was removed that is still in the CPU memory. If the data tables have been left on the card, new data will be appended to the end of the old files. If the data tables have been deleted, new ones will be generated.

NOTE Check the status of the card before leaving the datalogger. If a CF card was not properly accepted, the CFM100 will flash orange. In that case, the user needs to reformat and erase all data contained on the CF card. Formatting or erasing a CF card might be done on a PC or datalogger. The procedure for formatting a CF card is explained in Section OV5 of the CR1000 and CR3000 manuals.

7.3.2.3 Card Swapping

When transporting a CF card to a computer to retrieve data, most users will want to use a second card to ensure that no data is lost. For this method of collection, use the following steps.

1. Insert formatted card ("CF-A") in CFM100 attached to datalogger.

2. Send program containing **CardOut()** instruction(s).

3. When ready to retrieve data, press CFM100 button to remove card. LED will show red while the most current data is stored to the card and then go green. Eject card, while LED is green.

4. Put in clean card ("CF-B").

5. Use CardConvert to copy data from CF-A to PC and convert. The default CardConvert filename will be TOA5_*stationname*_*tablename*.dat Once the data is copied, use Windows Explorer to delete all data files from the card. NOTE: Windows98 and WindowsME users need to shift-delete to completely delete files. Using standard delete may create an invisible recycle bin on the CF card.

6. At the next card swap, eject CF-B and insert the clean CF-A.

7. Running CardConvert on CF-B will result in separate data files containing records since CF-A was ejected. CardConvert can increment the filename to TOA5_*stationname*_*tablename*_0.dat.

8. The data files can be joined using a software utility such as WordPad or Excel.

CardConvert File	CF-A Record Numbers	CF-B Record Numbers
TOA5_*tablename*.dat	0-100	
TOA5_*tablename*.dat		101-1234
TOA5_*tablename*.dat	1235-….	

Appendix A. Formatting CF Card

The CF card can be formatted using 1) Windows Explorer, 2) the CR1000KD or 3) LoggerNet File Control.

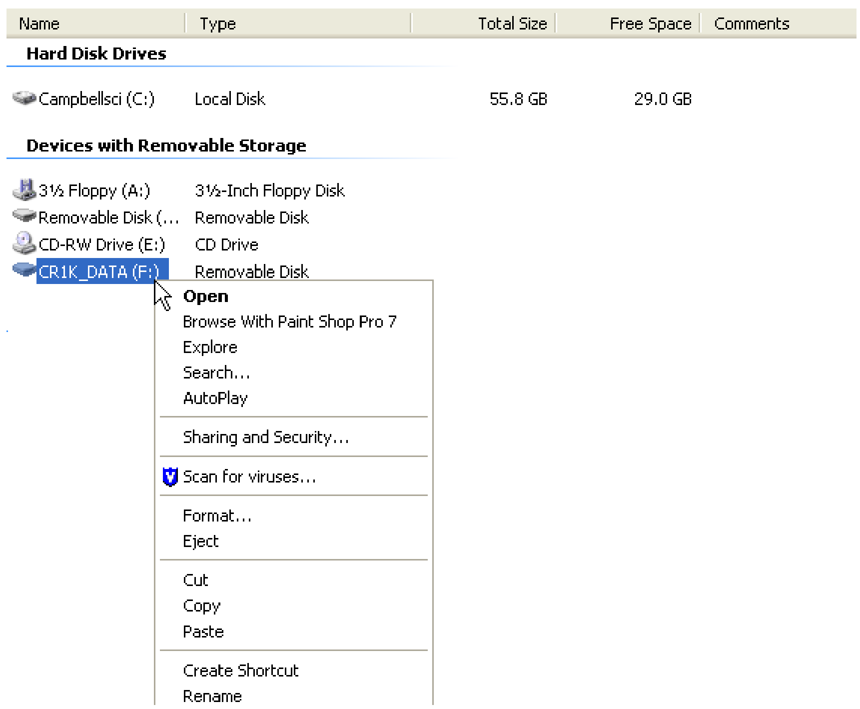
A.1 Windows Explorer

To format card using Windows Explorer:

1) Insert CF card into CF adapter or CF reader.

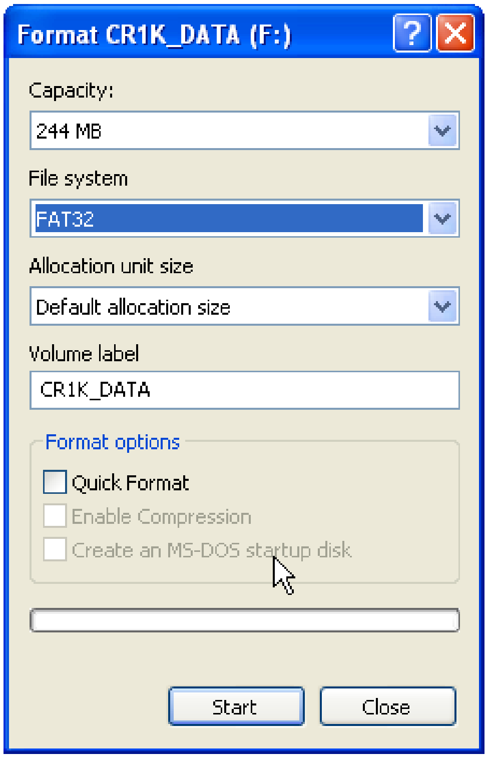
2) Windows Explorer should identify a drive as a removable disk (F:\).

3) Select that drive and right click.



4) Choose Format.

5) Choose FAT32 under file system, give the card a label, then Start. (The CR1000 will work with either FAT or FAT 32.)



A.2 CR1000KD

To format card using the CR1000KD:

1) Insert CF card into CFM100.

2) From Main Menu of CR1000KD, choose PCCard.

3) Choose Format Card..

4) Choose Yes to proceed.

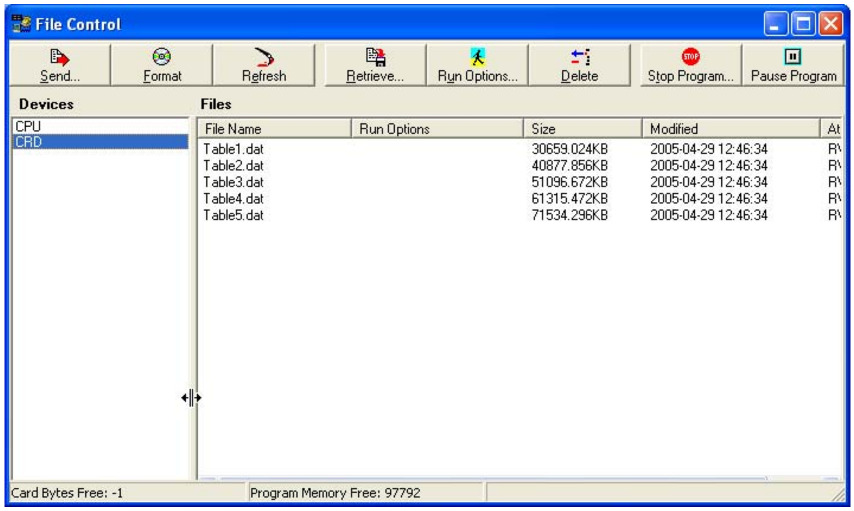
A.3 LoggerNet File Control

To format card using LoggerNet File Control:

1) Insert CF card into CFM100.

2) Use LoggerNet to connect to datalogger

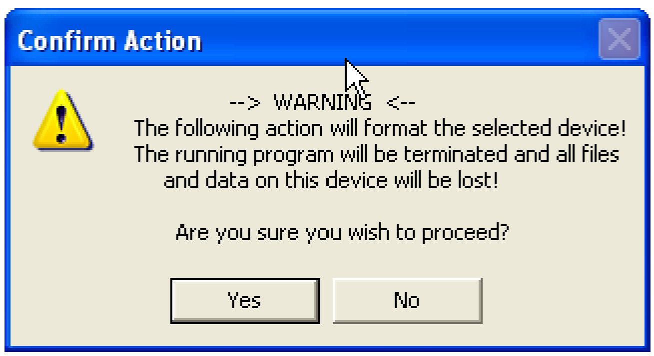
3) Choose FileControl under the Tools menu of the Connect screen.



4) Highlight CRD.

5) Press Format.

6) Press Yes to confirm.



Campbell Scientific Companies

Campbell Scientific, Inc. (CSI)
815 West 1800 North
Logan, Utah 84321
UNITED STATES
www.campbellsci.com • info@campbellsci.com

Campbell Scientific Africa Pty. Ltd. (CSAf)
PO Box 2450
Somerset West 7129
SOUTH AFRICA
www.csafrica.co.za • cleroux@csafrica.co.za

Campbell Scientific Australia Pty. Ltd. (CSA)
PO Box 8108
Garbutt Post Shop QLD 4814
AUSTRALIA
www.campbellsci.com.au • info@campbellsci.com.au

Campbell Scientific do Brazil Ltda. (CSB)
Rua Luisa Crapsi Orsi, 15 Butantã
CEP: 005543-000 São Paulo SP BRAZIL
www.campbellsci.com.br • suporte@campbellsci.com.br

Campbell Scientific Canada Corp. (CSC)
11564 - 149th Street NW
Edmonton, Alberta T5M 1W7
CANADA
www.campbellsci.ca • dataloggers@campbellsci.ca

Campbell Scientific Centro Caribe S.A. (CSCC)
300 N Cementerio, Edificio Breller
Santo Domingo, Heredia 40305
COSTA RICA
www.campbellsci.cc • info@campbellsci.cc

Campbell Scientific Ltd. (CSL)
Campbell Park
80 Hathern Road
Shepshed, Loughborough LE12 9GX
UNITED KINGDOM
www.campbellsci.co.uk • sales@campbellsci.co.uk

Campbell Scientific Ltd. (France)
3 Avenue de la Division Leclerc
92160 ANTONY
FRANCE
www.campbellsci.fr • info@campbellsci.fr

Campbell Scientific Spain, S. L.
Avda. Pompeu Fabra 7-9, local 1
08024 Barcelona
SPAIN
www.campbellsci.es • info@campbellsci.es

Please visit www.campbellsci.com to obtain contact information for your local US or international representative.

Appendix A3 - Digital Inclinometer Probe

Digitilt Inclinometer Probe

Applications

Digitilt® inclinometers are used to monitor subsurface movements of earth in landslide areas and deep excavations. They are also used to monitor deformations in structures such as dams and embankments.

Operation

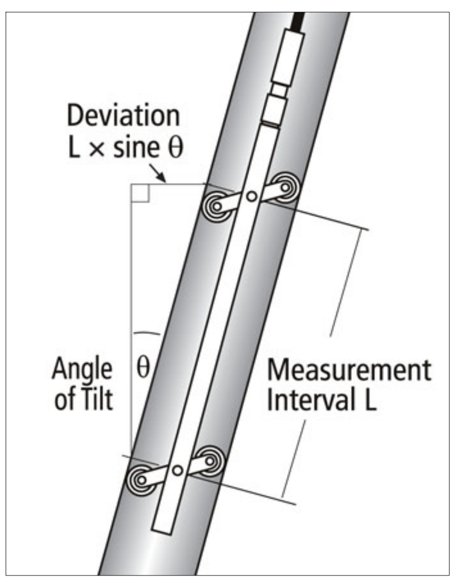
Inclinometer casing is typically installed in a vertical borehole that passes through suspected zones of movement into stable ground. The Digitilt inclinometer probe, control cable, pulley assembly, and readout are used to survey the casing. The first survey establishes the initial profile of the casing. Subsequent surveys reveal changes in the profile if ground movement occurs.

During a survey, the probe is drawn upwards from the bottom of the casing to the top, halted in its travel at 0.5 m or 2' intervals for tilt readings.

The inclination of the probe body is measured by two force-balanced, servo-accelerometers. One accelerometer measures tilt in the plane of the inclinometer wheels, which track the longitudinal grooves of the casing. The other accelerometer measures tilt in the plane perpendicular to the wheels.

Inclination measurements are converted to lateral deviations, as shown in the drawing below. Changes in deviation, determined by comparing current and initial surveys, indicate ground movement.

Plotting changes in deviation yields a high resolution displacement profile. Displacement profiles are useful for determining the magnitude, depth, direction, and rate of ground movement.



Advantages

Proven Performance: Digitilt inclinometer probes have earned a world-wide reputation for durability, high precision, and rapid response.

Repeatable Tracking: To ensure consistent tracking in all types of casing, the probe is equipped with robust wheel carriages, sealed wheel bearings, and specially designed wheels.

Extended Installation Life: The compact size of the Digitilt probe allows it to pass through small radius curves, extending the useful life of the installation beyond that provided by other inclinometer probes.

Computerized Testing: Each probe undergoes thorough testing on a computerized calibration table.

Reliable Control Cable: Digitilt control cable is durable and easy to handle, stays flexible in cold weather, resists chemicals and abrasion, and provides excellent dimensional stability. Flexible rubber depth marks are permanently vulcanized to the cable jacket. The marks cannot loosen and have no rigid edges that can damage the cable jacket and conductors.

Consistent Depth Control: The pulley assembly, a recommended accessory, helps the operator achieve uniform depth control. The one-way action of its cable clamp ensures consistent positioning of the probe.

Complete Solutions: Slope Indicator's inclinometer system includes high-quality casing, vertical and horizontal traversing probes, vertical and horizontal in-place sensors, recording readouts, graphing software, and specialized accessories.

DIGITILT INCLINOMETER PROBE

Metric-Unit Probe 50302510
English-Unit Probe 50302500

Digitilt inclinometer probe includes a carrying case and instruction manual. Control cable, pulley, and readout are not included.

METRIC PROBE SPECIFICATIONS

Wheel base: 500 mm.
Range: ±53° from vertical.
Resolution: 0.02 mm per 500 mm.
Repeatability: ±0.01% FS.
Calibration: 14 point calibration with NIST traceable calibration device.
Temperature Rating: -20 to +50 °C.
Dimensions: 25.4 x 653 mm. Control cable connector adds 92 mm to length of probe.
Weight: 1.8 kg.
Material: Stainless steel.

ENGLISH PROBE SPECIFICATIONS

Wheel base: 24".
Range: ±35° from vertical.
Resolution: 0.0012 inch per 24 inches.
Repeatability: ±0.01%FS.
Calibration: 14 point calibration with NIST traceable calibration device.
Temperature Rating: -4 to +122 °F.
Dimensions: 1 x 30". Control cable connector adds 3.75"to length of probe.
Weight: 4 lb.
Material: Stainless steel.

ACCURACY SPECIFICATIONS

Metric Systems: ±0.25 mm per reading and ±6 mm per 50 readings.

English Systems: ±0.01 inch per reading and ±0.3 inch per 50 readings.

These system accuracy specifications were derived empirically from the analysis of a large number of surveys and include both random and systematic errors introduced by casing, probe, cable, readout, and operator. Casing was installed within 3 degrees of vertical, and operators followed recommended reading practices.

When corrections for systematic error are made, the remaining error is random. It accumulates with the square root of the number of readings. Thus the best precision obtainable with a metric system is approximately ±1.4 mm per fifty readings, and the best precision of an English unit system is approximately ±0.05 inch per fifty readings.

CONTROL CABLE

30m Control Cable, Complete . . . 50601030
50m Control Cable, Complete . . . 50601050
100m Control Cable, Complete . . 50601100

100 ft Control Cable, Complete . . 50601002
150 ft Control Cable, Complete . . 50601003
300 ft Control Cable, Complete . . 50601004

Metric Cable, Custom Length. . . . 50601010
English Cable, Custom Length . . . 50601000
Connector for Readout 50301800
Connector for Probe. 50303100

Control cables listed as complete are standard lengths of cable and include connectors. If you order a custom length cable, you must also order connectors.

Control cable is supplied with no splices or surface defects and has a rated strength of 480 lb and a working strength of 120 lb.

Metric cable is graduated with yellow 0.5-meter marks and red 1-meter marks. English cable is graduated with yellow 2-foot marks and red 10-foot marks.

Cable has a steel core wire to control stretching, a dacron torsion braid to counter cable torque and eliminate slipping of cable jacket relative to the steel core, and depth marks that are molded onto the cable jacket. The Santoprene cable jacket resists chemicals and abrasions and stays flexible in cold temperatures.

PULLEY ASSEMBLY

Small Pulley 51104604
Large Pulley 51104606

Pulley assembly clamps onto top of casing to help operator control depth of probe. Cable clamp serves as reference for depth marks. Clamp is made of carbon-fiber and does not freeze in cold weather. Removable pulley wheel facilitates insertion of probe into casing.

Use small pulley with 48 or 70 mm (1.9 or 2.75") casing. Use large pulley with 70 or 85mm (2.75 or 3.34") casing.

READOUTS

Digitilt DataMate II. 50310900

The Digitilt DataMate II is a recording readout. The Digitilt 09 is a manual readout. See separate data sheets for details.

DUMMY PROBE

Metric Wheel Base 50304810
English Wheel Base 50304800
Reel & Line for Dummy Probe 50304900

Dummy probe is used to test for casing continuity, groove continuity, and obstructions or severe distortions of casing that could hinder retrieval of Digitilt probe and control cable. Dummy probe is stainless steel and has dimensions and wheels identical to those of Digitilt probe.

Reel with 60 m (200') of nylon line is used to lower and retrieve dummy probe.

SLIP-RING REEL

200 m (650') capacity 50503100
300 m (1150') capacity 50503300

Slip-ring cable reel allows the readout to remain connected while the reel is operated. Includes jumper cable to connect reel to readout.

STORAGE REEL

30m (100') capacity. 50502030
70 m (230') capacity 50502050
100 m (360') capacity 50502110

Sturdy storage reel with large diameter hub keeps cable neat when not in use.

Note: The use of reels is optional. Cable can also be stored in a figure-8 or using the over-under method of coiling cable, as presented in the manual. If you choose to use a reel, be sure that the hub of the reel has a diameter of eight inches or larger (as do the reels above). Power reels should be sixteen inches or larger.

Durham Geo Slope Indicator, 12123 Harbour Reach Drive, Mukilteo, WA, 98275 USA
Tel: 425-493-6200 Tel: 866-916-0541 Fax: 425-493-6250 Email: solutions@slope.com

Digitilt Inclinometer Probe 50302599

This equipment should be installed, maintained, and operated by technically qualified personnel. Any errors or omissions in data, or the interpretation of data, are not the responsibility of Durham Geo-Enterprises, Inc. The information herein is subject to change without notification.

SLOPE INDICATOR
12123 Harbour Reach Drive
Mukilteo, Washington, USA, 98275
Tel: 425-493-6200 Fax: 425-493-6250
E-mail: solutions@slope.com
Website: www.slopeindicator.com

NOVA METRIX

Contents

Introduction

Inclinometer System

An inclinometer system includes inclinometer casing, an inclinometer probe and control cable, and an inclinometer readout unit.

Inclinometer casing is typically installed in a near-vertical borehole that passes through a zone of suspected movement. The bottom of the casing is anchored in stable ground.

The inclinometer probe is used to survey the casing and establish its initial position. Ground movement causes the casing to move away from its initial position. The rate, depth, and magnitude of this movement is calculated by comparing data from the initial survey to data from subsequent surveys.

This Manual

This manual addresses the use and maintenance of the inclinometer probe and control cable. It also provides an overview of taking readings and reducing data.

Other manuals cover casing installation, inclinometer readouts, and software for reducing data.

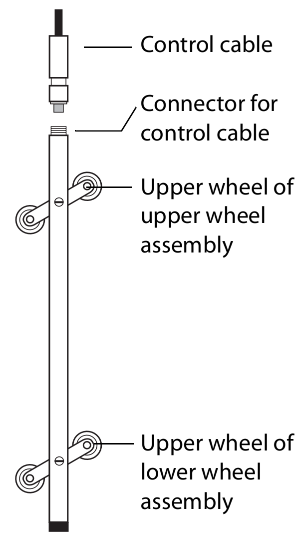
The Inclinometer Probe

Parts of the Probe

The inclinometer probe consists of a stainless steel body, a connector for control cable, and two pivoting wheel assemblies.

When properly connected to the control cable, the probe is waterproof and has been used deeper than 1000 feet.

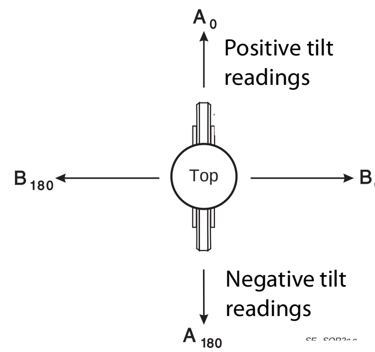
The wheel assemblies consists of a yoke and two wheels. One of the wheels in each assembly is higher than the other. This wheel is called the "upper wheel" and has special significance, as explained below.



Measurement Planes

The inclinometer probe employs two force-balanced servo-accelerometers to measure tilt. One accelerometer measures tilt in the plane of the inclinometer wheels. This is the "A"axis. The other accelerometer measures tilt in the plane that is perpendicular to the wheels. This is the "B" axis.

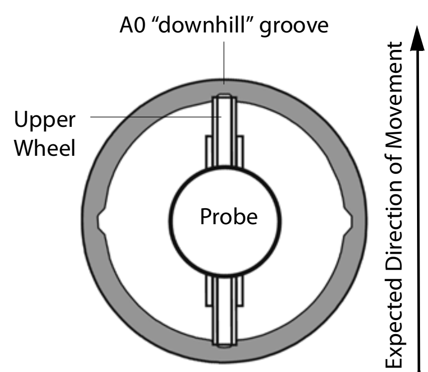
The drawing at right shows the probe from the top. When the probe is tilted toward the A0 or B0 direction, readings are positive. When the probe is tilted in the A180 or B180 directions, readings are negative.



Orientation of the Probe

Inclinometer casing is installed so that one set of grooves is aligned with the expected direction of movement. One groove, typically the "downhill" groove should be marked A0.

In a standard inclinometer survey, the probe is drawn from the bottom to the top of the casing two times. In the first pass, the upper wheels of the probe should be inserted into the A0 groove. This ensures that movements are positive values.



Always start surveys with upper wheel in A0 groove.

Handling the Probe

The inclinometer probe is a sensitive measuring instrument. Handle it with care.

- Transport the probe in its carrying case. If you drive to the site, carry the casing in the passenger compartment, preferrably on a passenger seat.
- When you connect control cable to the probe, avoid overtightening the nut, since this will flatten the O-ring and reduce its effectiveness.
- Before you lower the probe into the casing, turn the power on.
- When you insert the probe into the casing, cup the wheels with your hands to compress the springs and allow smooth insertion.
- When you lower the probe into the borehole, do not allow it to strike the bottom.
- When you withdraw the probe from the casing, again cup the wheels with your hands to prevent them from snapping out.
- When you rotate the probe, keep it upright and perform the rotation smoothly.
- The probe is rated for temperatures from -20 to 50 °C (-4 to 122 °F). Avoid using the probe in temperatures outside this range.

Caring for the Probe

This is an overview. See the last chapter, Inspection and Maintenance, for additional information.

Cleaning the Probe: When you finish a survey, wipe moisture off the probe and replace the protective cap. If necessary, rinse the probe in clean water or wash it with a laboratory grade detergent when you return to the office.

Cleaning the Connectors: Do not clean connectors with spray lubricants or electrical contact cleaners. Solvents in these products will attack the neoprene inside the connector. When it is necessary to clean the connectors, use a cotton swab slightly moistened with alcohol. Be careful to use only a small amount of alcohol.

Drying the Probe: When you return to the office, remove protective caps from the control cable, probe, and readout unit. Allow connectors to air-dry thoroughly for a number of hours. Afterwards, replace the caps.

Storing the Probe: The probe, control cable, and readout unit should be stored in a dry place. For extended storage, keep the probe in a vertical position.

Lubricating the Wheels: Lubricate the wheels regularly. Spray a small amount of lubricant or place a drop of oil on both sides of the wheel bearings. Check that the wheels turn smoothly.

O-Ring Care: Periodically clean and lubricate the O-ring on the connector end of the inclinometer probe. Use O-ring lubricant.

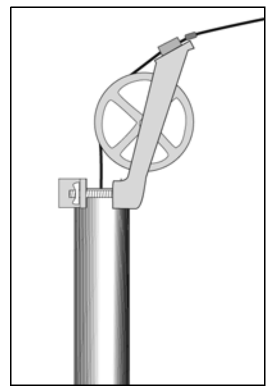
Control Cable

Introduction

Control cable is used to control the depth of the inclinometer probe. It also conducts power to the probe and returns signals to the readout.

- Metric control cables are graduated with yellow marks at 0.5 meter intervals and red marks at 1-meter intervals. There are numeric marks at 5-meter intervals.
- English control cables are graduated with yellow markers at 2-foot intervals and red marks at 5-foot intervals. There are numeric marks at 50-foot intervals. In addition, there are yellow bands of tape at 10 foot intervals. Each band represents 10 feet from the last numeric mark. For example, 4 bands represent 40 feet from the last numeric depth mark.

Depth Control



Accurate inclinometer measurements depend on consistent placement of the inclinometer probe. Always align the depth marks on the control cable with the same reference. Aim for placement repeatability of 6 mm (1/4 inch) or better.

We recommend using a pulley assembly to assist with depth control. The jam cleat on the pulley assembly holds the cable and the top edge of the chassis provides a convenient reference for cable depth marks.

The small pulley assembly is used with 48 mm and 70 mm casing (1.9 and 2.75 inch). The large pulley assembly is used with 70 mm and 85 mm casing (2.75 and 3.34 inch).

Using the Pulley Assembly

1. Remove the pulley from the chassis.
2. Clamp the chassis to the top of the casing.
3. Insert the inclinometer probe and control cable.
4. Replace the pulley.

Note: The distance between the top edge of the pulley chassis and the top of the casing is one foot. Your data reduction software can automatically adjust for this, so keep your survey procedure simple: use the marks on the cable and the top edge of the pulley chassis for reference. Let the software do any extra work required.

Check that operators consistently use the pulley assembly. If the pulley is used for one survey and not for the next, the resulting data sets will not be directly comparable. Sometimes a monument case or a protective pipe makes it impossible to attach the pulley assembly to the casing. In this case, you can make a removable adapter for the pulley assembly. If you use an adapter, be sure to use it consistently.

Cable Tips

Connecting Cable: When you connect control cable to the probe, avoid overtightening the nut, since this will flatten the O-ring and reduce its effectiveness.

Calibrate your Cable: If you have time, "calibrate" your cable, recording the exact position of cable marks. This can be important for long term monitoring projects.

Caring for Cable

Cleaning the cable: If necessary, rinse the cable in clean water or wash the cable in a laboratory-grade detergent, such as Liquinox.® Do not use solvents to clean the cable. Be sure the protective cap is in place before immersing the end of the cable in water. Do not immerse the Lemo connector.

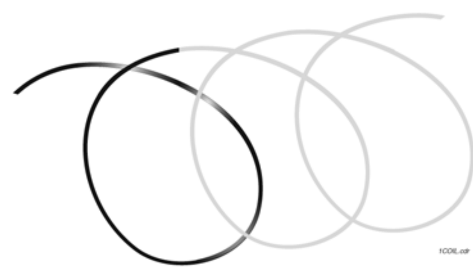
Cleaning Connectors: If it is necessary to clean the connector, use a cotton swab moistened with a small amount of alcohol. Do not use spray lubricants or electric contact cleaners. Solvents contained in such products will attack the neoprene inserts in the connectors.

Drying Connectors: When you return to the office, remove protective caps from the control cable, probe, and readout unit. Allow connectors to air-dry well for a number of hours.

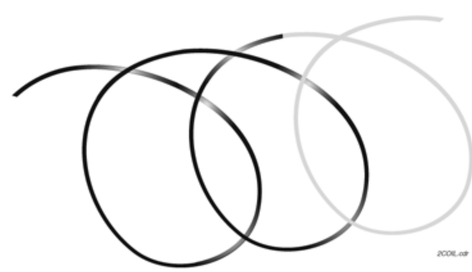
Storage: Store cable on a cable reel when possible. The reel should have a minimum hub diameter of 300 mm (12 inches). If a reel is not available, use the technique below to coil the cable.

Coiling Cable

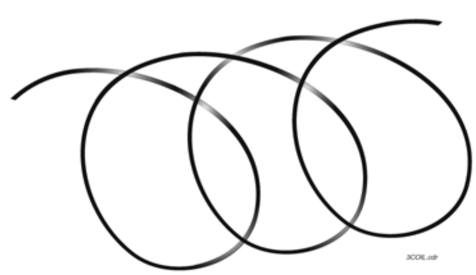
1. Loop cable forward as shown in drawing.



2. Twist cable backwards to make a second loop as shown in drawing.



3. Continue coiling cable, alternating loops as in steps 1 and 2.



Taking Readings

Good Practices

- Use the same probe and control cable for each survey, if possible.
- Use a pulley assembly, if possible. It protects the control cable and provides a good reference.
- Use a consistent top reference. The goal is placement repeatability within 5 mm or 1/4 inch. If one technician uses a pulley and another technician does not, probe positioning will be inconsistent, and data will have to be manipulated before it is useful.
- Always draw the probe upward to the reading depth. If you accidentally draw the probe above the intended depth, lower the probe down to the previous depth, then draw it back up to the intended depth. This technique ensures the probe will be positioned consistently.
- Wait 10 minutes for the probe to adjust to the temperature of the borehole.
- Wait for displayed readings to stabilize as much as possible. If the readings do not stabilize, try to record an average reading.

Setting Up

1. When you arrive at the site, lay out a plastic sheet or tarp to set the equipment on. You should have the inclinometer probe, the indicator, the control cable, and the pulley assembly. Some people find it is useful to bring a basket or box to hold the control cable and a rag to wipe off the probe and cable after readings have been taken.
2. Unlock and remove the protective cap from the casing. Attach the pulley assembly.
3. Remove protective caps from probe and control cable.
4. Align the connector key with the keyway in the probe. Then insert the connector and tighten the nut to secure the connection. Do not over-tighten the nut, since this will flatten the O-ring and reduce its effectiveness.

Position the Probe

1. Turn on the indicator. This energizes the accelerometers, making them less susceptible to shock.
2. Insert the probe into the casing with the upper wheels of both wheel assemblies in the A0 groove. (Cup the wheels with your hands to compress the springs for a smooth insertion). If you are using the pulley assembly, take out the pulley wheel, insert the probe, and then replace the wheel.
3. Lower the probe slowly to the bottom. Do not allow it to strike the bottom. Allow the probe to adjust to the temperature inside the casing. Five or ten minutes is usually sufficient.

Record Data

1. Raise the probe to the starting depth. Wait for the numbers on the readout to stabilize. If you are using the DataMate, press the button to record both the A and B axis readings. If you are using a manual indicator, write down the A-axis reading, then switch to the B-axis and record that reading.
2. Raise the probe to the next depth. Wait for a stable reading, and then record it. Repeat this process until the probe is at the top of the casing.
3. Remove the probe and rotate it 180 degrees, so that the lower wheels of both wheel assemblies are inserted into the A0 groove. When you remove the probe, cup the wheels with your hands to prevent them from snapping outwards. Also, hold the probe upright when rotating it.
4. Lower the probe to the bottom, raise it to the starting depth, and continue the survey. Take readings at each depth until you have reached the top. Remove the probe. At this point, you may want to validate the data set and make any corrections necessary.

Leaving the Site

Wipe off the probe and cable. Replace end-caps on cable and probe and return the probe to its protective case. Replace the indicator's protective plugs. Coil the cable. Remove the pulley assembly and replace and lock the protective cap.

At the Office

Wipe off the indicator and recharge its batteries. Transfer the data set to a PC. Oil the probe wheels. If the storage place is dry, remove protective caps from probe, indicator, and control cable to allow all connectors to dry.

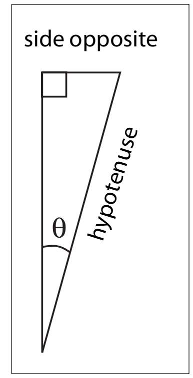
Data Reduction

Inclinometer Measurements

The inclinometer probe measures tilt, rather than lateral movement. How does tilt provide information about lateral movement? The basic principle involves the sine function, an angle, and the hypotenuse of a right triangle. We are interested in the length of the side opposite the angle θ.

$$\sin\theta = \frac{\text{side opposite}}{\text{hypotenuse}}$$

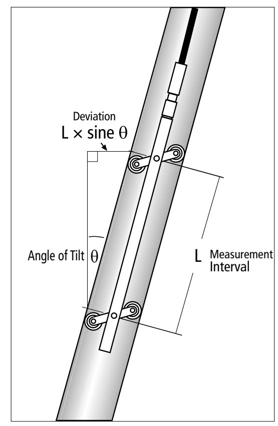
$$\text{side opposite} = \text{hypotenuse} \times \sin\theta$$



Deviation

In the drawing at right, the hypotenuse of the right triangle is the measurement interval. The measurement interval is typically 0.5 m with metric-unit inclinometers or 2 feet with English-unit inclinometers.

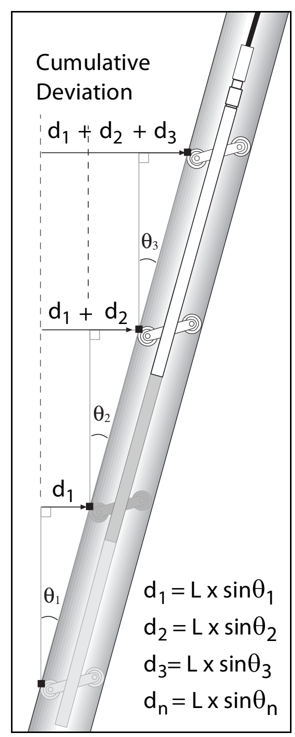
The side opposite the angle of tilt is deviation. It is calculated by multiplying the sine of the angle of tilt by the measurement interval. This calculation translates the angular measurement into a lateral distance and is the first step to calculating lateral movement.



Cumulative Deviation

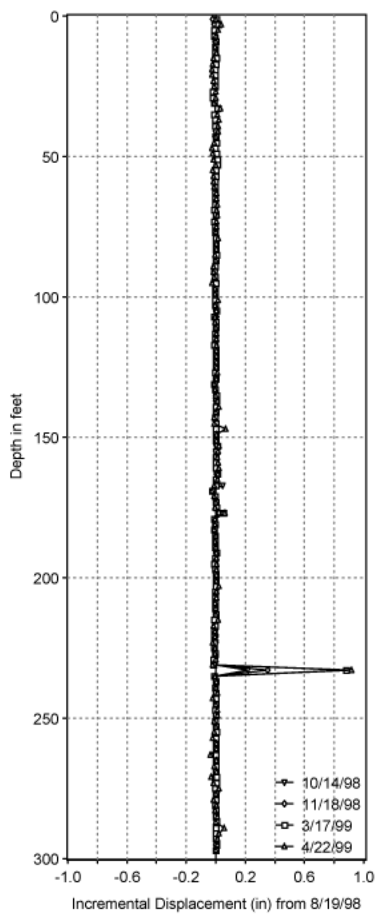
By summing and plotting the deviation values obtained at each measurement interval, we can see the profile of the casing.

The black squares at each measurement interval represent cumulative deviation values that would be plotted to show the profile of the casing.

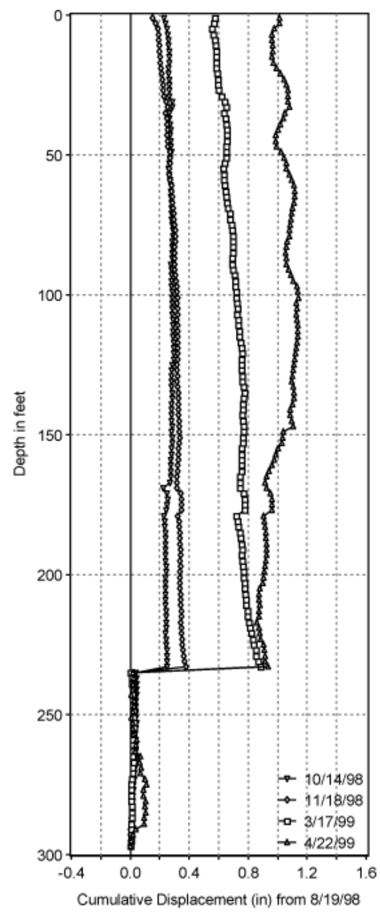


Displacements

Changes in deviation are called displacements, since the change indicates that the casing has moved away from its original position. When displacements are summed and plotted, the result is a high resolution representation of movement.



Incremental displacement plot shows movement at each measurement interval. The growing “spike indicates a shear movement.



Cumulative displacement plot shows a displacement profile. Displacements are summed from bottom to top.

Reducing Data Manually

Normally, computer software is used to reduce inclinometer data. Here, we show only a simple overview.

Displayed Readings

Slope Indicator's readouts display "reading units" rather than angles or deviation. Reading units are defined below:

$$\text{Displayed Reading} = \sin\theta \times \text{Instrument Constant}$$

$$\text{Reading}_{\text{English}} = \sin\theta \times 20{,}000$$

$$\text{Reading}_{\text{Metric}} = \sin\theta \times 25{,}000$$

Combining Readings

The standard two-pass survey provides two readings per axis for each interval. The probe is oriented in the "0" direction for the first reading and in the "180" direction for the second reading. During data reduction, we find the algebraic difference of the two readings, and then we divide by 2, since there were two readings. Use of the algebraic difference lets us preserve the direction of the tilt, as indicated with a positive or negative sign.

$$\text{A0 Reading} = 359 \qquad \text{A180 Reading} = -339$$

$$\frac{\text{Algebraic Difference}}{2} = \frac{359 - (-339)}{2} = 349$$

Calculating Deviation

To calculate lateral deviation, we find the algebraic difference of the two readings, divide by 2, divide by the instrument constant, and multiply by the measurement interval. In the example below, the English-unit measurement interval is 24 inches and the English-unit instrument constant is 20,000.

$$\text{Lateral Deviation} = \text{Measurement Interval x } \sin\theta$$

$$= 24\text{ inches} \times \frac{359 - (-339)}{2 \times 20,000}$$

Find the algebraic difference of the A0 & 180 readings and divide by 2.

Divide reading unit by instrument constant to obtain sine of angle.

$$= 0.4188\text{ inches}$$

Calculating Displacement

Displacement, the change in lateral deviation, indicates movement of the casing. To calculate displacement, we need two surveys. We subtract the algebraic difference of the initial reading from the algebraic difference of the current reading, divide by 2 x the instrument constant, and multiply by the length of the measurement interval.

$$\text{Algebraic Difference}_{\text{current}} = 700 \qquad \text{Algebraic Difference}_{\text{initial}} = 698$$

$$\text{Displacement} = \text{Measurement Interval} \times \Delta\sin\theta$$

$$= 24\text{ inches} \times \frac{700 - 698}{2 \times 20,000}$$

$$= 0.0012\text{ inches}$$

Calculating Checksums

A checksum is the sum of a "0" reading and a "180" reading at the same depth.

A0 reading = 359   A180 reading = -339

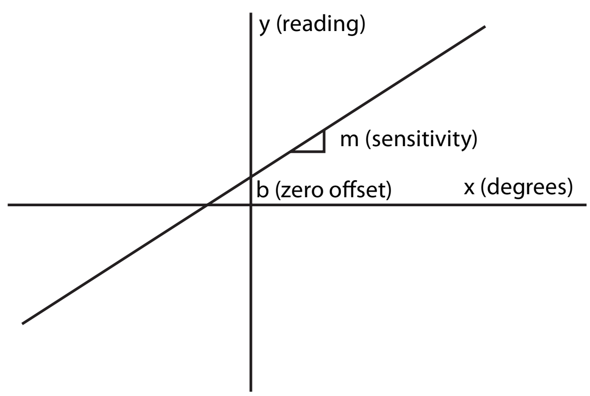
Checksum = 359 + (-339)

= 20

Bias (zero offset)

If you hold your inclinometer probe absolutely vertical and check the reading, you will typically see a non-zero value for each axis. The non-zero value is the result of a slight bias in the output of the accelerometers. The bias (or zero offset) may be negative or positive and will change over the life of the probe. This is not normally a matter for concern, because the zero offset is effectively eliminated by the standard two-pass survey and the data reduction procedure.

Below, we show an readings that have a zero offset of 10. During the first pass the probe measures a tilt of 1 degree. During the second pass the probe measures a tilt of -1 degree, because it has been rotated 180 degrees. See how the offset increases the positive reading and decreases the negative reading, even though the measured angle has not changed. However, when the two readings are combined, as discussed in "Combining Readings" above, the offset is eliminated and the correct value emerges.



Tilt angle = 1 degree.   Theoretical reading unit = 349   (20,000 x sin (1))

Offset = 10

Displayed A0 reading = 359   (349 + 10)

Displayed A180 reading = -339   (-349 + 10)

Algebraic Difference = 698   (359 - (-339))

$$\frac{\text{Algebraic Difference}}{2} = 349$$

Inspection & Maintenance

Probe Inspection

Part	What to check for	Remedy
Wheel yoke	Side to side movement	Check pivot pin, which looks like screw. If pivot pin has been turned too far, it may spread the wheel yoke. Turn the pivot pin counter-clockwise to see if movement disappears. If movement persists, replace the nylon spacers or the entire wheel assembly. The wheel assembly can be replaced by the user: kit number 50302555.
Wheel yoke	Yoke does not return to fully extended position.	If yoke is dirty, clean it. If problem persists, spring may be broken or weak. Replace spring and roll pins or replace wheel assembly using kit 50302555.
Wheel	Side to side movement	Bad bearing. Replace wheel assembly.
Wheel	Does not turn freely	Lubricate. If movement is still bad, replace wheel assembly.
Body screws	Loose screws, wobble in body, loose bumper	Tighten screws. (Do not tighten pivot pin).
Connector keyways	Wear, corrosion	Worn keyway may degrade O-ring seal. Learn how to connect cable without "hunting." Remove corrosion and change practice - allow connector to dry after use.
Connector O-ring	Flattened, split	Replace if flattened or split.
Connector pins	Bent pins	Bent pins are easily broken when straightened. Replacement of connector requires recuperation of probe (expensive). Change connection practice - no hunting.

Probe Maintenance

Moisture Management	Wipe off the control cable and probe when you finish the day's final survey, then wipe off the probe. Do not store wet cloth with the probe. Allow the connector to dry thoroughly: remove connector cap and allow connector to air-dry for a number of hours. Lubricate the wheels. This helps displace moisture.
Wheels	Lubricate the wheels by spraying a small amount of lubricant or placing drops of oil on both sides of the wheel bearings.
O-Ring	Lubricate regularly with O-ring lube or silicone based grease. Do *not* use WD-40 or any other lubricant spray that contains chlorinated solvents.
Connectors	Clean connectors as necessary. Use a slim cotton swab moistened with alcohol. Be careful not to bend pins. Do not use electrical contact cleaners, especially sprays. Solvents in these products will attack the neoprene inside the connectors. When attacked, the neoprene swells and reduces the effectiveness of the O-ring seal.
Storage	Store probe in dry place. Be sure that the box is dry, the wheels are oiled, the connector is dry. If probe is to be stored for an extended period, stand it vertically.

Control Cable Inspection

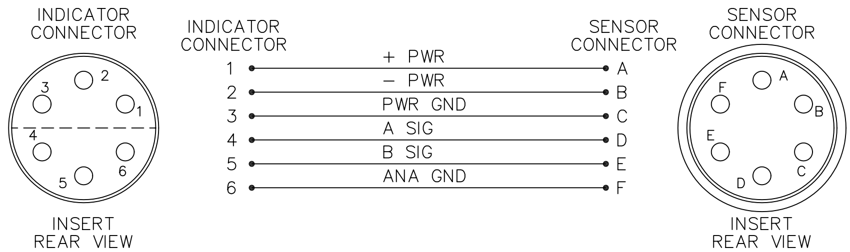
Part	What to check for	Remedy
Cable	Continuity	If you have intermittent failures, perform continuity tests. If a wire fails continuity test, you can check the Lemo connector or return cable for servicing or replacement.
Cable	Twists, worn markings, kinks, gouges	Twists indicate poor coiling technique. Change practice: use cable reel, figure-8 coils, or over-under coils. Worn markings: user is dragging cable over the edge of the casing. Change practice - but must keep consistent depths. Kinks: if kinks do not straighten, there is probably internal damage and likelihood of intermittent reading failures. If any deep gouges, water can enter cable. In both cases, bad section of cable must be removed, either by shortening the cable or replacing the cable.
Connector key	Wear, corrosion	Change connection practice - no hunting. Remove corrosion and change practice - allow connector to dry after use.
Connector rubber insert	Swelling, poor seal	Rubber swells when attacked by WD-40 or contact cleaners. Swelling may prevent good seal and allow water to enter connector. Return for service if sealing is compromised.
Connector for Indicator (Lemo)	Corrosion, bad connection.	Perform continuity check first. Then check this connector to eliminate as possible source of intermittent failures. Unscrew bottom nut, being careful not to twist cable. Slide shell off the end of the cable. Slide strain relief collet out of the way and inspect connections. Twist and pull wires gently. Good connections will not break. Repair as necessary.
Connector for Probe	Check O-ring	Do *not* disassemble this connector. Requires about two hours and a pressure test to reassemble.

Control Cable Maintenance

Moisture Management	Wipe off the control cable as you draw the probe up on the last run of the day. When you return to the office, remove connector caps and allow connectors to air-dry for a number of hours.
Cable	When necessary, rinse cable (but not connectors) in clean water or wash the cable in a laboratory-grade detergent, such as Liquinox. Do not use solvents to clean the cable.
Connectors	If it is necessary to clean the connector, use a cotton swab moistened with alcohol. Sockets can be cleaned with a brush. Do not use spray lubricants or electric contact cleaners. Solvents contained in such products will attack the neoprene inserts in the connectors.
Storing Control Cable	Improper coiling of any electrical cable twists conductors and can cause reliability problems. There are several ways to control twisting: • Use cable reel with hub diameter of at least 200mm or 8". • Coil cable in a figure-8. • Coil cable using over-under loops (2-foot diameter loops).

Control Cable Connectors

Below is the wiring diagram for the connectors on the control cable.



Testing

Connectors are made to mate with each other but not with any other objects. Never insert the probe of your multimeter into a socket. In making the measurements below, simply touch the probe to the top of the socket.

Continuity Test: Pin 1 to Pin A, Pin 2 to Pin B, etc, should measure a little less than 1 ohm per 30 m (100 feet).

Isolation Test: Pin to pin should measure infinity. Also any pin to the body of the connector should measure infinity.

Servicing

Use caution when attempting to service either connector.

The Lemo connector on the indicator end of the cable is easier to service. When you disassemble the connector, be sure that you do not twist the cables.

The heavy connector on the sensor (probe) end of the cable is more difficult to service. We recommend that you send it to the factory unless you are experienced and are willing to spend some time working with it.

Appendix A4 - Digitilt DataMate II

Digitilt DataMate II

Simple to operate, the compact Digitilt DataMate runs 16 hours on one charge, stores up to 320 surveys, and transfers data to a PC for processing.

The Digitilt DataMate II

The DataMate records data from inclinometer probes, tiltmeters, and spiral sensors. It stores up to 320 complete inclinometer surveys and can power a Digitilt inclinometer probe for 16 hours.

The DataMate II is compatible with the original DataMate but features updated electronics for faster operation, increased memory capacity, and a USB port for data transfers

The DataMate is designed for hard use in difficult environments. It has a bright, backlit display that is visible under all lighting conditions. The box is splashproof and sealed against humidity. In addition, all connectors are located on the top of the box, away from contact with mud, water, or snow.

Recording Surveys

The Digitilt DataMate stores a list of inclinometer installations in memory, so to begin a survey, the operator selects an installation from the list.

The DataMate then displays the starting depth for that installation, and the operator positions the probe at that depth.

The display shows the depth, the A-axis reading, and the B-axis reading. When both readings are stable, the DataMate displays a “ready” signal. The operator then records the reading, using the hand switch or the keypad. The DataMate beeps confirmation and then displays the next depth. The operator raises the probe to this depth, waits for the ready signal, and then records the readings, repeating these steps until the probe reaches the top of the casing. The DataMate then prompts the operator to rotate the probe 180 degrees and begin the second pass through the casing.

The operator can correct a mistake at any time by simply scrolling through the data to any depth, repositioning the probe, and continuing the survey from that point.

Validating Surveys

The DataMate provides checksum statistics to help the operator validate the survey. By comparing the mean and standard deviation of checksums for the current survey with those of previous surveys, the operator can be confident that the data are good.

The DataMate provides routines to help the operator identify questionable readings, which can then be corrected by repositioning the probe. The DataMate displays “live” and recorded readings side by side for comparison, and the operator can overwrite the recorded reading with the live reading, if appropriate.

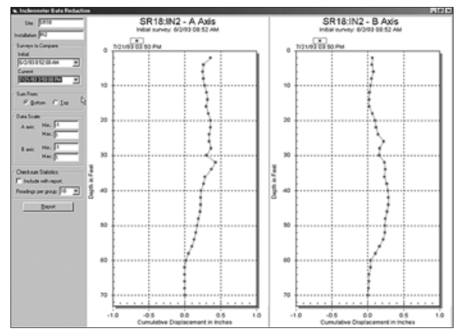
Convenient hand switch reduces fatigue and lets you keep the DataMate clear of the work area.

Retrieving Surveys

Returning to the office, the operator connects the DataMate to a PC, and then runs the DataMate Manager program. The manager program retrieves the recorded surveys and stores them in a database for easy access.

Processing Surveys

Slope Indicator inclinometer software eliminates repetitive work, ensures that calculations are performed accurately, and dramatically reduces the time required to process data.



DMM for Windows software lets you retrieve surveys and produce reports containing readings and graphics.

The DataMate Manager program is included with the DataMate. It can can print reports containing inclinometer readings, checksum statistics, and simple graphs. It also provides routines for settlement correction, spiral data set expansion, and bias shift analysis.

DigiPro for Windows is an optional graphing program that provides additional types of graphs, including some diagnostic plots, and a number of sophisticated correction routines. A trial version is available for download from the Slope Indicator web site.

DIGITILT DATAMATE II READOUT

Digitilt DataMate II 50310900

The Digitilt DataMate is a portable readout for Digitilt sensors. It provides depth prompts and stores readings in memory for transfer to a PC. Includes hand switch, battery charger, USB interface cable for PC, and CD with DMM for Windows and manual. Specify type of plug required for the charger. DigiPro software is not included.

Sensor Compatibility: English and metric versions of vertical and horizontal Digitilt inclinometer probes, tiltmeters, and spiral sensors.

Displayed Units: Metric indicator displays readings as 25000 x the sine of the angle of tilt. English indicator displays readings as 20000 x the sine of the angle of tilt.

Survey Types: 2-pass survey for inclinometer probes; 4-pass survey for spiral sensors.

Memory Capacity: Stores 160 installations and nominally 320 surveys of 100 depths each (a total of 32000 depths allocated to any number of surveys up to a maximum of 320).

Maximum Survey Depth: 500m or 2000 feet.

Reading Intervals: Fixed intervals. Minimum interval is 0.5 m with metric probe or 1 foot with English-unit probes.

Menu-Selected Functions

Record: Prompts operator with starting depth. Displays A and B axis readings. Displays ready signal when readings are stable. Displays next depth after readings are recorded.

Manual Read: Allows use of DataMate when memory is full or depth display is not required.

Validate: Calculates checksum statistics.

Correct: Allows user to correct mistakes.

Compare: Calculates a single value for cumulative deviation or cumulative displacement.

Comm: For communication with PC.

Print: Outputs ASCII data to a terminal program running on a non-DOS/Windows computer.

Operating Time: 16 hours @ 20°C (68°F) of continuous power to probe. Backup battery preserves data for six months.

Temperature Rating: -20 to 50°C (-4 to 122°F).

Display: 20 x 2 backlit LCD rated for extended temperatures.

Battery: 6 volt, 6 Ah, gelled electrolyte, lead-acid battery. Recharges to 80% capacity in 16 hours using the included charger.

Case: Splashproof, non-submersible, aluminum case with plastic shell. Connectors are waterproof when capped or in use.

Dimensions: 127 x 178 x 178 mm (5 x 7 x 7").

Weight: 3 kg (6.5 lb).

DMM FOR WINDOWS

DMM for Windows 50310970

The DataMate Manager program (DMM) transfers readings from Digitilt DataMate to a PC. DMM offers routines for checking surveys and maintaining the inclinometer database. DMM is supplied on a Resource CD with the purchase of the Digitilt DataMate. It can also also be downloaded free from www.slopeindicator.com. Note that DMM is not intended to replace DigiPro software. DigiPro software, available separately, is used to create presentation graphics and offers diagnostic and correction tools.

System Requirements: Windows computer with USB port.

Data Retrieval: DMM communicates with DataMate through a USB connection.

Data Storage: Surveys retrieved from DataMate are stored in an MDB database. DMM supports drag-and-drop operations between databases and provides easy functions for editing, renaming, moving, and archiving installations and surveys. Surveys retrieved from the DataMate can also be saved as ASCII files.

Data Manipulation: DMM provides a settlement correction routine and a spiral set expansion routine. Both routines generate new surveys.

Import Capabilities: DMM imports legacy data from Slope Indicator's previous formats and from GTILT®. The program also allows manual entry of data.

Report Capabilities: DMM prints inclinometer readings with checksums, compares two surveys (typically current vs initial) to generate A and B-axis graphs of cumulative displacement. The program generates graphs of cumulative deviation. Graphs are displayed on screen and can be printed in a report. Reports can also include checksum statistics, bias-shift analysis tables, and tabular data in digi units (differences and changes).

DIGIPRO SOFTWARE

DigiPro Trial . . . . Free Download
DigiPro, 1-User License 50310001
DigiPro, 3-User License 50310000
DigiPro, 12-User License 50310002

DigiPro software processes and plots inclinometer data recorded by the Digitilt DataMate readout. It creates high-resolution graphs and supports advanced routines for identifying and correcting systematic error. DigiPro is not included with the Digitilt DataMate. See separate datasheet for details.

DIGITILT 09 INDICATOR

Digitilt 09, Metric 50300910
Digitilt 09, English 50300900

The Digitilt 09 Indicator is a portable readout for Digitilt sensors. It displays readings, but does not record them. The user must keep track of depths and readings on a field data sheet. A battery charge is included. Please specify 100, 115, 220, or 240 volt and 50 or 60Hz.

Compatibility: Digitilt inclinometer probes, Digitilt tiltmeters, and spiral sensors.

Displayed Units: Metric indicator displays readings as 2.5 x the sine of the angle of tilt. English indicator displays readings as 2 x the sine of the angle of tilt.

Readings can be entered into the DMM for Windows database and graphed with DigiPro for Windows. If you chose to do this, write down readings without the displayed decimal point and enter the readings as integers.

Resolution: Metric indicator provides resolution of 1 in 25,000. English indicator provides resolution of 1 in 20,000.

Display: Large, backlit 4.5 digit LCD with heater for cold weather operation.

Battery: Rechargeable 6 volt, 6 Ah gelled electrolyte, lead-acid battery. Battery life is 12 hours with fully changed battery. LCD heater reduces operating time up to 50% when temperature is below 5° C (40° F).

Temperature Rating: -20 to 50°C (-4 to 122°F).

Dimensions: 127 x 178 x 178 mm (5 x 7 x 7").

Weight: 3.4 kg (7.5 lb).

Durham Geo Slope Indicator, 12123 Harbour Reach Drive, Mukilteo, WA, 98275 USA
Tel: 425-493-6200 Tel: 866-916-0541 Fax: 425-493-6250 Email: solutions@slope.com

DGSI Durham Geo Slope Indicator

Digitilt DataMate II

50310999

This equipment should be installed, maintained, and operated by technically qualified personnel. Any errors or omissions in data, or the interpretation of data, are not the responsibility of Durham Geo Slope Indicator. The information herein is subject to change without notification.

DGSI
Durham Geo Slope Indicator

12123 Harbour Reach Drive
Mukilteo, Washington, USA, 98275
Tel: 425-493-6200 Fax: 425-493-6250
E-mail: solutions@slope.com
Website: www.slopeindicator.com

Contents

Digitilt DataMate II

What is the DataMate II?

The Digitilt DataMate II is a recording readout used with the Digitilt inclinometer probes, the portable Digitilt tiltmeter, and the spiral sensor. It works with both metric and English-unit versions of these sensors.

The Digitilt DataMate records readings from inclinometer surveys. DMM software is used to transfer the recorded readings to a PC. The use of DMM software is covered by a separate manual: DMM for Windows.

DataMate Controls

Power Switch

The power switch locks into position. To switch on, pull the lever up, then move it to the On position. To switch off, pull the lever up, and then move it to the off position. The DataMate displays a copyright notice for ten seconds when you switch it on. The copyright date serves as the version number for the DataMate.

Connector Sockets

Probe: Socket for inclinometer control cable.

Charger: Socket for battery charger or external power.

USB: Socket for computer interface cable and remote hand switch.

Sockets are waterproof only when connectors are plugged in or when protective caps are in place.

KeyPad

Up: Moves cursor up. Also scrolls forward through the alphabet (a...z).

Down: Moves cursor down. Also scrolls backwards through the alphabet (z...a).

Left: Moves cursor to the left.

Right: Moves cursor to the right.

Esc: Cancels current process and returns to menu.

Enter: Chooses menu items. In record mode, records readings.

DataMate Menus

1. Use the arrow keys to select a menu item with the cursor.
2. Press Enter to choose the item or Esc to exit the item.

Main Menu

The Main menu appears when you turn on the DataMate. The Main menu shows the main functions of the DataMate.

Read	Surveys
Comm	Utilities

Read Menu

The Read menu lets you record inclinometer readings, edit inclinometer installation parameters, review and correct readings, and operate the readout in manual mode, which displays readings but does not record them.

Record	Installation
Correct	Manual Read

Surveys Menu

The Surveys menu lets you list the surveys that are stored in memory, validate a survey, check available memory, delete a survey, compare one survey to another, and print a survey to a terminal program.

Dir	Validate	Memory
Del	Compare	Print

Comm Menu

Comm puts the DataMate into communications mode for transferring data to and from a computer. Communications requires that the DataMate II is connected to the computer's USB port via the interface cable that is supplied with the DataMate.

Waiting for PC . . .

Utilities Menu

The Utilities menu lets you set defaults, and check battery voltage and memory.

Batt	Beep	Light
Temp	Date	Contrast

Setting Defaults

Go to the Utilities menu to set the defaults below:

Date and Time: Choose Date. The DataMate displays the current date and time. Press Enter to edit the date. Press Up or Down to change the year, then press Right to move the cursor to month, etc. Press Enter when done.

Beeper: Choose Beep. Press Enter to toggle the beeper on or off. The beeper produces a noise when you record a reading.

Backlight: Choose Light to toggle the backlight on and off. Backlight increases battery drain by about 12 percent.

LCD Contrast: Choose Contrast. Press Up or Down to adjust contrast for easy viewing. Press Esc when done.

Checking the Battery

Go to the Utilities menu. Choose Batt. A new, fully charged battery shows approximately 6.6 volts with a full charge. Recharge if below 6 volts.

Recharging the Battery

Recharge the battery after every use of the DataMate. It is best to charge overnight.

Plug the charger into an AC mains socket. Plug the Lemo connector into the DataMate's Charger socket. You can verify that charging is taking place by going to the Utilities menu and choosing Batt. You should see increasing voltage value.

Checking Memory

Go to the Surveys menu. Choose Memory. The DataMate displays how many depths and surveys are free (available to store data). The maximum numbers are 32000 depths and 320 surveys.

Moisture Management

When you return to the office, remove caps from the DataMate's connectors and allow connectors to air-dry for a number of hours.

Use desiccant to keep the inside dry. This is particularly important in hot humid weather. Warm moist air trapped in the readout can condense when the readout is brought into a cool air-conditioned office.

To check the moisture level in the DataMate, go to the Utilities menu and choose Temp. The DataMate displays humidity and temperature. Humidity levels from 20% to 60% are normal. If humidity exceeds 75%, replace the desiccant. See instructions in the chapter on inspection and maintenance.

Set Up

Overview

Setting up the DataMate involves entering a list of inclinometer installations into the DataMate's memory. You can do this with DMM software or with the DataMate's keypad.

Setting Up with DMM Software

This method is convenient when you are in the office:

1. Use DMM to create a setup database on your PC.
2. Connect the DataMate to your PC.
3. Use DMM to transfer the setup to the DataMate.

Setting Up with DataMate Keypad

This method is convenient when you are in the field.

1. Choose Read.
2. Choose Installation.
3. Press Down key to scroll past any previously entered installations. The cursor stops on the word, "Create." Press Enter.
4. Enter the required information into each field. The fields are explained on the next page. To make an entry:

   Press the Right key to enter edit mode.

   Press the Up or Down key to change the character under the cursor.

   Press the Right key to move to the next column.

   Press Enter when you are done. The DataMate exits edit mode and moves the cursor to the next line.
5. To correct a mistake, press the Up or Down key to display the line that you want to correct. Then press the Right key to enter edit mode.

Installation Fields

Site & Installation: Every installation has a two-part identifier consisting of a "site" and an "installation." Enter a 6 character identifier for each.

A0 dir: (Optional) Enter up to 3 characters to identify the compass heading of the A grooves. Not used for any calculation.

Operator: Optional) Enter up to 3 characters to identify the operator. Optional.

Sensor#: Enter the serial number of the probe. Optional, but recommended.

Sens Type: Choose Digitilt for inclinometer probes or Spiral for spiral sensors.

Units: Choose Metric or English. If you don't know, check the distance between the upper and lower wheels of the probe: 0.5 m for metric systems; 2 feet for English-unit systems.

Ins Constant: Use 25000 for metric-unit systems or 20000 for English-unit systems.

Start: Enter the starting depth for the survey. Surveys typically start at the bottom of the casing. With English-systems, it is best to use an even number so that 2-foot intervals coincide with cable markings.

End: Enter the ending depth for the survey, typically 0.5 for metric-unit systems or 2 for English-unit systems.

Interval: Interval is typically 0.5 for metric-unit systems and 2 for English unit systems. For a Spiral Sensor, set the interval to 1.5 meters or 5 feet.

Check the Installations

Verify that the DataMate now holds your installation list:

1. Choose Read from the main menu.
2. Choose Installation.
3. Scroll through the list of installations.

Recording Surveys

Good Practices

1. Use the same probe and control cable for each survey, if possible.
2. Use a pulley assembly, if possible. It prevents damage to the control cable.
3. Use a consistent top reference. The goal is repeatable placement of the probe within 5 mm or 1/4 inch. If one technician uses a pulley and another technician does not, probe positioning will be inconsistent, and data will be unusable.
4. Connect the probe to the DataMate and switch the power on before you insert the probe into the casing. Powered-up sensors resist shock better than unpowered sensors.
5. Wait 10 minutes for the probe to adjust to the temperature of the borehole. This helps prevent bias-shift (offset) errors.
6. Always pull the probe upward to the reading depth. If you accidentally pull the probe past the intended depth, lower it to the previous depth, then pull it back up to the intended depth. This ensures consistent placement.
7. Wait for displayed readings to stabilize. The DataMate displays 3 diamonds when readings have stabilized within two units. If the reading does not stabilize, watch the display and try to record an average reading.
8. When you remove the probe from the casing, use your hand to compress the wheels so that they don't spring free or force the body of the probe to strike the side of the casing. This helps prevent bias-shift errors.
9. Check your readings using the DataMate's Validate command. If necessary, reposition the probe at the required depth and use the Correct command to obtain a new reading for that depth. The Correct command is explained later.
10. If you accidently turn off the DataMate during a survey, turn it back on, and then use the Correct command resume the survey. There is no need to start a new survey.

Recording a Survey

1. Connect the control cable to the probe. Do not over-tighten. Plug the other end of the control cable into the Probe socket on the DataMate. Plug the handswitch into the USB socket.

2. Insert the probe into the casing with upper wheels in the A0 direction. Lower the probe to slightly below the start depth.

3. Switch on the DataMate and wait for the main menu. Choose Read.

Read	Surveys
Comm	Utilities

4. Choose Record.

Record	Installation
Correct	Manual Read

5. Choose an installation from the list.

Select Installation
SR18 IN1

6. Press Enter to step past the installation parameters without making changes. Normally, no editing is required.

Edit Installation	
Site	:SR18 IN1

Press Enter or Down to step past each parameters

7. Finally, the DataMate displays the Start depth (bottom depth).

Start depth

50.0♦	204	48
Depth	A0	B0

8. Wait ten minutes for the probe to adjust to the temperature at the bottom. This step is important for consistent readings.

9. Begin the survey. Raise the probe to the start depth, then watch for a stable reading. You will see three diamonds, as shown below. Press Enter to record the reading.

50.0♦	206♦	52♦
Depth	A0	B0

Three diamonds ♦ ♦ ♦ indicate stable reading. Press Enter to record.

Recording a Survey continued

10.The DataMate beeps and scrolls to the next depth. The reading just recorded is now on the bottom line. Raise the probe to the next depth (shown in the top line of the display) and wait for the numbers to stabilize. Press Enter to record the reading.

After you record the reading, pull the probe up to the next depth.

48.0♦	210	55
50.0*	206*	52*

Recorded readings are marked with a *

11. Repeat this process until you have recorded the reading for the top depth. The DataMate displays a menu. Choose Continue.

Continue	0
Done	Del

12.The DataMate now displays the starting depth for the second pass. Remove the probe from the casing and rotate it 180 degrees so that the upper wheels point to the A180 direction. Insert the probe and lower to the bottom of the casing, or slightly below the start depth.

50.0♦	-210	-60
Depth	A180	B180

13.Pull the probe up to the start depth. Wait for the numbers to stabilize. Press Enter to record.

48.0♦	-215	-75
50.0π	-210π	-60π

Recorded readings for the second pass are marked with the Pi symbol.

14.Repeat these steps until you have recorded the reading for the top depth. A menu appears. This time, choose Done. Then remove the probe from the casing.

Continue	0
Done	Del

15.You may want to validate the survey using the DataMate's validate command. See Appendix 1 for instructions.

Making Corrections

If you make a mistake during the survey, you can easily correct it.

1. Use the Down key to return to the depth where the mistake was made. Stop scrolling when the depth appears in the top line of the display.
2. Now position the probe to that depth: lower it below the depth and then pull it upwards to the exact depth.
3. Press Enter to activate the top line of the display. A diamond appears next to the depth.
4. Wait for the readings to stabilize, then press Enter to record.
5. Continue recording just as you would in a normal survey. Or if you are finished, scroll to the top depth and complete the survey as you normally would.

Cancelling a Survey

1. Press Esc. If you press Esc by mistake, press Continue.
2. Choose Del to delete the survey that you cancelled. Cancelled surveys remain in memory until deleted.
3. The DataMate prompts for confirmation. Press Up to confirm.

Deleting a Survey

If you want to record a survey, but the DataMate prompts "no room in memory" or "too many surveys," you must free some memory by deleting a survey.

1. Choose Surveys from the main menu.
2. Choose Del.
3. Select a survey to delete and press Enter. (Surveys marked with the ^ symbol have been retrieved by a PC, so it might be safe to delete one of them.)
4. Press Up to confirm the deletion or Esc to cancel. The DataMate deletes the survey. To avoid possible loss of data, do not switch the DataMate off during this process.

Deleting an Installation

The DataMate itself provides no way to delete installations. DMM is required for deleting installations.

Retrieving Surveys

Overview

To retrieve surveys, connect your DataMate to your PC and run the DMM program. This is the normal and most efficient way to retrieve data.

Using DMM

Detailed instructions are provided in the DMM manual. The basic steps are:

1. Connect the DataMate to your PC. Choose Comm on the DataMate.
2. Start DMM, go to Datamate in the menu, and choose either Retrieve New or Retrieve all.
3. Drag and drop the retrieved surveys into your project database (or export surveys to a text file).

Using a Terminal Program

You can "print" surveys, one by one, to a PC that is running a terminal program on your PC to receive it. This is mainly for troubleshooting. The DMM program can import print files.

1. Connect the DataMate to the PC.
2. Start your terminal program. Set it for 8-bit, no parity at 9600 bps.
3. Set the terminal program to "capture" or "log" the data sent from the DataMate. Specify a file name for the captured data.
4. Choose Print from the DataMate survey menu. Set the baud rate for 9600 and press Enter. Then select the survey and press Enter to "print" it.
5. Your terminal program will usually display the readings as they are sent from the DataMate.
6. Close the file with your terminal program.

Validating Surveys

About Checksums

A checksum is the sum of 0 and 180 degree readings at the same depth. Ideally, the sum should be zero since the readings have opposite signs. In practice, checksums are rarely zero.

In general, you should look for consistency in checksums. A checksum that is significantly different from checksums above and below it may indicate that the probe wasn't positioned correctly or the reading was not stable when recorded. A large checksum may also be caused by debris in the groove, an out-of-round casing section, a separated casing section, or a wheel falling in the joint of a telescoping casing section.

A graph of checksums shows very clearly whether checksums are consistent or not. Alternatively, scanning through a column of checksums gives you an idea of consistency. Unfortunately, the DataMate provides neither graphs nor columns of checksums. However, the DataMate does provide the standard deviation of checksums, which can be used as a measure of reading quality, as explained below.

Standard Deviation of Checksums

The standard deviation of checksums can be used as a way to confirm that the current survey is comparable to other surveys for the same borehole.

You must first establish a "typical SD" for each axis. This is obtained from your initial survey. (It is good practice to take several surveys initially, then compare them and select one to be the "official" initial.) Since the initial survey represents good set of readings, the standard deviation of checksums for that survey can be used as a "typical SD" for that installation. Note that the "typical" is likely to be different for every installation.

When you obtain a new survey, run the DataMate's validation routine. Compare its SD to those of the initial survey. If the typical standard deviation of the A-axis is 3 to 5 units, the data is probably good. For example, if the typical standard deviation is 4, then acceptable standard deviations for subsequent surveys could range as high as 7 or 9 (typical for B-axis).

Narrower limits may be appropriate for deeper installations and critical measurements. Wider limits may be appropriate for shallower installations or for poorly-installed casing.

Validating a survey

Here is a typical validation procedure:

1. Check the standard deviation of checksums. Is it typical for this casing? If so, the survey is probably good and needs no further validation. You can quit the validation routine.
2. If the standard deviation is not typical, check the standard deviation for the different zones. If any group shows an obvious problem, examine the individual checksums in that group. Also look for drifting mean checksums. A drifting mean may indicate a problem with the electronics inside the probe.
3. If you find a checksum that is too large, examine the readings at that depth to determine whether the bad reading was recorded in the 0 or the 180 orientation. Afterwards, you can correct the data by taking another reading for that depth.
4. The steps below explain this in detail.

Check the Standard Deviation

1. Choose Validate from the Surveys menu.
2. Choose a survey to validate.
3. After a short delay, you will see a display that shows both the mean (MN) checksum and the standard deviation (SD) of checksums:

```
MN  A=51.337    B=45.674
SD  A=4.1781    B=5.7170
```

4. Compare the standard deviation with the "typical" SD that you have established for the installation. If the standard deviation is acceptable, press Esc to quit. Otherwise, look at the SD for each zone.

Check Zone Statistics

1. Press Enter to view the zone with the largest SD. You will see a display that looks something like this:

```
25.  -  20.     S.D.
A=3.2264       B=10.3388
```

Zone statistics include 10 readings. In this case, there are 10 half-meter readings in the zone from 25m to 20m.

2. To view the mean checksum for this zone, press the Left arrow. Press Right to redisplay the SD.
3. Press Up or Down to display other zones. Again, the Left and Right keys toggle between mean and standard deviation.
4. If you decide the survey is acceptable, press Esc to quit. Otherwise, note the zones (depths) that you want to inspect and continue.

View Individual Checksums

Follow the steps below to find depths with large checksums:

1. After viewing the checksum statistics, press Enter to view checksums. The DataMate first displays the largest checksum in the survey. In this case, the 89 in the B axis is largest.

25.	20	89
25.5	25	34
Depths	A	B

2. Use the Up and Down keys to view checksums at other depths. When you are finished viewing checksums, press Esc.

Isolating the Bad Reading

A large checksum may indicate a bad reading, but does not indicate which reading was bad (Was it the 0 or the 180 reading?). To isolate the bad reading, you must view readings above and below the suspect reading.

1. Choose Read from the main menu.
2. Choose Correct, then choose a survey (If necessary, press Right to see dates).
3. Press the Enter key to skip through parameters.
4. Choose 0 (orientation). Scroll through readings to the suspect depth. Check readings above and below the depth. A bad reading does not fit with the readings above and below it.
5. To view 180 readings at the same depth, press the Right arrow. Press again to display the 0 readings.
6. Note the depth and orientation of the bad reading. Then press Esc.

Correcting a Reading

1. Choose Correct from the Read menu.
2. Choose 0 or 180, and scroll the DataMate to the required depth. The depth should be displayed on the top line.
3. Lower the probe to the required depth. Wait for the probe to adjust to the temperature in the borehole (5 to 10 minutes if the probe has been in open air)
4. Press Enter to activate the reading. Press Enter again to record the reading.

Comparing Surveys

Overview

The DataMate can calculate a single value for cumulative deviation or for cumulative displacement.

Cumulative Deviation

1. At the Main Menu, select "Surveys." Then select "Compare."
2. The DataMate prompts for the current survey. Press Enter to select the suggested survey or scroll to find a different survey.
3. The DataMate prompts for a "previous" survey. Press Esc since you do not want to calculate displacement.
4. The DataMate asks you to confirm a conversion value of 1. Press Enter. This will display metric data in meters and English data in feet.
5. The DataMate then calculates the cumulative deviation for the survey and displays it.
6. Press Esc to return to the Surveys menu.

Note The DataMate calculates cumulative deviation by summing incremental deviations from the bottom of the casing to the top.

If you are interested in borehole drift, you probably want the top of the borehole to be used as reference. The DataMate does not offer this as a choice, but when summing from the top, the deviation at the bottom of the borehole will be the same value except in the opposite direction.

Cumulative Displacement

To calculate displacement, the DataMate must contain two surveys for the same installation.

1. Choose Surveys from the main menu, then choose Compare.
2. The DataMate prompts for the current survey. Press Enter to select the suggested survey or scroll to find a different survey. Then the DataMate prompts for a "previous" survey. Scroll to find the initial set, then press Enter.
3. The DataMate prompts for a conversion value. Enter 1000 for a displacement in millimeters (with metric data). Enter 12 for a displacement in inches (with English unit data).
4. The DataMate then calculates the cumulative displacement for the survey and displays it. Press Esc when done.

Inspection and Maintenance

Inspection

Part	What to check for	Remedy
Desiccant	Check humidity under utilities menu.	If humidity exceeds 75%, replace or recharge desiccant.
Batteries	Check main battery and Memory keep alive power under utilities menu.	Main battery can be recharged. If battery does not hold charge, battery can be replaced. Lithium backup battery is good for 7 to 10 years if main battery keeps charge. Return for servicing if memory power is bad.
Connectors	Dirt, bent pins, o-ring	Clean with alcohol moistened swab. Note that connectors are "water proof" only when capped or when connector is plugged in.
Self Test	Error A input Error B input	Bad signal input. Return for servicing. A value is displayed, but is not useful.
	Error +12volt Error -12volt	±12V sensor power. Disconnect control cable and probe. Try again. If error goes away, problem could be in probe or cable. Connect cable only. If no error, then probe is the problem. This error could also be caused by discharged battery. Try recharging battery first. If error persists, some component must be returned for servicing.
	Error battery	Main battery is low. Try recharging. If error persists, replace battery.
	Error +3v pwr	Memory keep alive power is bad. Retrieve any data before switching off, then return for service.
	Error temp	Operating temperature range exceeded. Either below -20 or above 60C.
	Error humidity	Humidity above 80%. Replace desiccant.

Maintenance

Battery	Recharge battery after every use. Charge at least two hours for every hour of use. Charging overnight is common practice. Do not charge longer than 72 hours. Longer charge time may damage the battery. A new, recharged battery will show 6.6V or higher. The DataMate displays a low battery warning when voltage drops to 5.5 volts. Turn off the DataMate when the warning appears and then recharge as soon as possible. Deep discharge of the main battery can reduce its performance and shorten its life.
Desiccant	Check humidity under utilities menu. If humidity exceeds 75%, replace desiccant.
Connector sockets	If it is necessary to clean the connector, use a small brush or a slim cotton swab. Do not use spray lubricants or electric contact cleaners. Solvents contained in such products will attack the neoprene inserts in the connectors.

Replacing Desiccant

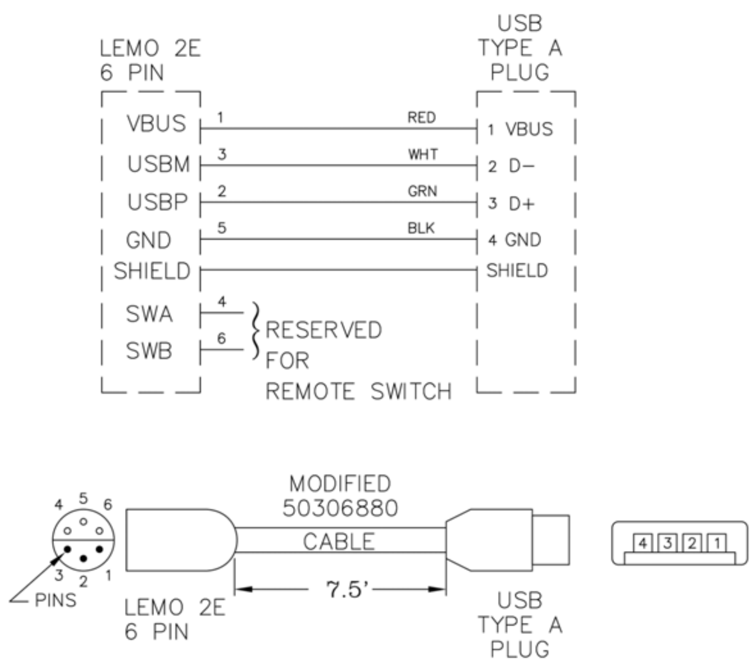
You must open the DataMate to change the desiccant. You should ground yourself to prevent a static discharge that could damage the DataMate's electronics.

Remove the two screws from the bottom of the case. Hold the top panel and pull off the case. Look for the desiccant pack between the battery and the panel connectors. Replace the desiccant pack with a new one. You may be able to renew the desiccant in an oven at 250 °F (121 °C) for 16 hours. Do not use a microwave oven to renew the desiccant. You may damage your microwave oven.

Before you replace the case, apply a light coat of silicone grease to the gasket. Also lubricate the O-rings on the screws. Then slip the DataMate back into its case, checking that the gasket is seated properly. Replace the screws and tighten to draw the top panel squarely against the case. Do not over-tighten the screws

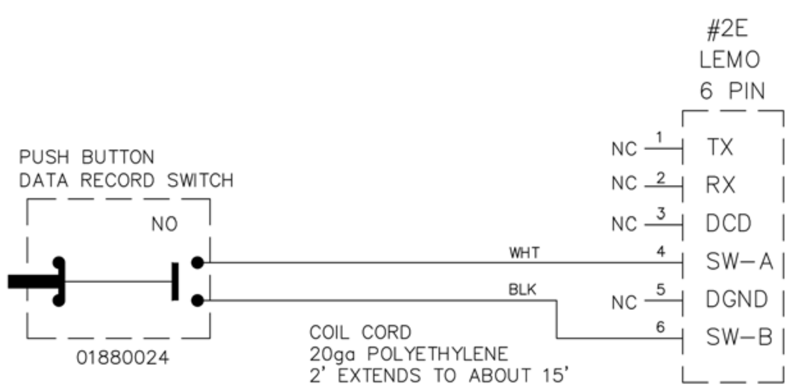
Wiring Diagram for USB Interface Cable

Below is the wiring diagram for the connectors on the USB interface.



Wiring Diagram for Hand Switch

Below is the wiring diagram for the hand switch.



Trouble-Shooting

Tech Notes on slopeIndicator.com

Many questions can be answered by a visit to the Tech Notes section of www.slopeindicator.com. Go to Support - TechNotes. Then scroll down the page to find the inclinometer tech notes. Take a look at the Digitilt DataMate Q & A page.

Readings Not Stable

The DataMate's ready signal is displayed when readings in both axes are stable within 2 digits. If this happens occasionally, but readings vary within 3 or 4 digits, you can record the readings with no significant loss of accuracy.

- If this problem always occurs at a single installation and at a just a few depths, it is possible that the backfill around the casing has washed away or was simply incomplete.
- In some situations, such as when there is no water in the inclinometer casing, control cable can go into a slow oscillation, shaking the probe, and preventing full stabilization of readings. The same may occur at sites where heavy construction machines are active. In this case, look for the average reading.
- Reading instability can also be caused by a low battery, so always check battery voltage before you leave the office.
- If readings always take a long time to stabilize, and this happens at all installations, contact Slope Indicator.

Strange Readings

A & B readings are midrange or higher (e.g. +6000 or -6000): Mid-range readings like this point to a cable problem. It is likely that one of the power wires is bad. The problem may be in a broken or corroded wire in the connector.

Readings are very high, for example 12,000: If your DataMate shows a full scale reading, such as 10,000 or 12,500, when the probe is near vertical, there is probably water in the connector or in the cable.

Reading of +1786 (English) or 3125 (Metric): This is the same number that the DataMate displays when the probe is not connected, so there is most likely a problem in the cable or a connector.

Reading of 60 or some other low number: If you see a low number that stays constant in one axis, the problem is mostly likely in the probe. The accelerometer for that axis is not working and the op amp is trying to compensate, resulting in a constant value.

Appendix A5 - DMM for Windows

DMM for Windows

50310970

DGSI
Durham Geo Slope Indicator

12123 Harbour Reach Drive
Mukilteo, Washington, USA, 98275
Tel: 425-493-6200 Fax: 425-493-6250
E-mail: solutions@slope.com
Website: www.slopeindicator.com

Contents

Introduction

Read This

- If you hate manuals, at least read the Quick-Tour pages.
- If you can't find a way to do something, read the "How To" pages.
- If you have the DataMate II, be sure to install the latest version of DMM.

What is DMM?

DMM (DataMate Manager) is software supplied for the Digitilt DataMate inclinometer readout. DMM is used to:

- Retrieve readings stored by the DataMate.
- Send setup data to the DataMate.
- Retrieve readings from the DataMate.
- Store readings on disk, either in a database or in an ASCII file.
- Edit and maintain the database.
- Print data, and statistics. DMM also has a simple graphing function to compare two surveys.

Installation

Obtaining DMM

We recommend that you download the DMM setup file from the the Slope Indicator web site: www.slopeindicator.com. The web site always offers the most recent version.

You can also install DMM from a Resource CD, but be sure to check the date on the Resource CD. If it is more than four months old, you may have better results by downloading DMM from the website.

Instructions for both methods follow.

Downloading DMM

1. Start your browser and navigate to www.slopeindicator.com.
2. Choose Downloads.
3. Choose Software.
4. Choose DMM for Windows.
5. Follow on screen instructions to download and install the software. You may want to print the instructions.

Installing DMM from a Resource CD

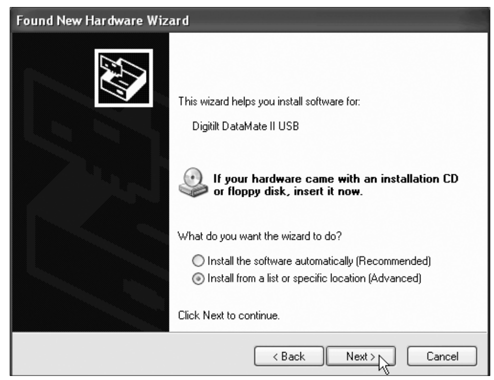
1. Insert the Resource CD in your CD-ROM drive.
2. Wait for your browser to start. If necessary, eject and reinsert the CD, or start your browser, navigate to the CD, and open the file called cdmenu.html.
3. Choose software from the menu.
4. Choose DMM for Windows.
5. Follow on screen instructions. It may be useful to print the instructions.

Installing USB Drivers (DataMate II Only)

The DataMate II connects to the PC via a USB cable. Follow the steps below to install the USB software. There are two drivers, so you go through two installation procedures.

1. Start your PC.
2. Connect the DataMate to the PC.
3. Switch the DataMate on.
4. The hardware wizard appears and asks to search for software.
5. Choose “No, not this time.”
6. Click Next.

1. Windows wants to install software for the Digitilt DataMate II USB.
2. Choose “Install from a list or specific location.”
3. Click Next.



1. Windows asks for the location of the driver.
2. Click “Include this location in the search.”
3. Enter the following path. You can also browse to the path:

C: \program files\dmmwin\DGSI-USB-Drivers\Win2k-XP

This folder contains 32-bit drivers. In the future, there will also be a folder with 64-bit drivers, which you would choose if you have a 64 bit operating system.

4. Click Next.

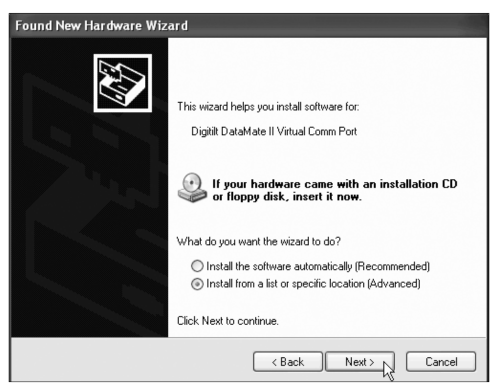
Installing USB Drivers Continued

1. Windows starts the installation process.
2. If you see this warning message, choose "Continue Anyway."

1. Windows completes the installation and displays this screen.
2. Click Finish.

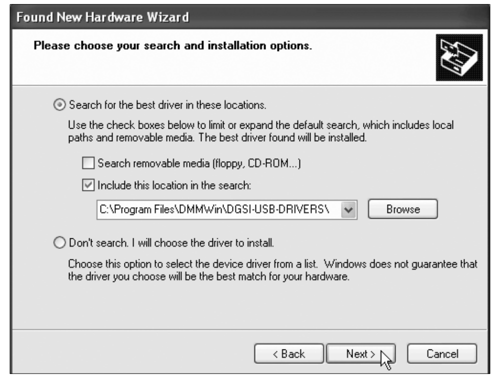
1. Windows immediately detects new hardware.
2. Another wizard appears and asks to search for software. Choose "No, not this time."
3. Click Next.

1. Windows wants to install software for the Digitilt DataMate II Virtual Comm Port.
2. Choose "Install from a list or specific location."
3. Click Next.



Installing USB Drivers Continued

1. Windows asks for the location of the driver.
2. Click “Include this location in the search.”
3. The path you recently entered should appear. If not, enter or browse to the following path:

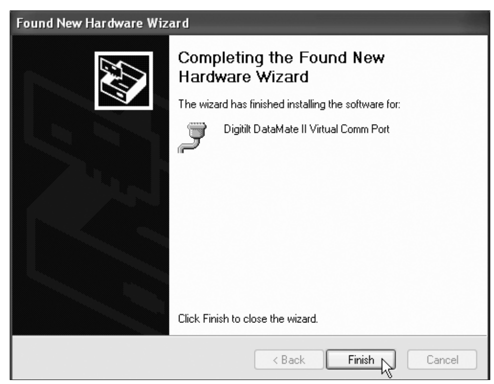


C: \program files\dmmwin\DGSI-USB-Drivers\Win2k-XP

(or the 64-bit folder name, if you have a 64-bit OS.)

1. Windows starts the installation process.
2. If you see this warning message, choose “Continue Anyway.”

1. Windows completes the installation and displays this screen.
2. Click finish.



Note: You must tell DMM which com port to use for the USB device:

1. Start DMM.
2. Choose DataMate - Options. DMM displays the available com ports.

This USB device is likely to use the Com port with the highest number. For example, if DMM lists Com1, Com4, and Com7, try Com7 first.

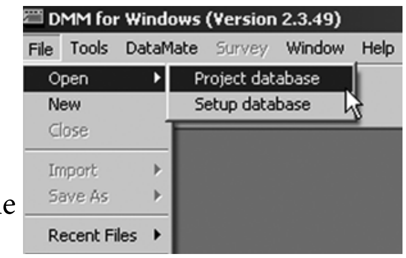
Quick Tour of DMM

Start DMM

1. Click the Start button.
2. Choose Programs.
3. Choose DMM for Windows.
4. Click on DMMWin.exe from the slide-out menu.

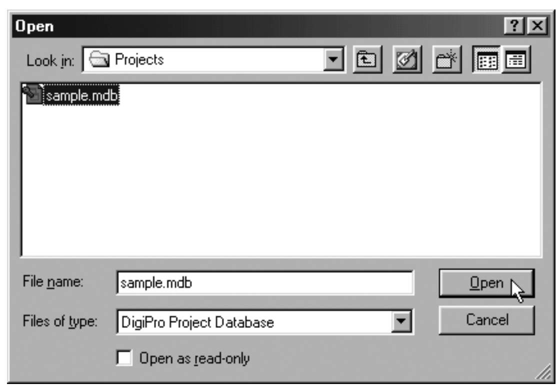
Open the Sample Database

1. Choose File.
2. Choose Open - Project Database.
3. DMM displays a folder of project databases. The default folder is called Projects and is located in the DMM folder.



   You can use different folders for your projects. DMM remembers the last folder used. DMM keeps a recent file list, so you can also select your database from File-Recent Files.

4. For now, select "sample.mdb" and click the Open button.



The Database Window

DMM opens a window to show the database. You can open other databases, too. Every database appears in its own window.

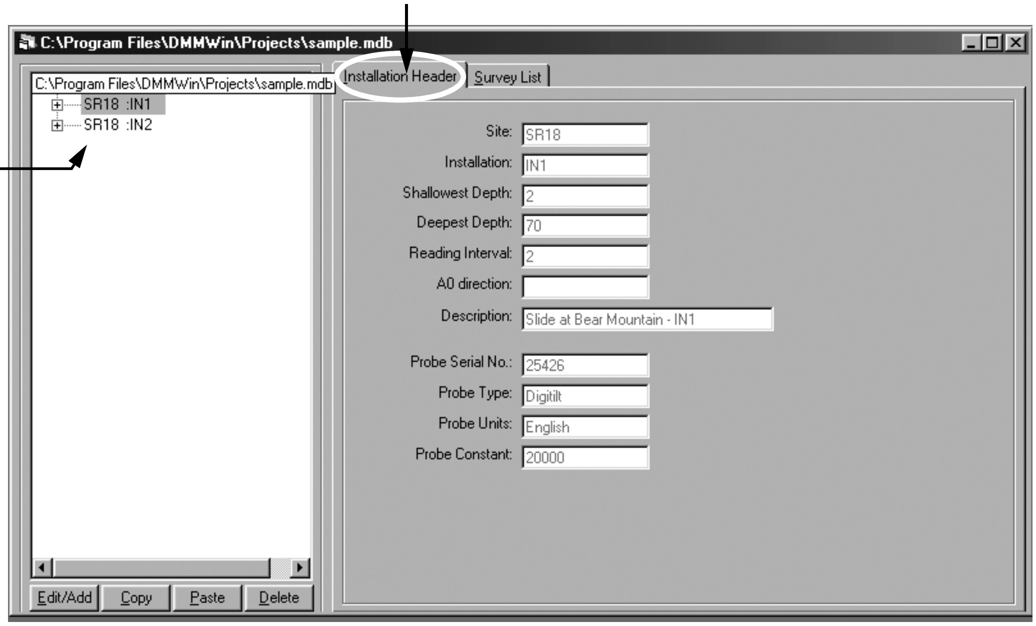
Viewing Installations

The first view of a database shows inclinometer installations. An installation, sometimes called a “borehole” or “hole” is the installed inclinometer casing.

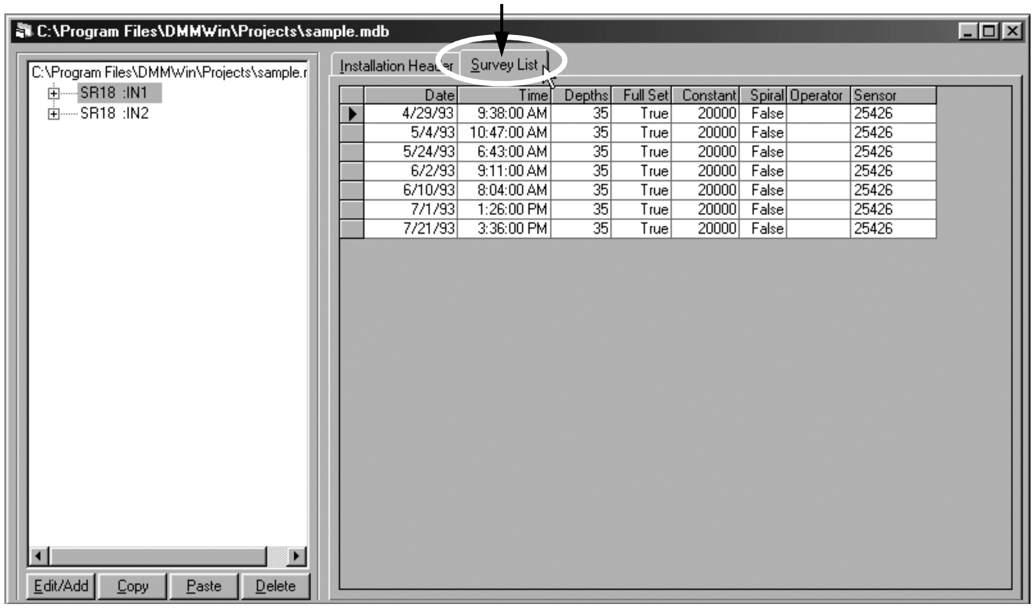
The Installation Header tab shows installation parameters.

Database name

These are installations.



The Survey List tab shows surveys for the installation.



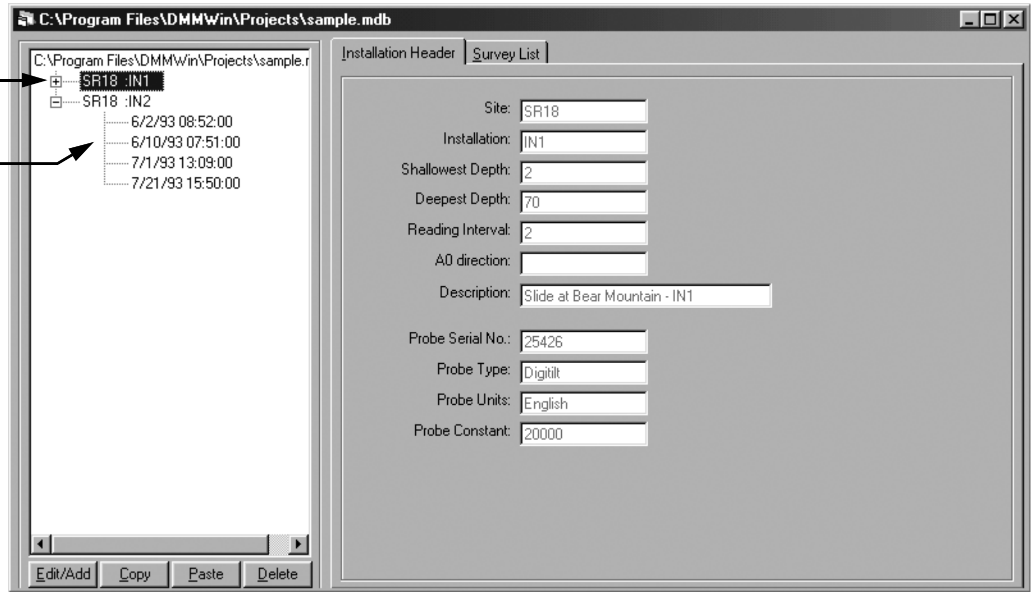
The fields in this view are mainly for trouble-shooting. It lets you check that the number of depths is the same for each survey, etc.

Viewing Surveys

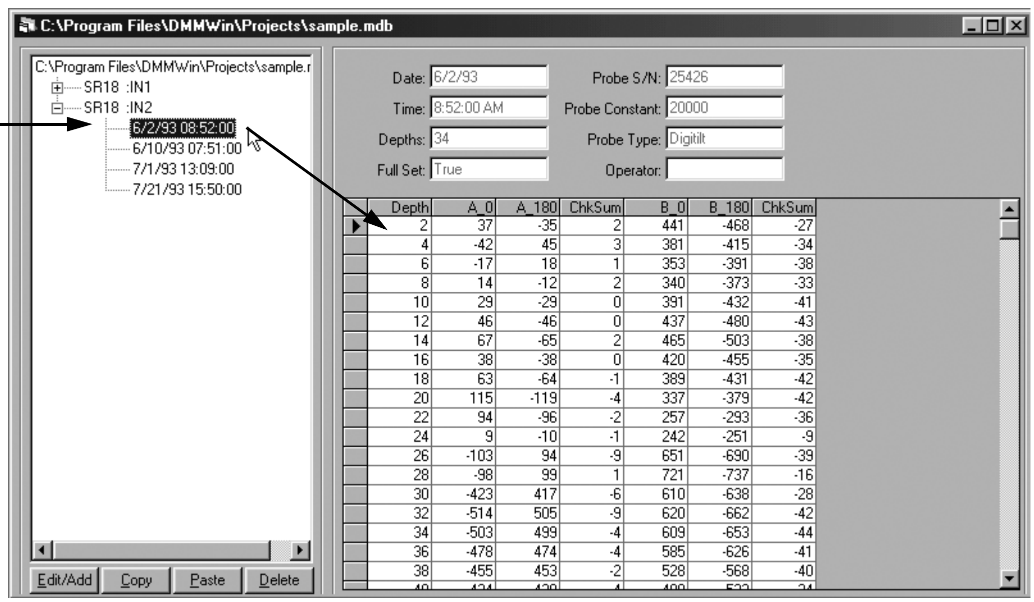
Click the + next to an installation to see surveys sorted by date. Surveys, sometimes called datasets, are the readings from the inclinometer probe.

Click + to see surveys.

Surveys are listed by date and time.

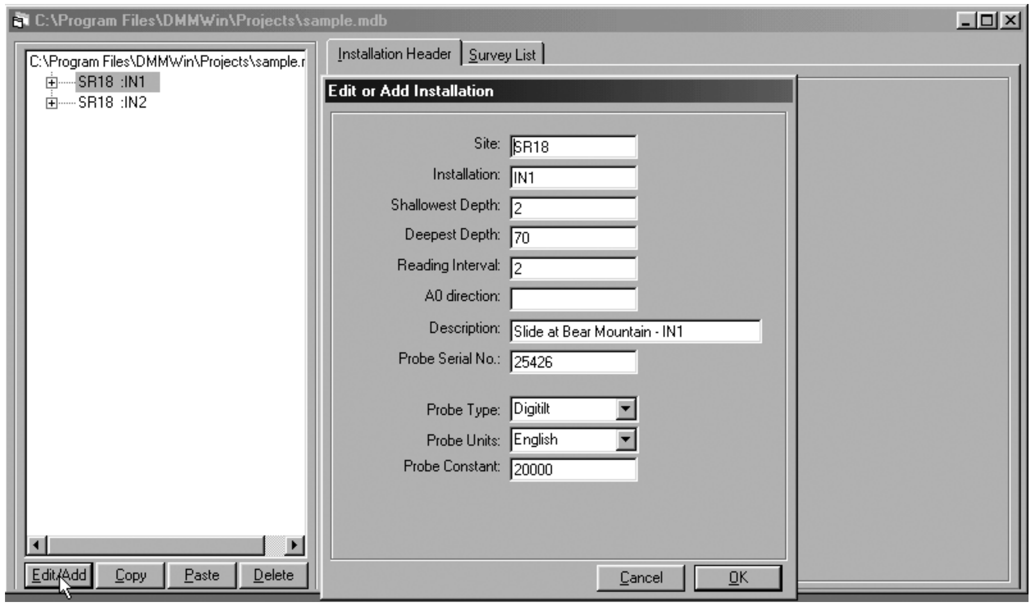


When you select a survey, readings appear at right



Editing Installations

Select an installation, then click the Edit/Add button.



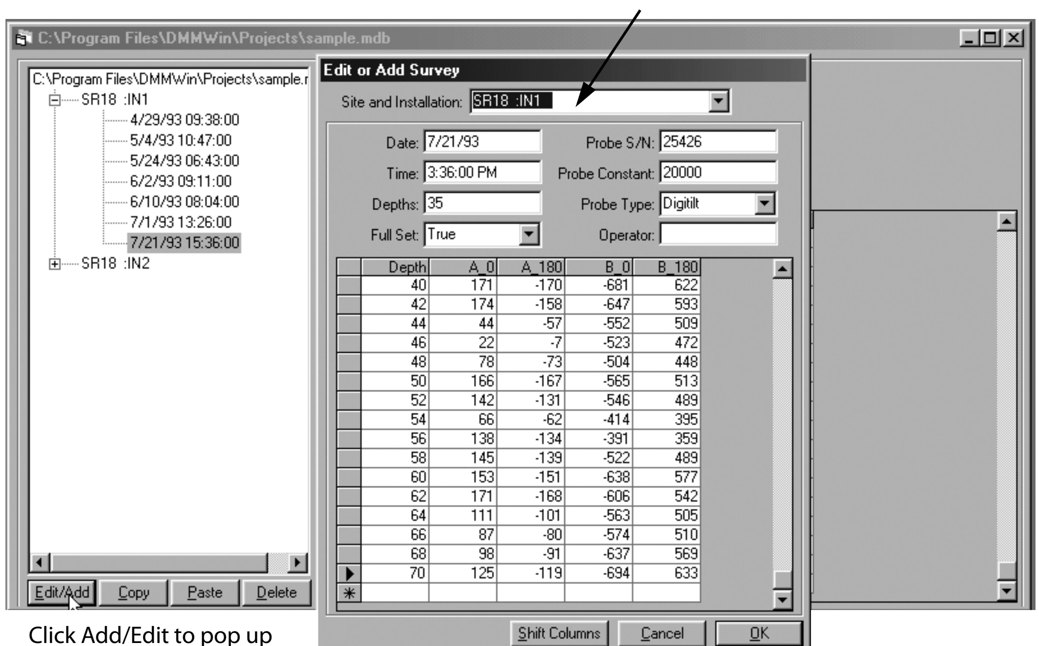
Click Add/Edit to pop up an edit window.

The edit window shows the selected installation and allows you to make changes.

Editing Surveys

Select a survey, then click the Edit/Add button.

Use this field to move a survey to a different installation.



Click Add/Edit to pop up an edit window

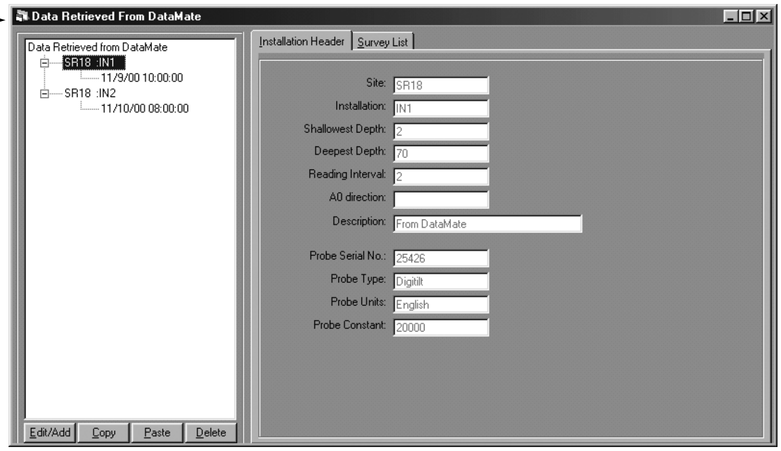
The edit window shows the selected survey and allows you to make changes.

Retrieving Data from the DataMate

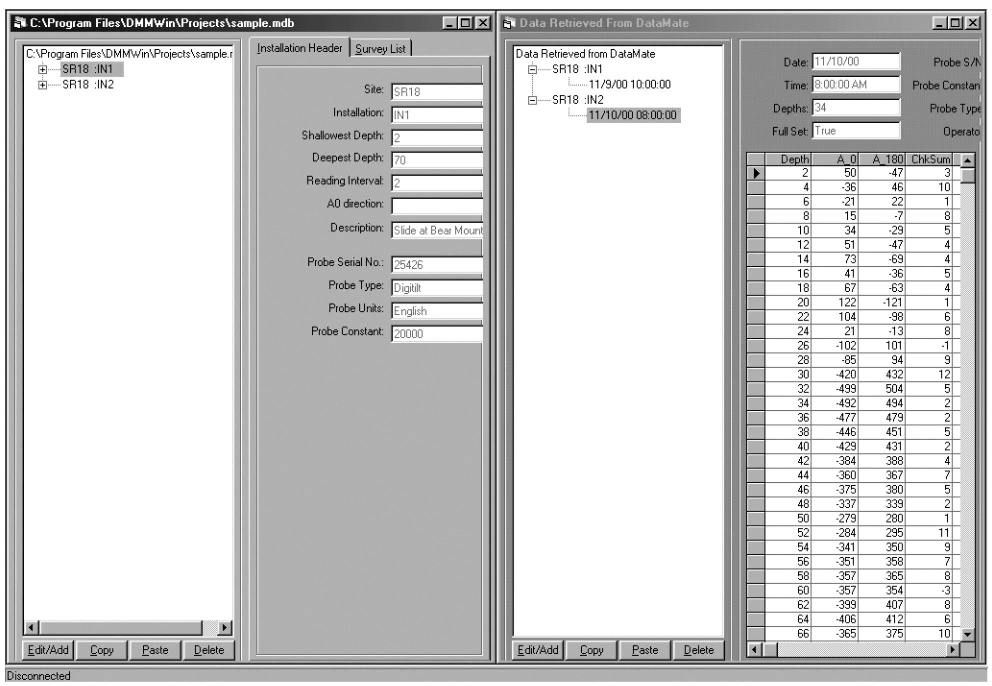
1. Connect the DataMate to your PC.
2. Run DMM and choose DataMate-Retrieve All or Retrieve New from the menu. DMM displays the retrieved data in a window.

This window is called: "Data retrieved from DataMate".

You will drag and drop surveys from this window into your project database.



3. Open a project database to receive the data. Place the two windows side by side using the Windows-Tile command.



Project Database

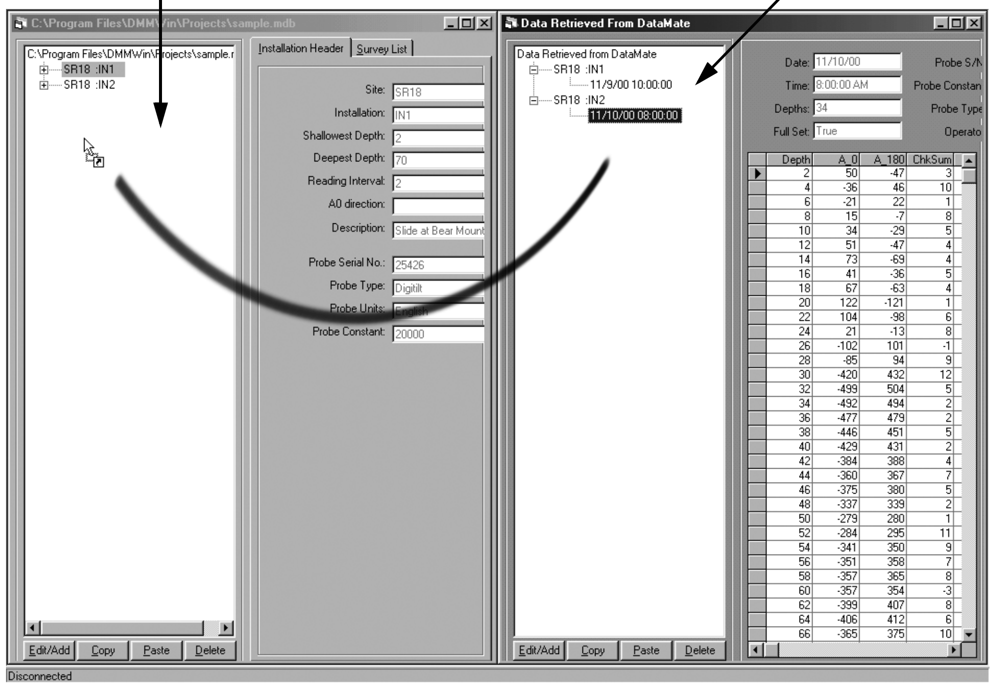
Data Retrieved from DataMate Window

Retrieving Data continued

4. Click, drag, and drop surveys one by one. Click on the survey to select it. Then drag and drop it into the project database. It is not necessary to drop the survey on the installation. You can also use the copy and paste buttons: copy from the temporary database, and paste into the project database.

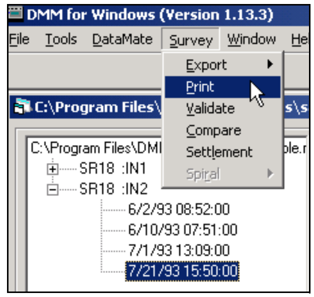
First, click on a survey to select it.

Then drag and drop the survey anywhere in this window.



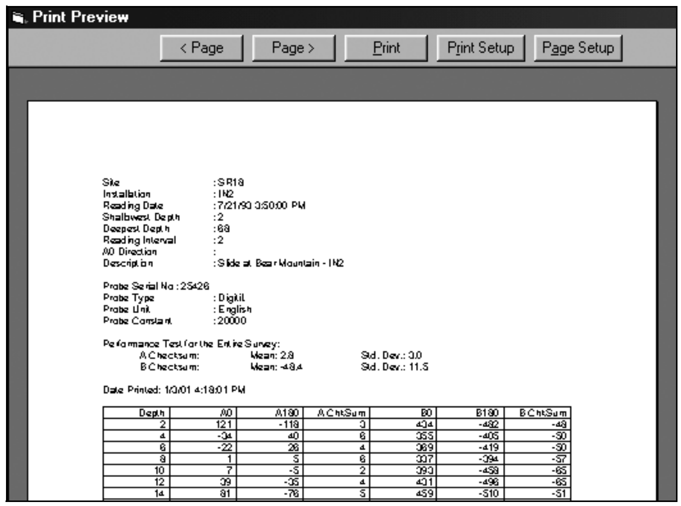
Printing a Survey

1. Choose Survey-Print from the menu bar.



2. The print preview screen appears.

Zooming To zoom in, double-click the left mouse button. To zoom out, double-click the right mouse button.



Site : SR18
Installation : IN2
Reading Date : 7/21/93 3:50:00 PM
Shallowest Depth : 2
Deepest Depth : 68
Reading Interval : 2
A0 Direction :
Description : Slide at Bear Mountain - IN2

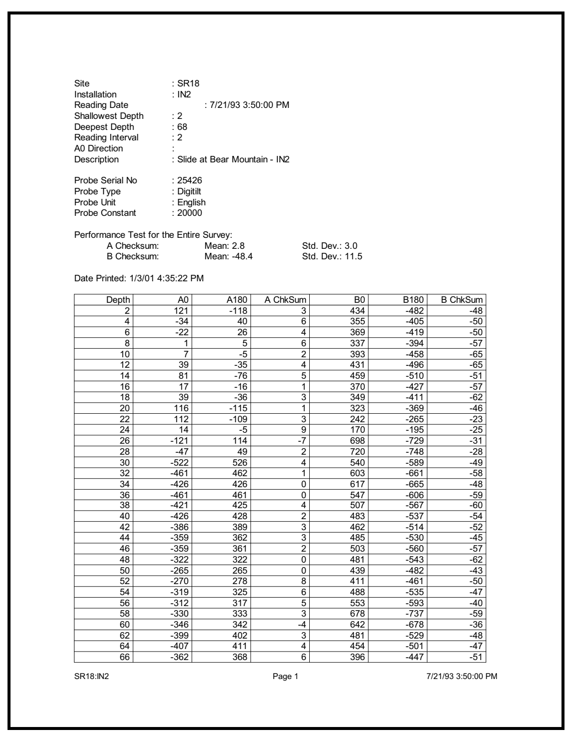
Probe Serial No : 25426
Probe Type : Digitilt
Probe Unit : English
Probe Constant : 20000

Performance Test for the Entire Survey:
A Checksum: Mean: 2.8 Std. Dev.: 3.0
B Checksum: Mean: -48.4 Std. Dev.: 11.5

Date Printed: 1/3/01 4:18:01 PM

Depth	A0	A180	A ChkSum	B0	B180	B ChkSum
2	121	-118	3	434	-482	-48
4	-34	40	6	355	-405	-50
6	-22	26	4	369	-419	-50
8	1	5	6	337	-394	-57
10	7	-5	2	393	-458	-65
12	39	-35	4	431	-496	-65
14	81	-76	5	459	-510	-51

3. The printed page looks like this:



Site : SR18
Installation : IN2
Reading Date : 7/21/93 3:50:00 PM
Shallowest Depth : 2
Deepest Depth : 68
Reading Interval : 2
A0 Direction :
Description : Slide at Bear Mountain - IN2

Probe Serial No : 25426
Probe Type : Digitilt
Probe Unit : English
Probe Constant : 20000

Performance Test for the Entire Survey:
A Checksum: Mean: 2.8 Std. Dev.: 3.0
B Checksum: Mean: -48.4 Std. Dev.: 11.5

Date Printed: 1/3/01 4:35:22 PM

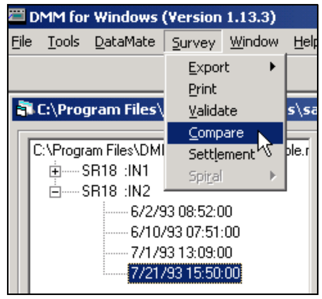
Depth	A0	A180	A ChkSum	B0	B180	B ChkSum
2	121	-118	3	434	-482	-48
4	-34	40	6	355	-405	-50
6	-22	26	4	369	-419	-50
8	1	5	6	337	-394	-57
10	7	-5	2	393	-458	-65
12	39	-35	4	431	-496	-65
14	81	-76	5	459	-510	-51
16	17	-16	1	370	-427	-57
18	39	-36	3	349	-411	-62
20	116	-115	1	323	-369	-46
22	112	-109	3	242	-265	-23
24	14	-5	9	170	-195	-25
26	-121	114	-7	698	-729	-31
28	-47	49	2	720	-748	-28
30	-522	526	4	540	-589	-49
32	-461	462	1	603	-661	-58
34	-426	426	0	617	-665	-48
36	-461	461	0	547	-606	-59
38	-421	425	4	507	-567	-60
40	-426	428	2	483	-537	-54
42	-386	389	3	462	-514	-52
44	-359	362	3	485	-530	-45
46	-359	361	2	503	-560	-57
48	-322	322	0	481	-543	-62
50	-265	265	0	439	-482	-43
52	-270	278	8	411	-461	-50
54	-319	325	6	488	-535	-47
56	-312	317	5	553	-593	-40
58	-330	333	3	678	-737	-59
60	-346	342	-4	642	-678	-36
62	-399	402	3	481	-529	-48
64	-407	411	4	454	-501	-47
66	-362	368	6	396	-447	-51

SR18:IN2 Page 1 7/21/93 3:50:00 PM

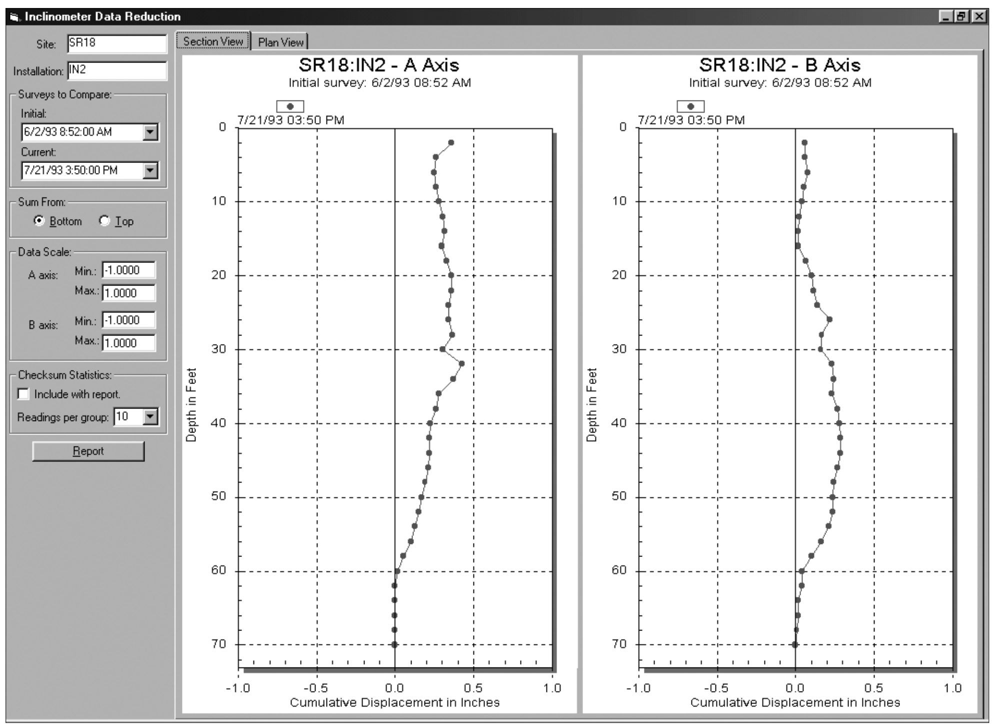
Plotting Survey Data

DMM has a convenient plotting routine that lets you compare two surveys.

1. Click on a survey, then choose Survey - Compare from the menu bar.



2. DMM displays a graph of cumulative displacement.



3. Now that you've seen DMM's main features, please take a look at the rest of the manual.

Menu Summary

File

Use this menu to create, save, open, and close databases.

Open: Offers a choice of project database or setup database. A project database contains your inclinometer surveys. A setup database contains a list of installations that you send to the DataMate.

New: Creates a new project database in its own window.

Close: Closes the database in the active window. All changes are saved. There is no explicit "Save" command.

Import: Imports surveys from RPP, PCSLIN, and GTILT. See Appendix 5, Importing Data.

Save As: Offers a choice of a project database or a setup database. Used to copy a database or create a setup database.

Recent Files: Shows the path and name of the most recently opened databases. Click on a database to open it.

Exit: Closes the DMM program.

Tools

Compact Database: Removes empty spaces left in the database after heavy editing.

Convert HDR to MDB: Starts the HDR2MDB utility to convert a DOS database to a Windows database. See Appendix 3.

DataMate

Use this menu to communicate with the DataMate.

Retrieve New: Retrieves only *new* surveys and displays them in a special window called "Data Retrieved from DataMate." In DataMate terms, "New" means a survey that is not stamped with a ^. The ^ stamp indicates that the survey has been retrieved at least once. If there are no new surveys, this command retrieves only a list of installations.

Retrieve All: Retrieves *all* surveys and displays data in a special window called "Data Retrieved from DataMate." This command always retrieve surveys, new and old, if there are any in the DataMate.

Send Setup: Used to transfer a setup database to the DataMate. Erases the DataMate's memory, then transfers the contents of the active database to the DataMate. This command is normally used to send a setup database to the DataMate, but it can be used to send a project database to the DataMate (within limits of memory).

DataMate Menu, Continued

Erase Memory: Erases installations and surveys from the DataMate and leaves the memory blank.

Options: Used to set the communications port. Also used to change the background color of the DataMate Window.

Survey

This menu becomes active when you have selected a survey. The same commands appear on a right-click menu, as well.

Export: Offers choice of exporting to RPP, Tab-Delimited ASCII, or PCSLIN. See Appendix 7.

Print: Prints the current survey along with checksum statistics.

Validate: Prints checksum statistics for the current survey.

Compare: Reduces data and displays a displacement graph of the A-axis and B-axis. Provides a “report” function that prints printing of the graphs along with data and statistics. See the chapter on data reduction and graphing for details.

Settlement: Generates a survey that is adjusted for settlement. See Appendix 10.

Spiral: Generates an interpolated spiral survey used for spiral corrections in DigiPro. This command becomes active only if there is a spiral survey found in the database. See Appendix 9.

Right-Click Survey Menu

The menu items above also appear on a right click menu. To display the menu, select a survey, then click the right button of your mouse.

Window

Use the Window menu to arrange windows on your screen. This is useful when you retrieve data from the DataMate.

Cascade: Stacks windows on top of each other, leaving only title bars visible, except for the window in front.

Tile Vertical: Arranges windows side by side. Useful for dragging surveys from the DataMate window to the project database window.

Tile Horizontal: Arranges windows side by side, using the full width of each window.

Help: Displays the version number of the program. The version number is also visible on the title bar.

Creating a Project Database

What's a Project Database?

The project database stores a list of inclinometer installations and the inclinometer surveys recorded for each installation.

Installation: This is a term used by Slope Indicator to refer to installed inclinometer casing. Other commonly used names are "inclinometer," "well," or "borehole." The project database holds the name of the installation, its depth, and measurement intervals.

Survey: This is a term used by Slope Indicator to refer to readings that are recorded for an installation. Other commonly used terms are "reading set" or "data set."

Creating a New Project Database

1. Start DMM.
2. Choose File-New.
3. Enter a name for the project, choose a folder, and click Save.
4. The new database is empty. The next steps explain how to add installations.

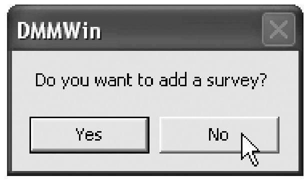
Overview of Adding Installations

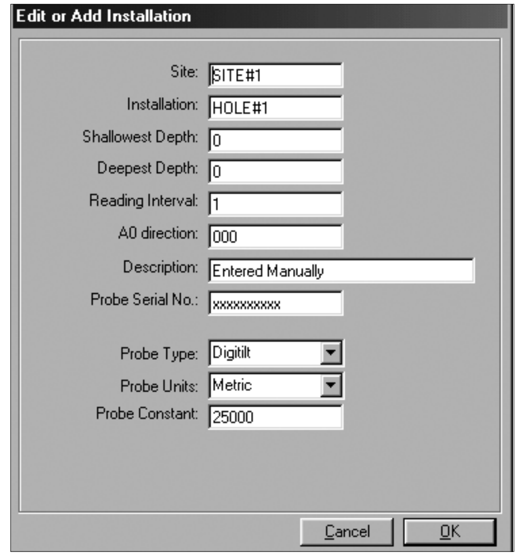
There are several ways to add installations to the new database.

- You can add installations manually, as discussed next.
- You can retrieve data from the DataMate. This adds both installations and surveys. See "Retrieving Surveys."
- You can drag and drop installations from other DMM databases into the new database. This brings surveys as well. See "How To - Make a Composite Database."
- You can import data from legacy formats. This brings in both installations and surveys. See Appendix 1.

Adding Installations Manually

1. Click Edit/Add.
2. Enter the required information. Each field is explained below.
3. Click OK.
4. Click No to the prompt asking if you want to add a survey.





Installation Fields

Site & Installation: Every installation has a two-part identifier: “site” and “installation.” Enter up to 6 characters for each part.

Shallowest Depth: Typically, 0.5 for metric-unit systems or 2 for English-unit systems. Unit labels are not used.

Deepest Depth: Enter the appropriate value. With English-systems, it is best to use an even number so that 2-foot intervals coincide with cable markings. Unit labels are not used.

Reading Interval: Typically, 0.5 for metric-unit systems and 2 for English unit systems. Unit labels are not used.

A0 direction: Optional field of 3 characters for entering the compass heading of the A grooves. Not used for any calculation.

Description: Optional field up to 35 characters long.

Probe Serial No: Enter the serial number of the probe assigned to this installation.

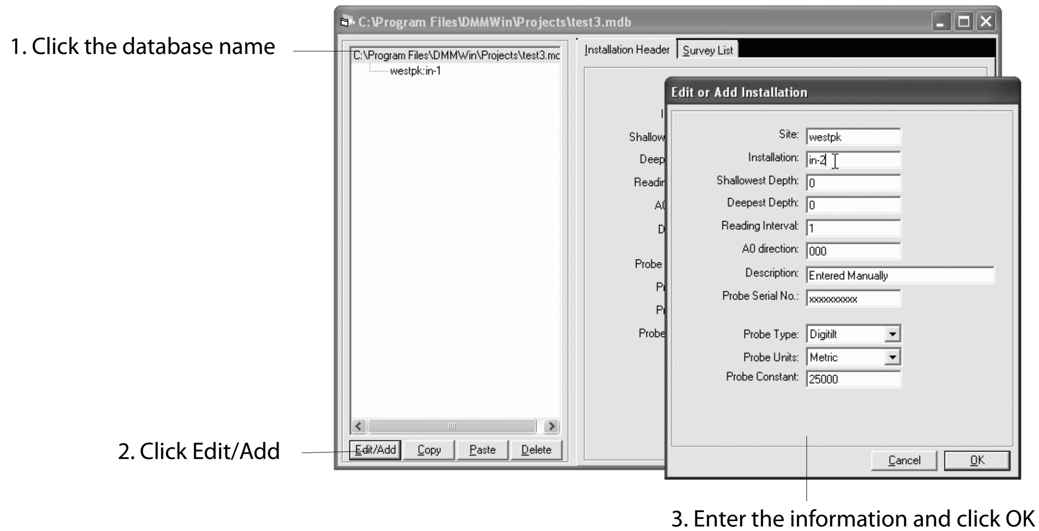
Probe Type: Choose Digitilt for inclinometers.

Probe Units: Choose Metric or English. If you don’t know, check the distance between the upper and lower wheels of the probe: 0.5 m for metric systems; 2 feet for English-unit systems.

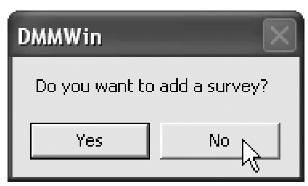
Probe Constant: Enter 25000 for metric-unit systems and 20000 for English-unit systems.

Add Another Installation

1. Click on the name of the database at the top of the column.
2. Click Edit/Add.
3. Enter the required information and click OK.

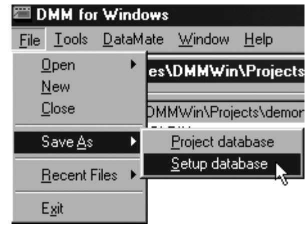


4. Answer No to the "Add Surveys" prompt.



Setting Up the DataMate

Create a Setup Database



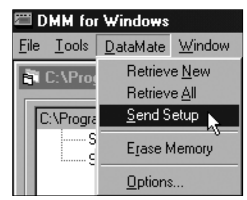
1. Open your project database.
2. Choose File-Save As Setup Database.

   DMM copies installations from the project database into a setup database. No surveys are copied.

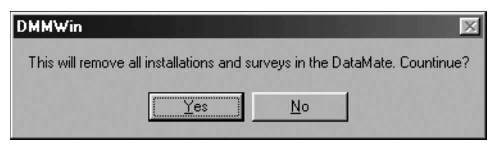
   The default name for the setup database is “setup for [name of your project database].” The default folder is “Setups” and is located in the DMM folder. You can use a different name and folder for your setups.

Send the Setup to the DataMate

1. Connect the DataMate to your serial port. Switch on the DataMate and select Comm. The DataMate displays: Waiting for PC.
2. Choose File-Open-Setup Database, if necessary. The setup database must be displayed.
3. Choose DataMate-Send Setup.



4. Sending a new setup removes any data that is in the DataMate. This is normally what you want, so click Yes.



   If you are not sure, click No. Then retrieve all surveys that are in the DataMate. You can store the retrieved surveys in a temporary project database, if necessary, and sort it out later.

5. DMM then sends the setup database to the DataMate. If you see an error message, try the troubleshooting steps listed on the next page.
6. When the database has been sent, check that the DataMate contains the required installations, then switch the DataMate off.

Note You can also send a project database to the DataMate, using the Send Setup command. Sending a project database sends the surveys as well, so check that you have not completely filled the memory.

Trouble-Shooting Communications

- If you see this error message, DMM may be using the wrong comm port. Choose DataMate-Options. DMM then scans for available comm ports and displays a list. Choose a different comm port and try again. Use this method even if you have a DataMate II, which uses USB communications.
- If DMM does not display a comm port that you think should be available, check if an "Active Sync" or "Hot Link" program is running and disable it. Such programs, supplied with Palm or Windows CE palmtop computers take control of the serial port and do not allow other devices to operate through it.
- All DataMates manufactured before the DataMate II use RS-232 serial communications. Most new notebook computers and many desktop computers no longer offer a serial port, so you can't connect the interface cable to the PC. (Note that serial port has 9 pins. Do not confuse it with a monitor port, which has 15 pins).

  You can solve this problem by purchasing a Serial to USB adaptor at your local computer store. One end connects to the USB port on your PC. The other end connects to the serial interface cable supplied with the DataMate. You must also install the USB drivers supplied with the adaptor. It is always a good idea to check the manufacturer's web site to download the most recent drivers.

More about Setup Databases

- The "File-Save As-Setup Database" command makes a copy of your project database, but removes survey data, so that only installation information remains.
- You can add installations from other project databases or other setup databases to your setup database. See the "How To" section for suggestions.
- When you send a setup database to the DataMate, it clears the entire data memory of the DataMate. If you share your DataMate, you may not want to erase installations and data that belong to someone else. In this case, add new installations using the DataMate's keypad.
- The original DataMate holds up to 40 installations. The DataMate II can hold 160. Your setup database must not have more installations than these maximums.
- The project database and the setup database are not linked. Thus, if you make changes to installation information in the project database, you should update your setup database or overwrite it with the Save-As Setup command.

Retrieving Surveys

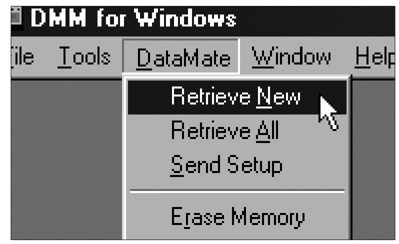
Overview

Retrieving surveys is a two step process.

1. Retrieve the surveys.
2. Copy the surveys into your project database.

Retrieve the Surveys

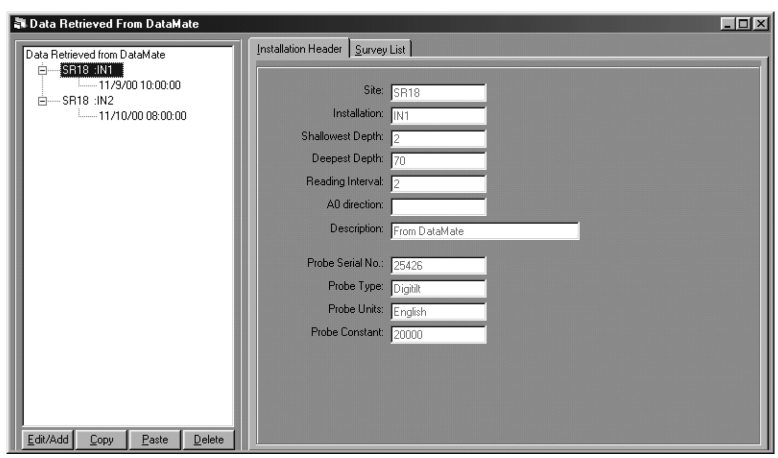
1. Connect the DataMate to your PC. Select Comm.
   The DataMate displays: Waiting for PC.
2. Run DMM. Choose DataMate - Retrieve All (or Retrieve New).



   If you choose Retrieve All, DMM displays all surveys. If you choose Retrieve New, DMM displays only new surveys (that have not been retrieved before).

   DMM retrieves the surveys from the DataMate. You can see its progress at the bottom left of the screen. If you have communications problems, see the troubleshooting steps in the previous chapter.

3. DMM displays the retrieved surveys in a temporary database window. This window is titled “Data Retrieved from DataMate” and is a slightly darker color. You can change the color of the window to make it easier to identify: Choose DataMate-Options. The color-change takes effect the next time that you retrieve surveys.



Data retrieved from DataMate is displayed in a temporary database.

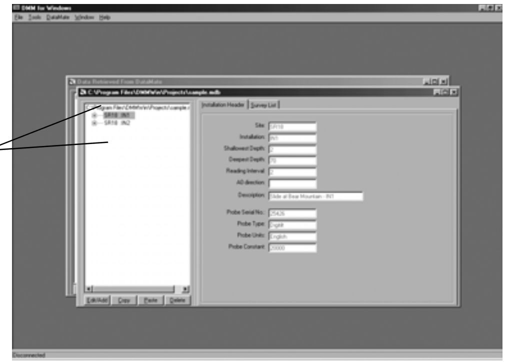
You can change the color of this window to make it easy to identify.

Copy Surveys to your Project Database

1. Open a project database to receive the data. If your DataMate holds surveys from different projects, you can open other project databases at the same time.

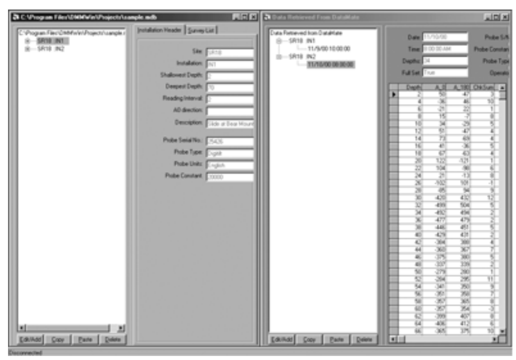
The project database window opens in front of the DataMate window.

To transfer surveys, you must see both windows, as shown below.



2. To position the windows side by side for easy drag and drop, Choose Windows - Tile Vertical.

Use the Windows Tile command or press Ctrl-T to place the windows side by side.



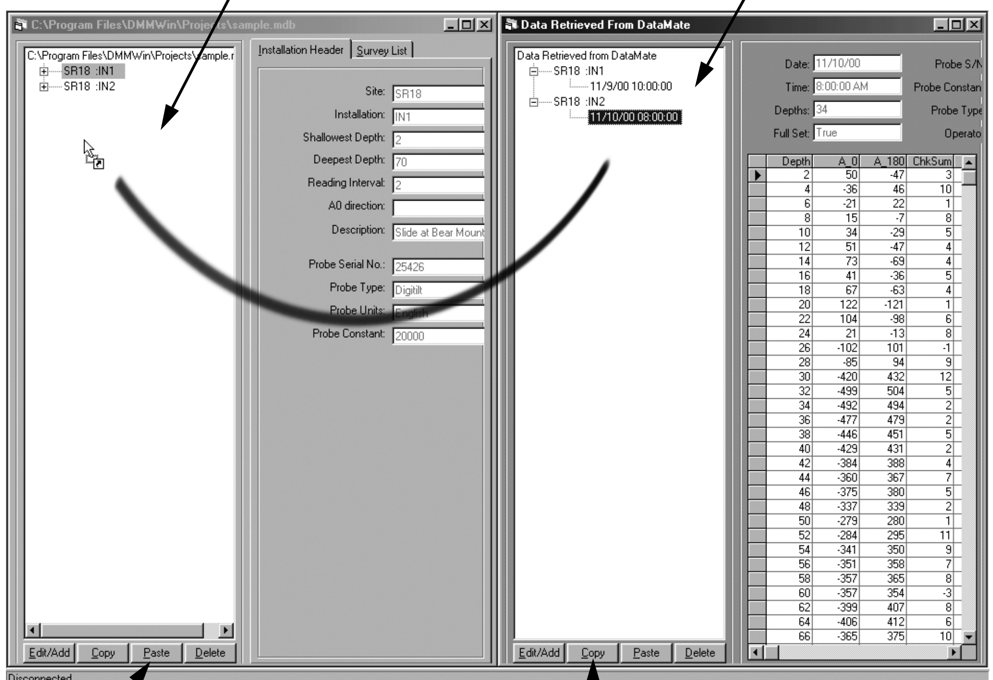
Project Database   Data Retrieved from DataMate

Retrieve Data continued

3. Click, drag, and drop surveys one by one from the DataMate window to the project window. It is not necessary to drop the survey on the installation. If you have difficulty copying surveys, you are probably trying to drag the survey before you select it. Instead of drag and drop, think: "Click, Drag, and Drop.

   You can also use the copy and paste buttons to copy from the temporary database and paste into the project database.

Click, drag, and drop: Click on a survey to select it, then drag the survey to the project window and drop it.



Using Copy and Paste: Click on a survey, click on the Copy button, and then click on the Paste button in the project window.

Data Reduction and Graphing

Introduction

Slope Indicator offers two programs for reducing inclinometer data: DMM for Windows and DigiPro for Windows.

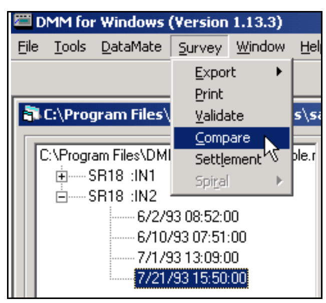
DMM for Windows can calculate checksum statistics, deviations, and displacements, and it can also create a graph of cumulative deviation or cumulative displacement (two surveys only).

DigiPro for Windows offers full graphing capabilities, more graph types, the ability to add titles, and a error correction routines. You can download a run-limited, full working version of DigiPro and the DigiPro manual from www.slopeindicator.com.

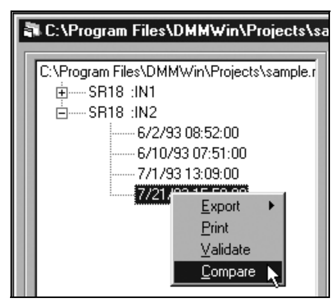
Data Reduction in DMM

DMM's data reduction functions are on the Survey menu or a right click menu. You must select a survey to activate the menus.

1. In the navigation window, click on the + next to an installation. Now you can see a list of surveys.
2. Select a survey.
3. Now click Surveys on the menu bar or click the right button on your mouse.



Select a survey, then click Survey on the menu bar.



The Right-Click Survey Menu

Print: DMM prints readings and checksums for the selected survey.

Validate: DMM displays the mean and standard deviation of checksums for the selected survey.

Compare: DMM compares the selected survey against an initial survey and displays graphs for the A and B axes. You can print a report that includes readings, graphs, and optionally, checksum statistics.

Printing Data

1. Select the survey that you want to print.
2. Click "Survey" on the menu bar.
3. Choose Print. DMM displays a print preview. It provides the following functions:

   Page: Page forward or backward through the preview.

   Print Setup: Choose a printer.

   Page Setup: Choose paper size and margins.

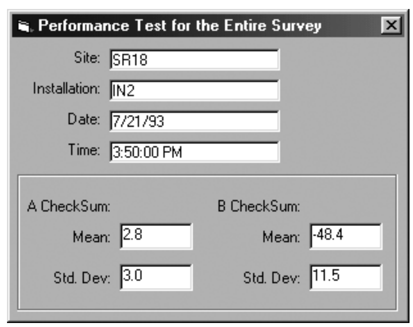
   Print: Print the data. You can print pages selectively.

   Left-Click: Double-click the left mouse button to zoom in. Drag the mouse to move the image.

   Right-click: Double-click the right mouse button to zoom out.

Validating Data

1. Select the survey that you want to validate.
2. Click "Survey" on the menu bar.
3. Choose Validate. DMM displays a table of checksum statistics. Click the X to close the table.



About Checksums

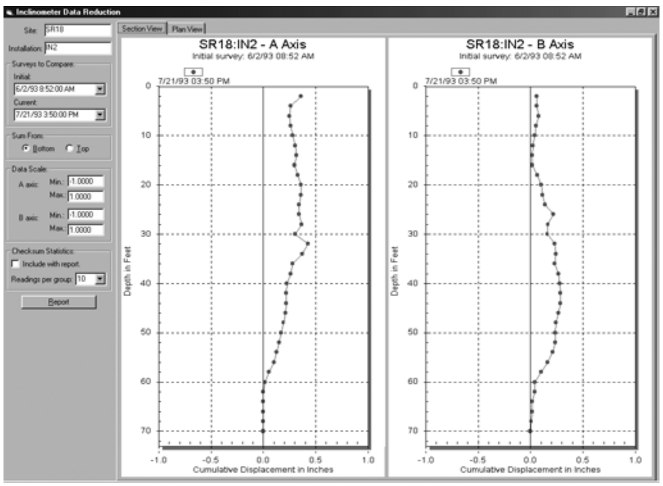
Checksums are one way to measure of the quality of your readings, but don't place too much importance on them. The consistency of checksums from survey to survey is more important than the actual value of the checksums. The standard deviation value is useful for comparing surveys.

Look at the checksums in DMM's display of survey data, especially if you have imported data or entered data manually. Very high checksums often reveal an omitted + or - sign.

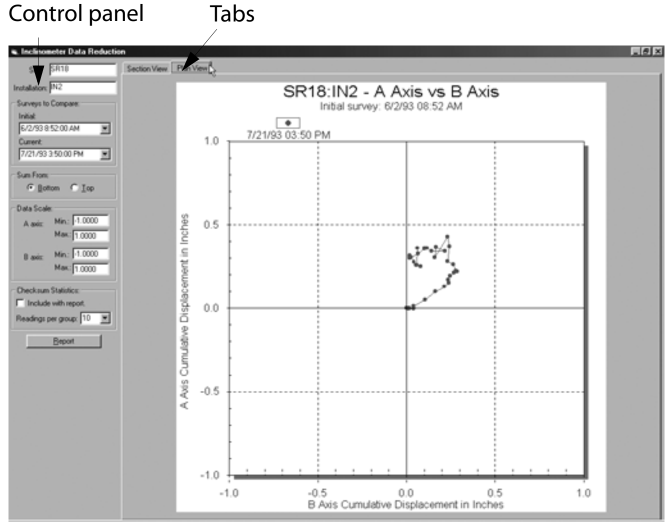
Look for a trend of checksums within a survey. A trend of decreasing checksums from bottom to top can be caused by omitting a warm up period for the probe. Trends of increasing or decreasing checksums within a survey may also indicate a problem with the probe.

Graphing

1. Select the survey that you want to compare.
2. Click “Survey” on the menu bar.
3. Choose Compare.
4. DMM displays a graph of cumulative displacement (movement). Note that DMM compares only two surveys.
5. Click on the tabs to show different views. Use the control panel to change options for the graphs and the printed report.

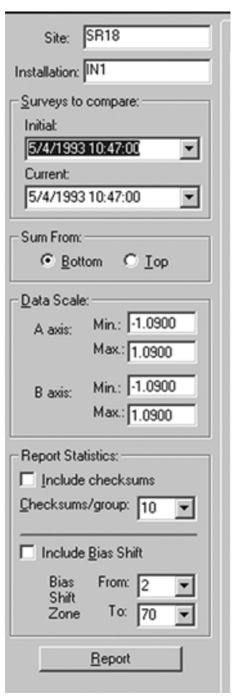


Section View: This view shows standard displacement graphs. A and B data are plotted against depth and shown in separate graphs.



Plan View: This view combines A and B-axis data by plotting the A value vs the B value at each depth.

Control Panel



Use the fields and buttons panel on the left side of the screen to control the graph.

Initial: Select a different initial survey. By default, DMM selects the earliest survey. You can also select “none” to force DMM to display a graph of cumulative deviation (the borehole profile).

Current: Select a different survey for comparison.

Sum From: Select top or bottom. Vertical inclinometers normally use sum from bottom since the bottom of casing is installed in stable ground.

Data Scale: We recommend that you use the scales set by DMM. You can enter other values, if necessary.

Printing a Report

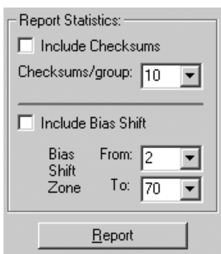
Report Button: When you click the Report button, DMM produces a report consisting of readings, graphs, and optional data. The report is displayed on screen as a print preview. You can page through the print preview and print all pages, the current page, or a range of pages. Some additional pages are added when you include checksum statistics and bias shift analysis.

Plain Report

With no checksum or bias shift information, the report contains:

- A-Axis readings, deviations & displacements in table form.
- B-Axis readings, deviations & displacements in table form.
- Graphs containing A-axis and B-axis displacement plots.
- Graphs of A-axis vs B-axis.

Include Checksums



To include checksum information with your report, click in the checkbox. (A check shows that checksum information will be included). Checksum statistics include a mean checksum and standard deviation of checksums for all readings in the survey. If the installation is deep, you may want to see statistics for smaller number of readings. To do this, enter a value from 1 to 10 in the groups field. Checksum information adds these pages to the report.

- A-axis readings, checksums, and change in checksums.
- A-axis checksum statistics.
- B-axis readings, checksums, and change in checksums.
- B-axis checksum statistics.
- A-axis readings, differences, and changes in digi units.
- B-axis readings, differences, and changes in digi units.

Include Bias Shift

The bias shift report, explained in Appendix 8, adds one page to the report:

- Differences and shifts for A and B axes.

How To . . .

Move a survey

This is useful if your survey is stored in the wrong place. For example, you chose the wrong installation when you started the survey and now you want to move the data to the correct installation.

1. Select the misplaced survey.
2. Click Edit Add to pop up the edit window.
3. Choose the correct installation from the drop down list at the top of the edit window, and click OK. This makes a copy of the survey and places it under the correct installation.
4. Finally, clean up the database. The original survey - the one you copied - is still there. Select it and click the delete button to remove it from the database.

Rename an Installation

1. Select the installation that you want to rename.
2. Click on Edit/Add to open the edit window.
3. Change the name of the installation and click OK. DMM adds a new installation to your database. There are no surveys under the installation.
4. Copy surveys one by one from the old installation to the new installation using the “misplaced survey” technique above.
5. After the surveys are copied, delete the old installation.

Enter Data Manually

Detailed instructions appear in Appendix 6, but here’s an overview.

- Click on an installation, then click Edit/Add. If there are no surveys, DMM asks if you want to add a survey. Answer yes.
- If there are already surveys for that installation, you click on an existing survey and click Edit/Add to modify the existing survey. This saves you the time of entering header information and depths. Modify the survey as required, changing the date and time first, then entering the appropriate readings. When you click OK, the new survey is added.

Copy a Database

This is useful for making backup-copies of your database.

1. Open a project database.
2. Choose File - Save As.
3. Enter a name and location for the database, and click OK.

Split a Database

1. Open a project database.
2. Choose File - New to create a new project database.
3. Drag and drop installations from the original database to the new database. Surveys are dragged along with the installations.
4. Delete installations from the original database.

Send New Readings to the Head Office

Sometimes there are two project databases, one at the field office and one at the home office. The field office must maintain its own database and send new readings to the head office.

1. When you retrieve surveys from the DataMate, choose "DataMate - Retrieve New." DMM retrieves new readings and displays the temporary DataMate database.
2. Copy the new readings into your field database as usual.
3. Now, while the temporary DataMate database is still open,
4. Choose File - Save As. Enter a name and location for a database that will contain the new readings, and click OK. This saves the new readings in a database that you can send. Close the new database and update your local project database as usual.
5. Then, copy the new database onto disk or email it as an attachment. It will be fairly small because it contains only the new readings. You can use Winzip to make the file even smaller.
6. The DMM user at the head office then copies readings from the database that you sent to the permanent project database.

Delete a line of Data

1. Select the survey and click Edit/Add.
2. Click in the gray box to the left of the line of data. This selects the line.
3. Press the Delete key.

Make a Composite Setup Database

Suppose you have several projects and want the DataMate to hold inclinometers from each of those projects. You may also want the DataMate to hold a previous survey for each of those inclinometers.

To send installations and datasets (surveys) to the DataMate, you make a "setup" database. To make a setup database, simply save your project database as a setup database. DMM makes a copy of the database and then strips out any data, so all that remains is installation information.

To add a previous survey to the setup database, view your project database and setup database side by side (Use the Ctrl-T Tile command) and click-drag-and-drop the needed surveys from the project database to the setup database. Just drop the survey anywhere in the white window. It will find its own way home. Now you can close the project database, but keep your setup database open.

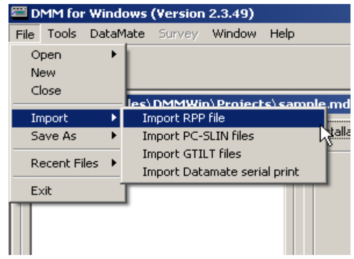
Now, open another project database and tile it side by side with your setup database. You'll be doing click-drag-and-drop operations again. Click-drag-and-drop surveys that you want in the DataMate. The surveys will bring installation information automatically. (Watch out: if you drag an installation, the installation will bring along all of its surveys. So drag a survey, not an installation).

Repeat this for any other installations that you need. Keep in mind that the DataMate has a 40 installation limit and the Datamate II has a 160 installation limit. If more than the maximum is installed, they will be arbitrarily truncated when sent to the DataMate. An alternative to this is to download the contents, save them, modify them (add new setups) and send them back to the DataMate

When the setup database holds the installations and surveys that you need, send the setup to the DataMate. This will cause the DataMate to delete everything that is in its memory and replace it with the contents of the setup database. So be sure that you have retrieved anything that you want from the DataMate before you send the setup.

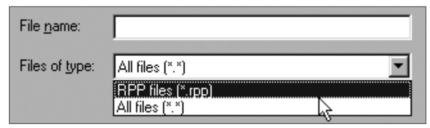
Appendix 1: Importing Data

Importing Data



1. Create a project database.
2. Choose File - Import.
3. Choose the type of import. These are explained below. To import data from a spreadsheet, see page 35.
4. Specify the file to import.
5. Click OK.

RPP Import Notes



- The import routine looks for an extension of RPP. If your RPP file has a different extension, click in the Files of Type field to show All Files.
- The first line of the RPP file must be a date. If DMM gives you an error message, open your RPP file with an ASCII editor such as notepad, and delete any lines above the date line
- If you have trouble importing, check that the date and time formats in the file match the date and time formats of your Windows computer.

The first line of the file must be time and date in this format.

Project and Hole # become Site and Installation. Check that these names are consistent in all surveys for this installation.

Check for missing equals (=).

```
TIME = 09:38:00   29 APR 1993
DIGITILT/SPIRAL = D
ENGLISH/METRIC = E
HOLE # = IN1
PROJECT = SR18
JOB DESC = Slide at Bear Mountain - IN1
DIR CODE =
PROBE SER # = 1
OPERATOR =
START DEPTH = +70.0
END DEPTH = +2.0
INCREMENT = 2.0
INSTR CONST = 20000
ROTATIONAL CORR A = 0.0000
ROTATIONAL CORR B = 0.0000
CALIBRATION CORR A = 0
CALIBRATION CORR B = 0


+2.00    A0    -472    B0    239
       A180     479 B180   -282
+4.00    A0    -265    B0    -17
       A180     273 B180    -13
```

PCSLIN Import Notes

- The import routine looks for an extension of PRN. If your PCSLIN file has a different extension, click in the Files of Type field to change to All Files.
- The first line of the file must start with the word "QUESTIONS." If there is an error, open the PCSLIN file with an ASCII editor such as Notepad and delete any lines before the word "QUESTIONS."

"QUESTIONS" must appear on the first line of the file.

Project No and Hole No become Site and Installation.

The import routine ignores reading set numbers.

Check that the equals (=) are always lined up. If necessary, shorten entries.

```
QUESTIONS
PCSLIN          = DATA FILE NAME
SR18            = PROJECT NO
Slide at Bear Mountain - IN1
IN1             = HOLE NO.
    1           = READING SET NO.
04/29/1993      = DATE
09:38           = TIME
       20.,     = STATISTICS INTERVAL
12345           = INSTRUMENT NO.
         0,     = HALF OR COMPLETE SET OF DATA
      .000,     = A-ROTATION ERROR CORRECTION
      .000,     = B-ROTATION ERROR CORRECTION
    20000.,     = INSTRUMENT CONSTANT
                = A+ COMPASS DIRECTION
                = A- COMPASS DIRECTION
                = B+ COMPASS DIRECTION
                = B- COMPASS DIRECTION
         0,     = SHIFT ANALYSIS PRINT
         0,     = A COMPONENT SHIFT
         0,     = B COMPONENT SHIFT
      400.,     = CHANGE IN READING SCALE
        2.,     = DEFLECTION SCALE
READINGS  ,   35
     2.000,      -472,       479,       239,      -282
     4.000,      -265,       273,       -17,       -13
```

GTilt Import Notes

The Gtilt import routine looks for an extension of GTL. If your file has a different extension, click in the Files of Type field to change to All Files.

Metric files are assigned an instrument constant of 25000 and a reading interval of 0.5 m. English files are assigned an instrument constant of 20000 and a reading interval of 2 feet.

This is truncated to 6 characters and becomes Installation.

This is truncated to 6 characters and becomes Site.

```
SAMPLE1
NORTH PORTAL SLOPE
Urban Transit Authority
North Slope Investigation
E
4
2.25
37
M
637.0
45
10000
 5
*
07061998
1327
1400
Top of cable clamp
31.2
EDM
EDM
EDM
6.45
6.21
TAJ
TAJ


-150  131 -216  236
-54  36 -180  187
 69 -85 -204  218
```

DataMate Serial Print

This import function is included mostly for diagnostics. The DataMate can print a survey to a serial device. There are very few serial printers these days, so a terminal program, such as Hyperterm, is used to capture the output of the DataMate and save it as a text file. This import utility provides a way to import that text file.

```
Site     :SR18
Survey   :IN1
A0 dir   :
Operator :
Sensor # :25426
Axes     :DIGITILT
Units    :ENGLISH
Ins const:20000.0
Start    :70.0
End      :2.0
Interval :2.0
Time     :93/05/04

Depth     A0      A180     B0      B180
  2.0    -475     477     235     -286
  4.0    -270     274      -7      -14
  6.0     334    -329    -206      161
  8.0     393    -390    -129       78
 10.0     298    -293    -223      159
 12.0     246    -235    -258      210
 14.0     170    -167    -301      260
 16.0     123    -114    -363      321
 18.0      57     -56    -438      387
 20.0      -5      10    -421      374
 22.0      77     -72    -500      447
 24.0     174    -167    -418      376
 26.0     242    -238    -434      384
 28.0     173    -167    -406      352
 30.0      91     -88    -422      398
 32.0      85     -77    -615      586
 34.0     110    -103    -697      644
 36.0     193    -189    -669      615
 38.0     212    -208    -690      627
 40.0     172    -168    -683      622
 42.0     174    -155    -651      594
 44.0      47     -54    -559      510
 46.0      27     -11    -537      482
 48.0      86     -78    -511      462
 50.0     171    -167    -569      517
 52.0     152    -135    -566      511
 54.0      75     -72    -437      411
 56.0     146    -139    -389      369
 58.0     155    -147    -526      499
 60.0     155    -153    -645      590
 62.0     174    -167    -603      550
 64.0     115    -103    -557      510
 66.0      88     -81    -562      511
 68.0      99     -90    -629      569
```

Importing Data from a Spreadsheet

1. Export the data for a single survey to a text file (see sample below).
2. In DMM, select an installation then right-click and select “Add Survey”.
3. Fill in the survey header information. Date, Time, Probe s/n, Probe Constant, Probe Type, Full Set, and Operator. Depths will be filled in during import.
4. Click “Import Data” at the bottom of the form.
5. Select the file to import.

Important:

- During the import, text lines will be ignored.
- Lines with at least 5 numeric values will be imported as data.
- When the import is complete, the data will be displayed and the number of depths will be set to the number of data lines read from the file.

Depth	A0	A180	B0	B180
2	289	-263	-194	208
4	60	-30	-23	40
6	-43	71	2	17
8	-67	98	38	-21
10	-57	87	3	19
12	-62	91	-17	43
14	-49	78	9	21
16	-4	34	-17	32
18	11	18	-62	82
20	29	-1	-88	107
22	63	-27	-104	127
24	66	-39	-96	127
26	29	2	-118	139
28	4	28	-111	131
30	2	28	-82	98
32	-12	48	-68	87
34	-63	89	-47	67
36	-104	133	-64	87
38	-103	133	-69	97
40	-124	153	-64	83
42	-110	143	-51	72
44	-140	169	-58	88
46	-167	196	-49	76
48	-126	157	-73	91
50	-74	101	-84	102
52	-30	60	-68	89

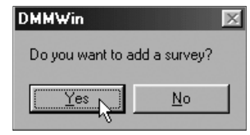
Appendix 2: Manual Entry of Data

Create a Database and Add Installations

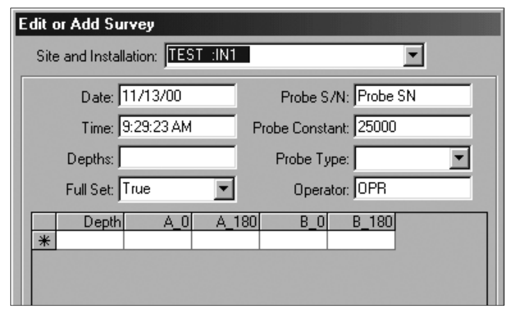
1. Create or open a project database.
2. Enter installation information. Both of these tasks are described in “Creating a Project Database.”

Enter the First Survey

1. .Click on the installation, then click on the Edit/Add button. DMM asks if you want to enter survey data. Click Yes.



2. The edit window appears. Enter the survey header information as explained below.



Site and Installation: Verify that the site and installation are correct. If not, choose a different installation from the drop-down menu.

Date and Time: Enter the date and time of the survey. DMM displays the current date and time so that you can see the proper format. The actual format will change according to your Windows’ short-date setting.

Depths: Skip this field. It will be entered automatically after you have entered readings.

Full Set: Enter True if you have readings for both the 0 and the 180 directions. Enter False if you have only the 0 readings. The Full-Set value is used in calculations later.

Probe S/N: Enter the serial number of the inclinometer probe.

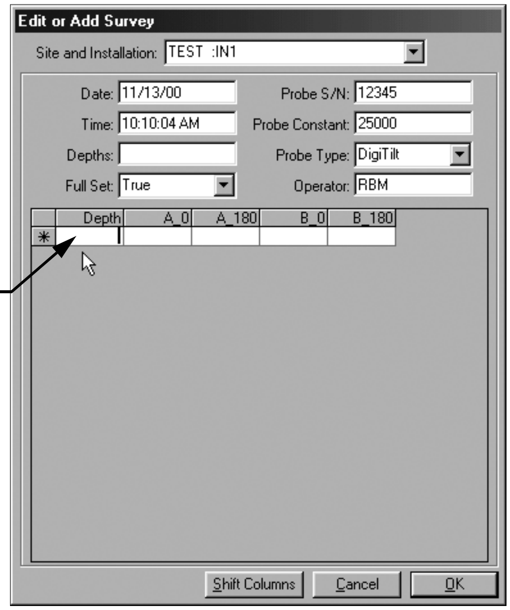
Probe Constant: Enter 25000 for metric-unit probes or 20000 for English-unit probes. This value is used in calculations

Probe Type: Enter Digitilt or Spiral. This value is used in calculations.

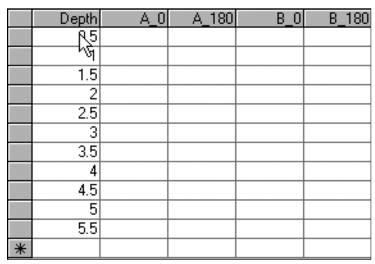
Operator: Enter initials of the operator (3 characters).

Enter the First Survey Continued

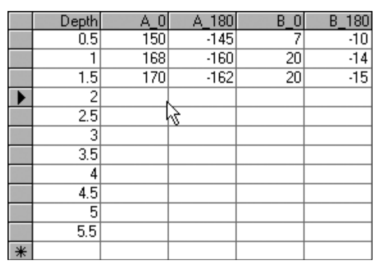
1. Enter depths, starting with the shallowest.
2. Enter the readings for each depth. When you are done, click OK.



Click here to enter a depth. Start with the shallowest depth.



Enter the depths first. Check that you have not missed any depths.



Enter readings for each depth. Press the arrow keys or tab to move from field to field.

Enter Subsequent Surveys

To enter other surveys for the same installation, you make a copy of the first survey (so that you do not have to enter depths again).

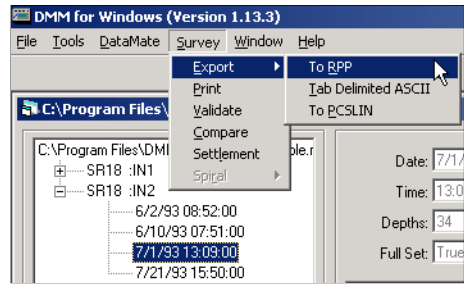
1. Select the first survey.
2. Click on Edit/Add. The edit window appears.
3. Correct the time and date for this survey.
4. Enter the readings and click OK.

Note: If there are many readings, you might want to save your work occasionally. To save your work simply click the OK button. To reopen the survey, select it (check the time and date), and click the Edit Add button.

Appendix 3: Exporting Data

Overview

1. Open a project database (or retrieve data from the DataMate).
2. Click on the + next to an installation. This makes surveys visible.
3. Select the survey that you want to export.
4. Click “Survey” on the menu bar and choose a format: RPP, Tab Delimited ASCII, or PCSLIN.
5. Specify a location and a name for the file and click OK.



RPP Format

This format includes header information, such as the installation ID and depth, the probe serial number, etc, followed by columns of data in fixed widths.

```
TIME = 10:00:00   09 Nov 2000
DIGITILT/SPIRAL = D
ENGLISH/METRIC = E
HOLE # = IN1
PROJECT = SR18
JOB DESC = From DataMate
DIR CODE =
PROBE SER # = 25426
OPERATOR =
START DEPTH = 70
END DEPTH = 2
INCREMENT = 2
INSTR CONST = 20000
ROTATIONAL CORR A = 0.0000
ROTATIONAL CORR B = 0.0000
SENSITIVITY FACTOR A = +0
SENSITIVITY FACTOR B = +0


+2.0     A0    -489    B0    209
       A180     494  B180   -293
+4.0     A0    -281    B0    -29
       A180     280  B180      9
+6.0     A0     337    B0   -220
       A180    -335  B180    185
+8.0     A0     411    B0   -139
       A180    -406  B180     90
+10.0    A0     323    B0   -207
       A180    -320  B180    169
+12.0    A0     267    B0   -263
       A180    -261  B180    219
+14.0    A0     192    B0   -305
       A180    -194  B180    264
+16.0    A0     142    B0   -373
```

Tab-delimited ASCII Format

This format includes column labels and tab-delimited values. It also includes checksums for both A and B readings.

Column labels can be excluded on import to the spreadsheet, as shown here.

2	-489	494	5	209	-293	-84
4	-281	280	-1	-29	9	-20
6	337	-335	2	-220	185	-35
8	411	-406	5	-139	90	-49
10	323	-320	3	-207	169	-38
12	267	-261	6	-263	219	-44
14	192	-194	-2	-305	264	-41
16	142	-139	3	-373	326	-47
18	81	-79	2	-451	393	-58
20	11	-9	2	-413	364	-49
22	91	-91	0	-493	445	-48
24	178	-171	7	-408	365	-43
26	245	-242	3	-431	377	-54
28	177	-170	7	-397	349	-48
30	93	-93	0	-414	393	-21
32	89	-85	4	-619	585	-34
34	112	-111	1	-700	646	-54
36	197	-193	4	-670	612	-58
38	213	-211	2	-691	631	-60
40	170	-168	2	-685	627	-58
42	164	-159	5	-650	599	-51
44	46	-55	-9	-557	515	-42
46	22	-8	14	-530	481	-49
48	80	-75	5	-505	455	-50
50	166	-166	0	-571	515	-56
52	145	-133	12	-554	507	-47
54	70	-66	4	-419	388	-31
56	138	-137	1	-397	365	-32
58	148	-143	5	-529	500	-29
60	152	-152	0	-641	593	-48
62	169	-169	0	-603	547	-56
64	110	-101	9	-558	511	-47

PCSLIN

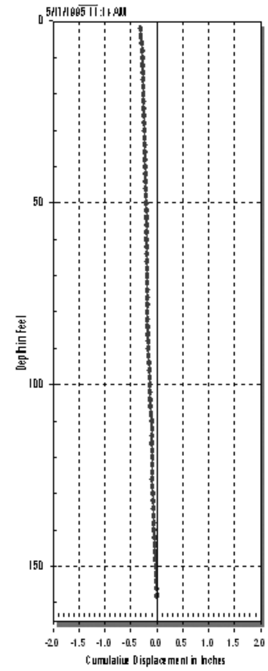
This format includes a header followed by space delimited columns of data.

```
QUESTIONS
PCSLIN          = DATA FILE NAME
SR18            = PROJECT NO
Slide at Bear Mountain - IN1
IN1             = HOLE NO.
    1           = READING SET NO.
04/29/1993      = DATE
09:38           = TIME
        20.,    = STATISTICS INTERVAL
12345           = INSTRUMENT NO.
         0,     = HALF OR COMPLETE SET OF DATA
      .000,     = A-ROTATION ERROR CORRECTION
      .000,     = B-ROTATION ERROR CORRECTION
    20000.,     = INSTRUMENT CONSTANT
                = A+ COMPASS DIRECTION
                = A- COMPASS DIRECTION
                = B+ COMPASS DIRECTION
                = B- COMPASS DIRECTION
         0,     = SHIFT ANALYSIS PRINT
         0,     = A COMPONENT SHIFT
         0,     = B COMPONENT SHIFT
      400.,     = CHANGE IN READING SCALE
        2.,     = DEFLECTION SCALE
READINGS  ,   35
     2.000,      -472,       479,       239,      -282
     4.000,      -265,       273,       -17,       -13
```

Appendix 4: Bias-Shift Analysis

What is Bias Shift

Bias: If you hold your inclinometer probe absolutely vertical and check the reading, you will typically see a non-zero value. This is the probe's bias. The bias value is normally eliminated in the data reduction process when the 0 readings are combined with the 180 readings.



Bias-Shift Error: If the bias value changes during a survey, the data reduction process cannot eliminate all of the bias. The remaining value is error that is embedded in the reduced data.

The straight, but leaning plot at right is the result of bias-shift error.

Identifying Bias Shift

Appearance: A straightened, but leaning cumulative displacement plot is a signature of bias shift error. The embedded error grows larger at each interval, so the plot leans to the left or right.

Unlikely Behavior: The graph above shows rotation of the entire 150 foot span of soil or rock. This unlikely behavior suggests error in the data.

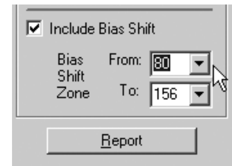
Site Knowledge: The plot shows movement where there should be no movement. Typically, the bottom 5 depths (or more) of the casing are anchored in stable ground. Any movement appearing there is generally error. In our example, we know that the casing entered rock below 80 feet, and that no movement has occurred from 80 feet downwards. This again suggests error in the data.

More information on bias-shift can be found in the training section of Slope Indicator's website: www.slopeindicator.com. Click on the link for Sample Chapters. Then click on "Bias Shift Error."

Quantifying Bias Shift Error

DMM provides a routine for quantifying bias shift error. The routine provides an average bias shift value that can be used as a correction value in DigiPro (but not in DMM).

1. Right click on the survey. Choose Compare.
2. Click the checkbox to include a bias shift analysis. Use the From and To drop boxes to limit the analysis to depths that you know are stable. This is important so choose the depths carefully. In our example, the casing is stable below 80 feet, so we enter 80 to exclude readings above 80 feet.



3. Click the report button. Then page through the report to find the bias-shift page.
4. The analysis routine finds the difference between current and initial A0 readings and the difference between current and initial A180 readings. This is reported in the Diff column. Since movement affects the A0 and A180 passes in the same way, the values in the A0 column should match the values in the A180 column.

   The Shift column shows the difference between the A0 column and the A180 column. If you have limited the analysis to depths where no movement is likely to occur, the value in the Shift column represents bias shift error (plus some possible random error).
5. An average error appears at the bottom of the column. This is the correction value that you can enter into DigiPro.

Bias Shift for A and B Axes:

Depth (ft)	Diff. A0	Diff. A180	Shift A	Diff. B0	Diff. B180	Shift B
80	1.0	8.0	-7.0	27.0	-8.0	35.0
82	-1.0	6.0	-7.0	28.0	-19.0	47.0
84	-2.0	6.0	-8.0	25.0	-5.0	30.0
86	-1.0	7.0	-8.0	30.0	-14.0	44.0
88	4.0	8.0	-4.0	24.0	-13.0	37.0
90	-1.0	11.0	-12.0	28.0	-14.0	42.0
92	-6.0	11.0	-17.0	29.0	-21.0	50.0
94	-2.0	9.0	-11.0	25.0	-25.0	50.0
96	-3.0	6.0	-9.0	28.0	-12.0	40.0
98	-4.0	13.0	-17.0	14.0	17.0	-3.0
100	0.0	8.0	-8.0	24.0	-7.0	31.0
102	-1.0	11.0	-12.0	26.0	-5.0	31.0
104	-2.0	9.0	-11.0	20.0	-1.0	21.0
106	-6.0	11.0	-17.0	44.0	-10.0	54.0
108	-16.0	18.0	-34.0	20.0	4.0	16.0
110	4.0	9.0	-5.0	15.0	11.0	4.0
112	9.0	-1.0	10.0	32.0	5.0	27.0
114	7.0	0.0	7.0	20.0	-4.0	24.0
116	-8.0	13.0	-21.0	35.0	-15.0	50.0
118	1.0	2.0	-1.0	40.0	-35.0	75.0
120	5.0	5.0	0.0	23.0	-17.0	40.0
122	3.0	3.0	0.0	27.0	-20.0	47.0
124	0.0	4.0	-4.0	32.0	-21.0	53.0
126	-2.0	11.0	-13.0	28.0	-19.0	47.0
128	-5.0	11.0	-16.0	20.0	16.0	4.0
130	-2.0	11.0	-13.0	29.0	-13.0	42.0
132	0.0	8.0	-8.0	35.0	-1.0	36.0
134	-2.0	8.0	-10.0	30.0	-20.0	50.0
136	-3.0	9.0	-12.0	32.0	-29.0	61.0
138	-3.0	8.0	-11.0	32.0	-21.0	53.0
140	-4.0	5.0	-9.0	29.0	-6.0	35.0
142	-4.0	13.0	-17.0	21.0	14.0	7.0
144	-4.0	12.0	-16.0	31.0	-24.0	55.0
146	-6.0	12.0	-18.0	44.0	1.0	43.0
148	6.0	9.0	-3.0	20.0	-11.0	31.0
150	1.0	8.0	-7.0	26.0	-5.0	31.0
152	-2.0	10.0	-12.0	25.0	-5.0	30.0
154	-3.0	11.0	-14.0	13.0	2.0	11.0
156	-2.0	10.0	-12.0	-1.0	-1.0	0.0
Average			-9.9			35.4

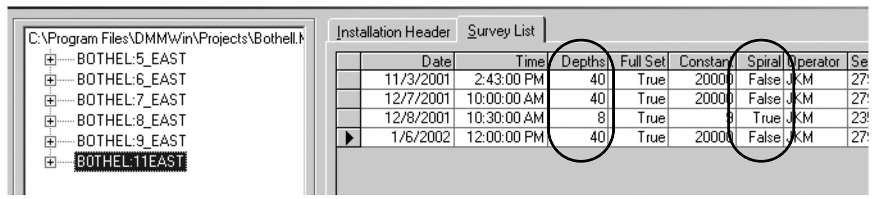
Averaged bias shift values

Appendix 5: Expanding Spiral Surveys

Spiral Surveys

Spiral surveys are obtained with a special-purpose spiral sensor. Please refer to the spiral sensor manual for instructions on conducting a spiral survey.

Spiral surveys are stored with inclinometer surveys in the project database. A typical spiral survey has depths and two or four columns of data, one column of data for each pass through the casing. The spiral survey can be identified as explained below:

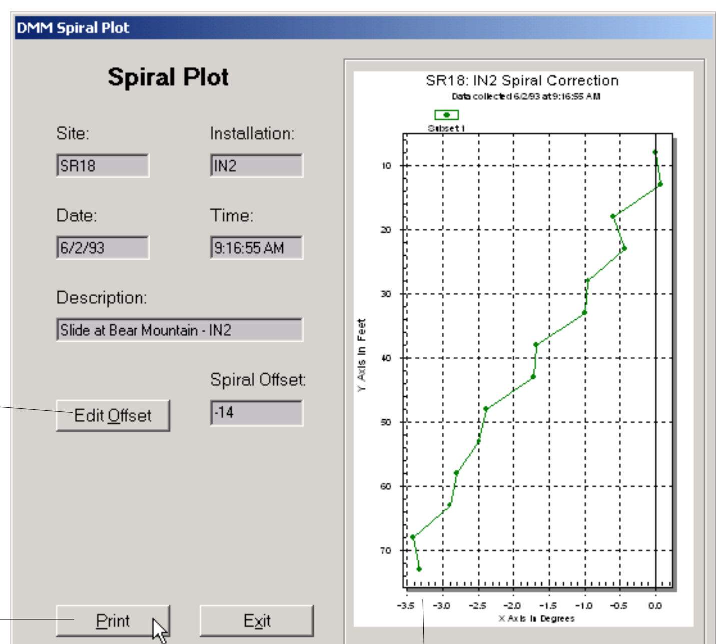


The spiral survey has fewer reading depths than an inclinometer survey. Also, it is marked True in the Spiral column.

Plotting Spiral Data

DMM can generate a plot from the spiral data. The spiral plot shows the magnitude of the spiral in the casing. If the accumulated spiral is small (<20 degrees), you may decide to ignore spiral.

1. Select the spiral survey.
2. Click Survey on the menu bar, then choose Spiral - Plot Spiral.



Click this button to enter an offset for the spiral sensor. See the spiral manual for detail.

You can print the spiral plot.

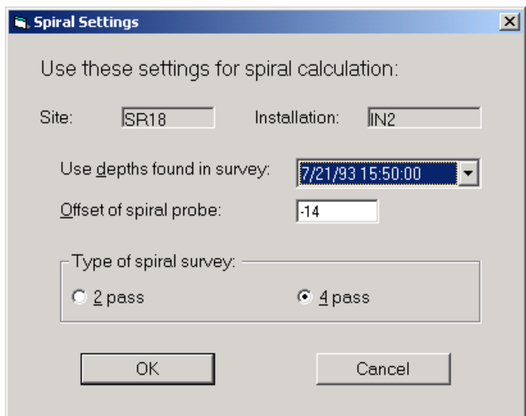
Spiral values are accumulated from top to bottom, so the maximum value appears at the bottom.

Expanding Spiral Data

To correct inclinometer surveys for Spiral, the DigiPro program requires a spiral value for each depth in the inclinometer survey.

DMM's spiral expansion routine reads the spiral survey and generates a new survey with values for each inclinometer depth. Later when you use DigiPro to graph inclinometer data, you simply switch on spiral correction and DigiPro automatically finds the expanded spiral survey and applies the data.

1. Select the unexpanded spiral set.
2. Click on Survey, and choose Spiral - Expand Spiral.
3. Specify which survey has the proper number of depths.
4. Enter the spiral sensor offset. (See the Spiral Manual).
5. Choose the number of data columns in the spiral survey (2 or 4).
6. Click OK. DMM then generates a new spiral survey. It has the same date as the original spiral survey, but the time is changed by one second. In addition, the operator field is marked EXP.

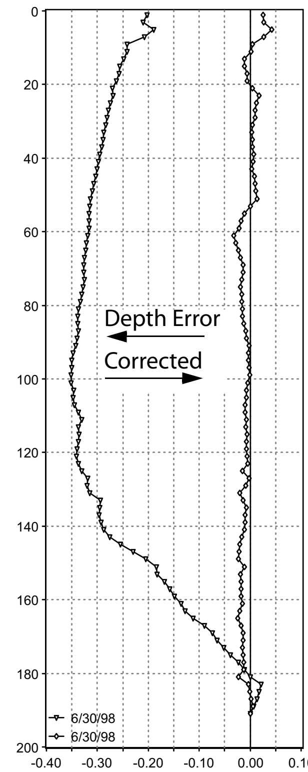


Appendix 6: Settlement Corrections

Depth Error

The accuracy of an inclinometer system depends on repeatable positioning of the inclinometer probe. When the probe is positioned consistently at each depth in the survey, readings can be compared reliably. If the reading changes, movement has occurred. If the reading stays the same, no movement has occurred.

However, if the probe is positioned above or below the proper depth, the reading will change, even if there is no movement. This changed reading is a depth error. In casing that is very straight, the change in reading is small, and can typically be ignored. But in casing that is "wavy," the change can result in obvious error, as shown in the DigiPro plot at right.



Sources of Depth Error

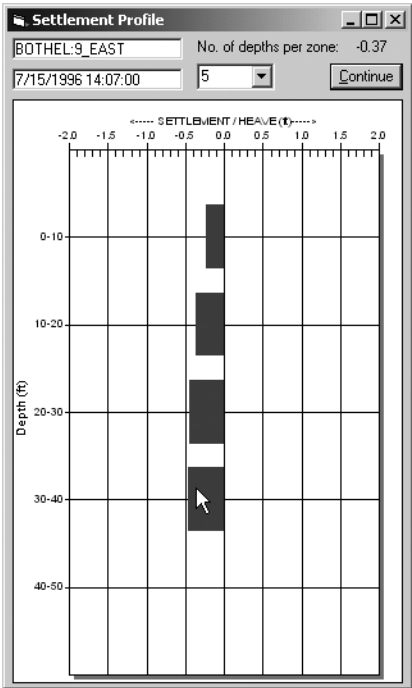
Changed reference: The operator positions the probe by aligning depth markers on the cable to a reference at the top of the casing. If the reference changes, every reading in the survey is affected. This can be corrected by DMM's settlement correction.

Change in casing length: If the casing is compressed by settlement, the probe will be positioned deeper in the casing. Readings are affected at and below the zone of settlement. This can be adjusted by DMM's settlement correction.

Change in cable length: Control cables may shrink or stretch over time. Cables may be interchanged with other cables that are not the same length. Repairs and splicing of cable may result in changed length. Readings are affected where differences in cable become active. This can be adjusted by DMM's settlement correction

Random positioning: A distracted operator accidently positions the probe at the wrong depth and take a reading. This cannot be adjusted by DMM's settlement correction. Edit the data instead.

Generating a Corrected Survey



1. Select the affected survey. Click on Survey. Choose Settlement.
2. Determine whether the depth error is settlement or heave (see explanation below).

Settlement	Heave
Reference is lower than before	Reference is higher than before
Casing is shorter than before	Casing is longer than before
Cable has stretched	Cable has shrunk

3. To enter a value, click on the zone line. A bar appears. You can see the numeric value of the bar in the upper right corner. Enter settlements on the left side and heave on the right side. Units are in feet or meters.

   If you reduce Sondex or Magnet extensometer readings as suggested in the manuals, your final calculations are changes for each ring or magnet. The values entered into DMM should be the complement of these changes (total settlement minus change).

   In the example below, the change for magnet 5 represents total settlement (the change in the distance between the datum magnet and the top magnet). You can see the required calculation. Although the values for DMM are positive, you should still enter them on the settlement side of the dialog.

Magnet	Change (feet)	Total Settlement - Change	Value for DMM
5	0.23	0.23 - 0.23	0
4	0.17	0.23- 0.17	.06
3	0.11	0.23 - 0.11	0.12
2	0.06	0.23 - 0.06	0.17
1	0.02	0.23 - 0.02	0.21

4. When you are done, click the Continue button. DMM generates a new survey, with the same date, but time changed to 23:59:59.

Appendix 7: Updating MDB Databases

Introduction

DigiPro for Windows version 1.26 and earlier had an automatic database conversion utility that copied data from a DOS “hdr” database into a Windows “mdb” database. The conversion was not perfect, so if you open these files with DMM for Windows, DMM will ask you to update the database.

To Update a MDB Database

1. Start DMM for Windows.
2. Navigate to your existing MDB database. They have the same name and are in the same location as your hdr databases, the ones created by the DOS version of DMM.
3. Open the mdb database.
4. Choose File-Save As and enter a new name for the database. After a short delay, DMM displays the new, updated database in its own window. From now on, you should use this new database. You may want to delete the old mdb database.

   Note: When you use the save-as command, DMM automatically assigns a file name using the words “copy of.....” It also uses the default folder (Program Files\DMMWin\Project\). You will probably want to specify a different name. You may want to specify a different folder as well. If you save the program into the same folder, you must use a different name. DMM will not overwrite the existing database.
5. Check each installation record. If you use an English-unit system, check that you have English units and an instrument constant of 20,000 entered into the installation record.

   If you have metric-unit database, you must correct any decimal entry: shallowest depth, deepest depth, reading interval. You must also check that you have chosen metric units and have entered an instrument constant of 25,000.

   Note that these corrections affect only the installation information. Data is not affected and requires no corrections.

Appendix 8: Converting DOS DMM Databases

Introduction

- DMM for Windows uses an ".mdb" database. It replaces the old ".hdr" database used by the DOS version of DMM.
- If you use DigiPro for Windows, you already have an ".mdb" database, but you must update it with DMM. See the previous page.
- To convert "hdr" databases directly to mdb databases without going through DigiPro, use the utility program called HDR2MDB.EXE.

Using the Hdr2Mdb Utility

This program is installed in your DMM for Windows folder. It is used to convert DMM DOS databases to the DMM Windows format.

1. Start the Hdr2Mdb program.
2. Open an hdr database.
3. Specify a name and location for the mdb database, and click OK. After a short delay, the program announces a successful conversion.

   The program will prompt you if it cannot determine the serial number of your probe or whether it is a metric-unit or English-unit probe.

Work-Around for Double-Byte Windows

The Hdr2Mdb program does not work properly with double-byte Windows systems, such as Chinese, Japanese, and Korean Windows. We are sorry for this inconvenience. Here are two work-arounds:

- Install HDR2MDB on a computer that is running a US version of Windows. Do the conversion, then copy the new mdb database to your double-byte version of Windows.
- Use DMM DOS to export your surveys in RPP format, then import the surveys with DMM for Windows.

Appendix 9: Windows vs DOS DMM

Introduction

If you used the DOS version of DMM, you'll want to know what is different in the Windows version:

System Requirements

- DMM for Windows requires Windows 95/98/ME/NT4/2000.
- DMM for Windows does not run on DOS or Windows 3.1.

Project Database

- DMM for Windows uses an ".mdb" database. It replaces the old ".hdr" database used by the DOS version of DMM.
- You can convert your DOS hdr files to mdb files using DigiPro for Windows or the utility program called HDR2MDB.EXE.

DataMate Setup

- DMM for Windows creates a "setup database" to load installations (and surveys) into the DataMate. (There is no equivalent to the setup database in DMM for DOS.)
- The setup database lets you create an installation list from separate databases and is also used to manage the DataMate's memory.

Retrieving Data

- Datasets are called "surveys" in DMM for Windows.
- DMM lets you retrieve all surveys or new surveys. (In DMM DOS, you tagged each survey and then retrieved them).
- DMM holds retrieved surveys in a temporary database. You then drag and drop surveys into one or more project databases. (In DMM DOS, you retrieved surveys directly into the project database)

Managing DataMate Memory

- DMM provides two ways to clear the DataMate's memory. You can send a setup to the DataMate or you can use the erase memory command provided in DMM.
- To delete individual surveys, you must use the DataMate itself.

Managing the Database

- You can move misplaced datasets.
- You can shift columns of readings.
- You can easily copy installations and datasets between databases.
- You can easily create a database of new readings for emailing.

Appendix A6 - DigiPro for Windows

DigiPro
for Windows

SLOPE INDICATOR
12123 Harbour Reach Drive
Mukilteo, Washington, USA, 98275
Tel: 425-493-6200 Fax: 425-493-6250
E-mail: solutions@slope.com
Website: www.slopeindicator.com

Contents

Introduction

Read This

- Even if you hate manuals, it is important that you read this introduction and the Quick Tour pages.
- If you have DigiPro version 1.26 or earlier on your computer, we suggest that you remove it before installing later versions. This will not affect your data files or your unlocking key.
- If you are working on an NTFS system (Windows NT 4, 2000, XP, or later), you may find that administrator rights are required to install DigiPro. See your IT person for help.

What is DigiPro?

DigiPro software is used to process and plot inclinometer data. It creates high-resolution graphs and provides advanced routines for identifying and correcting systematic errors.

DigiPro works with the project databases created by DMM for Windows. If your inclinometer readings are not in this format, see Appendix A.

DigiPro is not free software. It must be purchased. However, when you first install DigiPro, purchased or not, it will run 45 times, so you can get some work done without worrying about licensing. Read "About Unlocking Keys" on the next page.

Installing DigiPro from a Resource CD

1. Remove any earlier version of DigiPro first. Doing this will not affect your data or your unlocking key.
2. Insert the Resource CD in your CD-ROM drive. The CD will start automatically on some computers. On other computers, you have to open and close the CD-ROM drive a second time to make Autostart work.
3. The browser window appears: click on Software.
4. The software page appears: click on DigiPro for Windows.
5. The DigiPro page appears: click on "Download DigiPro."
6. The File-Download dialog appears: choose "Run this program from its current location" and click OK. You may see an security warning. Click Yes to continue the install.
7. Follow on-screen instructions. You may be asked to restart your computer more than once.

Installing DigiPro from a Setup File.

If you downloaded DigiPro from www.slopeindicator.com, you have a setup file named “setupdpwin.exe” on your hard disk.

1. Remove any earlier version of DigiPro first. Doing this will not affect your data or your unlocking key.
2. Click the Start button and choose Run.
3. The Run dialog appears: click the Browse button to navigate to the setup file that you downloaded.
4. Select the setup file (setupdpwin.exe) and click Open.
5. Click OK when the Run dialog reappears.
6. Follow on-screen instructions. You may be asked to restart your computer more than once.

About Unlocking Keys

After DigiPro is installed, it will run 45 times. After that, it will stop running. To remove the run-limitation, you must purchase DigiPro and request an unlocking key (a coded number). If you have already purchased DigiPro, we have your company and city in our database, but you must contact us for the key. Follow the steps below:

To obtain a key

1. Find your DigiPro serial number. Start DigiPro. When the start screen appears, click on the "License" button. A dialog appears with the serial number.
2. Use one of the methods below to contact us. We need your serial number, name, company, and city.

- Visit www.slopeindicator.com. Click on “Support,” then click on “Get a DigiPro Key” and fill out the form.
- Call Slope Indicator or your local distributor.
- Fax Slope Indicator or your local distributor.

3. We will generate a key to match your serial number and give it to you.

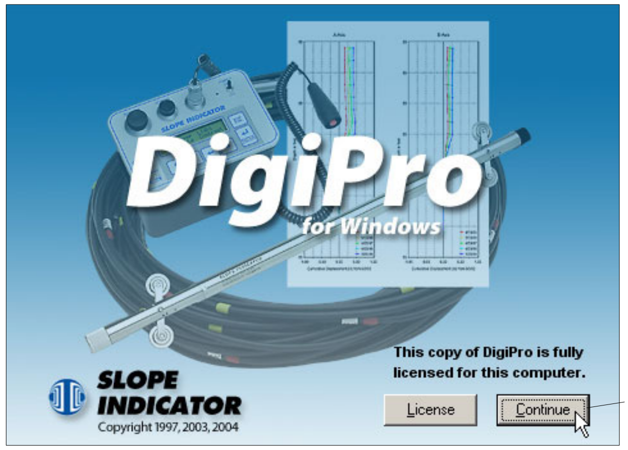
To enter the key

1. Start DigiPro. The start screen appears. Click on License.
2. Check that your serial number is the one that you sent us, then click on Modify.
3. Enter your the unlocking key, and click OK.
4. You should see the message: “This copy of DigiPro is fully licensed for this computer.”

Quick Tour

Start DigiPro

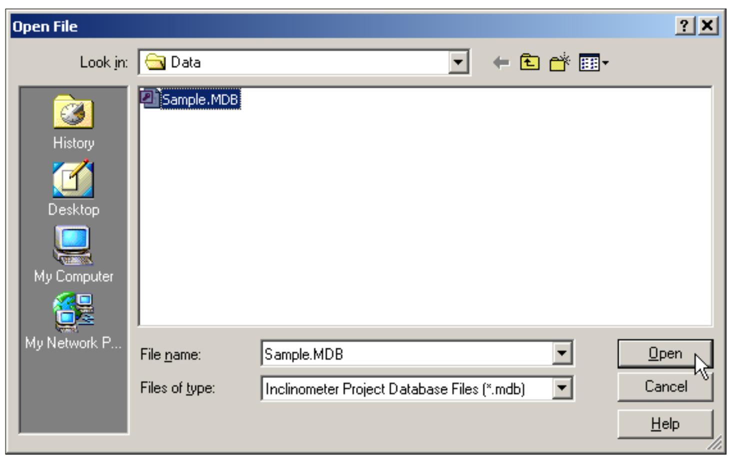
Click on the DigiPro shortcut, or go to:
Start > Programs > DigiPro > DigiPro.exe. Click Continue.



Click on the Continue button.

Open a Database

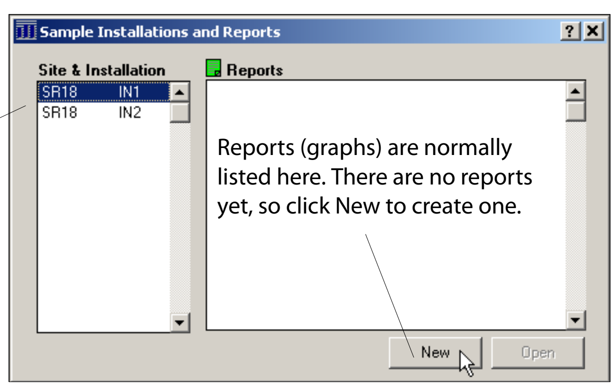
DigiPro displays the Open File dialog. Choose "Sample.MDB." If you don't see it, navigate to C:\Program Files\DigiPro\Data.



Choose an Installation and Create a Report

DigiPro displays a list of the installations in the database. Select the top one, SR18 IN1, and click New to create a report.

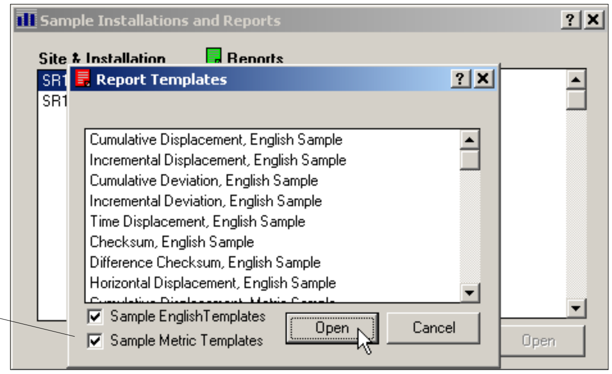
Installation List



Reports (graphs) are normally listed here. There are no reports yet, so click New to create one.

Choose a Report Template

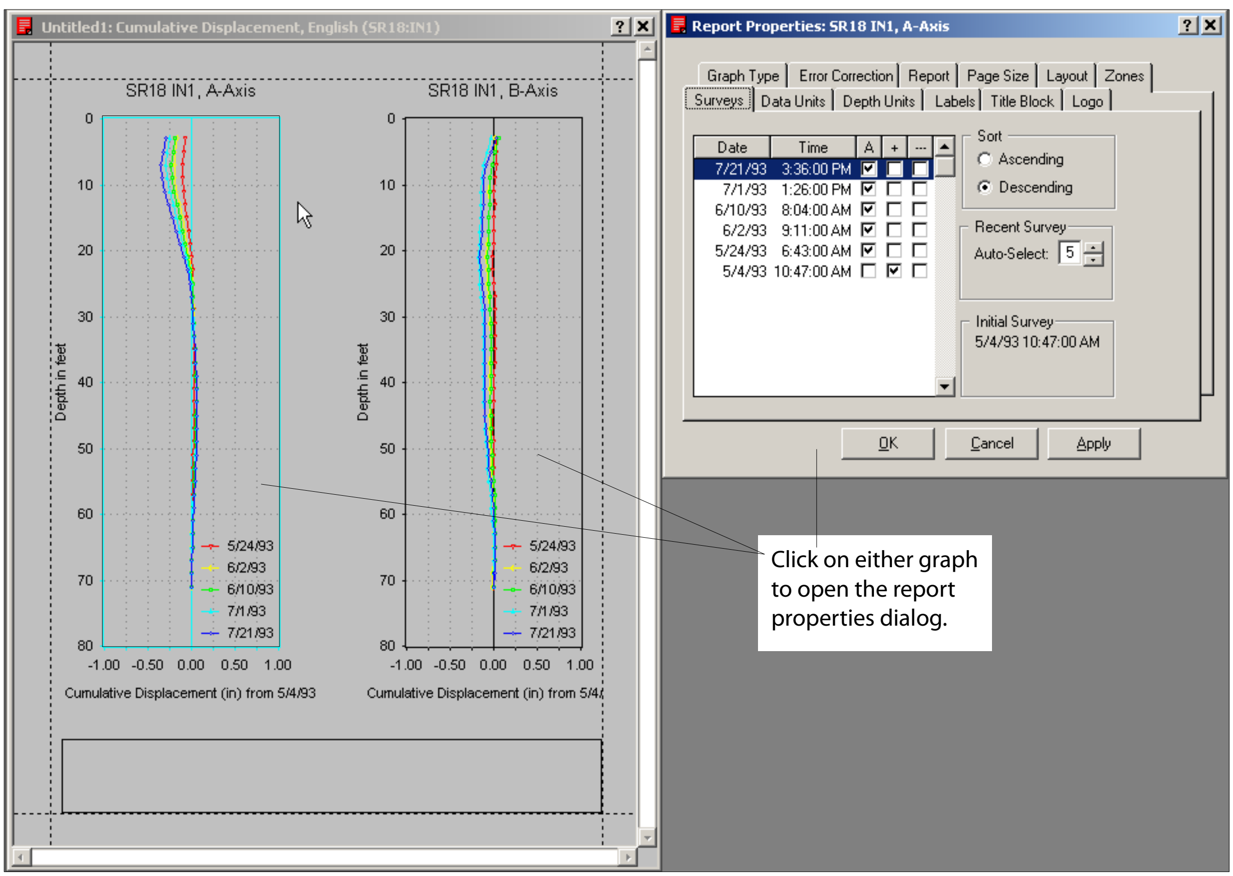
DigiPro displays a list of report templates. Each template offers a different type of graph. Choose “Cumulative Displacement, English Sample.” Click Open.



If you use metric data, you can hide the english-unit templates, and vice versa. You can also make your own templates.

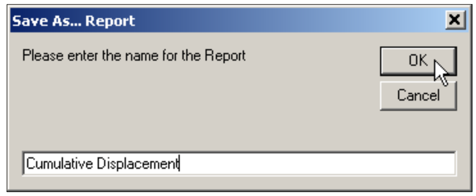
View and Modify the Report

The report appears with two graphs. Click on either graph to open the report properties dialog. Using the report properties dialog, you can select different surveys, modify scales and labels, add text to the title block, and make other changes.



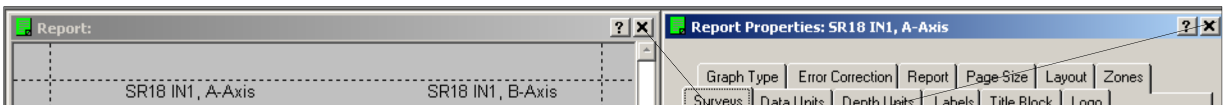
Save the Report

Click the disk icon or choose File > Save As >Report. Enter a name, and click OK. DigiPro stores the graph type and all the settings for the graphs.



Close the Report

Click the X in the upper right corner of the graph. Close the report properties dialog too.

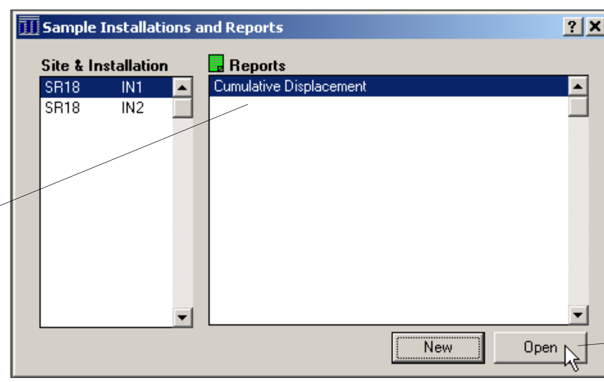


To close the dialog or graph, click the X box.

Open the Report to Recreate the Graphs

Select the report and click Open. DigiPro recreates your graphs. In addition, DigiPro automatically includes any new surveys that were added to the database, so the graphs are updated too.

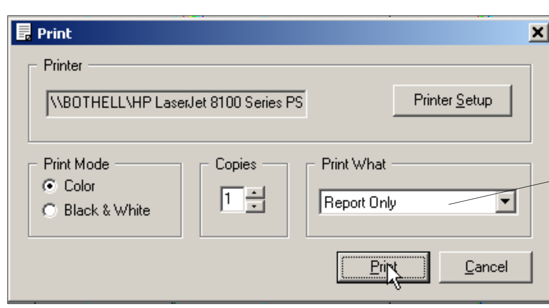
Reports are listed in the reports window. To recreate a graph, select a report and click Open.



Click Open to open a report.

Print the Report

When the graph appears on screen, click on the printer icon, or choose Print from the File menu.



This prints just the graph. You can also print a listing of the current survey.

Creating Reports

Overview of Reports

- It's easy to make reports: simply open a report template and save the resulting graph.
- Reports save time. You can reproduce or update a graph with just two mouse clicks.
- Reports can be customized. For example, you can specify two different types of graph for the report.
- You can create as many reports as you need.
- You can save the report as a template.

Creating a Report

These basic steps are explained in detail on the following pages.

1. Open a database.
2. Select an installation.
3. Choose a report template.
4. Save the report.

Open a Database

1. Start DigiPro, and click the Continue button.
2. The Open File dialog appears. DigiPro displays the most recently opened folder.
3. Select your database, and click Open.

How to find your database

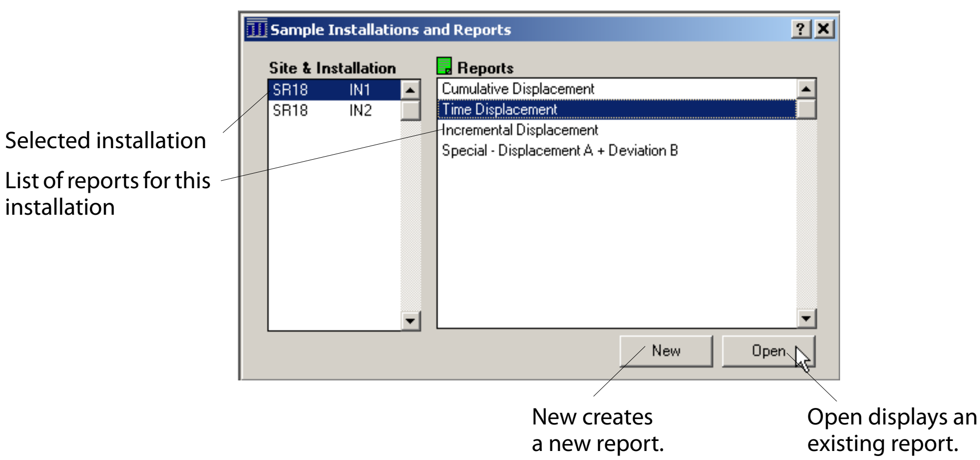
- If you can't see your database, click in the "Look-in" field to navigate to a different folder or drive.
- The default location used by DMM for Windows is: C:\Program Files\ DMMWin\Projects.
- DigiPro keeps a list of the last five databases that you opened. To see this list, click on the File menu (Close the Open File dialog first). The databases are listed at the bottom of the menu.

How to create a database

If you don't have a database, you must create one with DMM for Windows. DMM can also convert and import data. DMM is a free download from www.slopeindicator.com. See Appendix A for more information.

Select an Installation

After you open a project database, DigiPro displays the "Installations and Reports" dialog. The left side of this dialog shows a list of installations. Click on the installation of interest.



New vs Open

After you select an installation, you can choose to create a new report or open an existing report.

- To create a new report, click New.
- To open an existing report, select it and click Open.

Choose a Report Template

If you clicked New in the previous step, DigiPro displays a list of report templates. Each template offers a different type of graph. Graph types are explained on the following page.

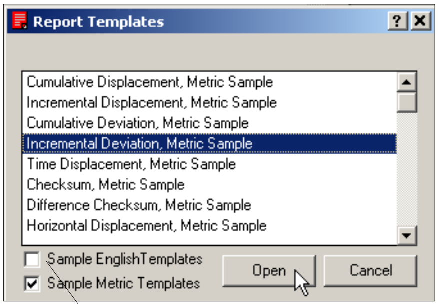
English-Units or Metric-Units?

1. Select a template. Note that there are English-unit templates and metric-unit templates.

   It is important to choose correctly because this controls how readings are processed.

   - Choose English if you use an English-unit probe.
   - Choose metric if you use a metric-unit probe.

2. Click Open.



If your data is metric, you don't need English unit templates. Remove the checkmark to hide them.

Note: DigiPro allows you to change the displayed units later, if necessary, but at this point, you must choose according to your probe units.

Creating Templates

You may find it convenient to make your own templates. For example, you may want templates that have:

- A title block with your company's name and logo.
- Standard depths.
- Different types of graph in the same report.

To Create a Custom Template

1. Open a report. Modify it as needed.
2. Choose File > Save As > Template.
3. The new template will appear in the Report Templates dialog.

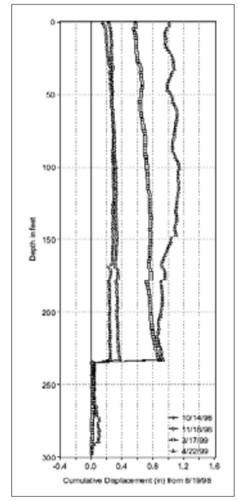
Note: DigiPro's templates are stored in the "templates.mdb" file in the DigiPro\System folder. You can copy this file to other computers.

Graphs for Analyzing Movement

These graphs are the standard graphs used to analyze the behavior of the ground.

Cumulative Displacement

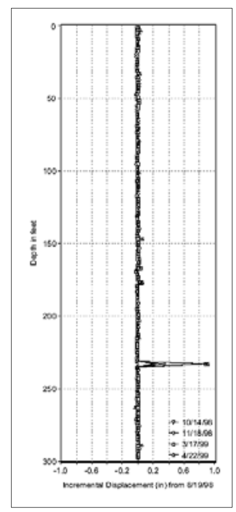
Displacements are changes in the position of the casing and are assumed to be equivalent to ground movement. A displacement graph requires at least two surveys: an initial survey and a current survey. The initial survey does not appear on the graph.



In a cumulative displacement graph, the plotted point at any depth is the sum of incremental displacements from the reference point (typically the bottom). The graph shows how subsurface movement relates to movement at the surface. Shear movements are easily seen.

Incremental Displacement

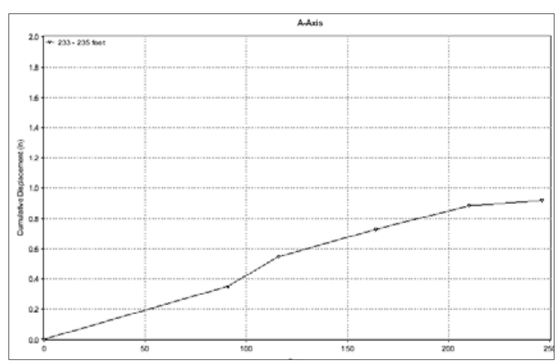
This graph shows displacements at discrete depths. A growing “spike” indicates movement. The graph at right uses the same data as the cumulative displacement plot above.



No summing is involved, so systematic error is minimized.

Time Displacement:

This graph shows the rate of movement at one or more zones. A steepening slope represents accelerating movements.

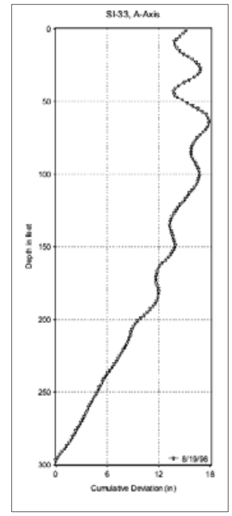


The plotted value for each zone is the difference between the displacement value at the top of the zone and the displacement value at the bottom of the zone. Zones are set in the “zone” tab of the report properties dialog.

Graphs for Diagnosing Systematic Error

These graphs are generally used for troubleshooting or verifying that graphs represent movements accurately.

Cumulative Deviation

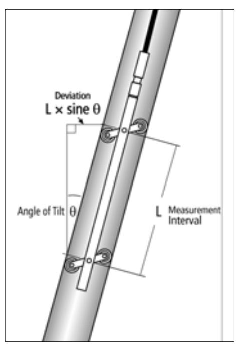


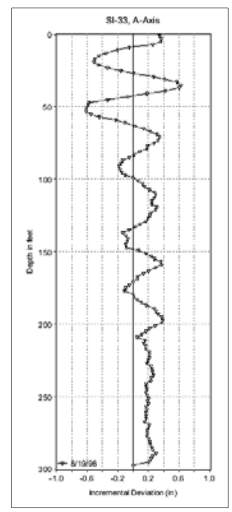
This graph shows the profile of the casing relative to vertical. Drillers can use this graph to see borehole drift.

The plotted point at any depth is the sum of incremental deviations up to and including that depth. (Deviations are defined below).

In error analysis, this graph is used to show the potential for systematic error due to cross-axis tilt and a rotation of the sensitive axis of the inclinometer probe.

Incremental Deviation

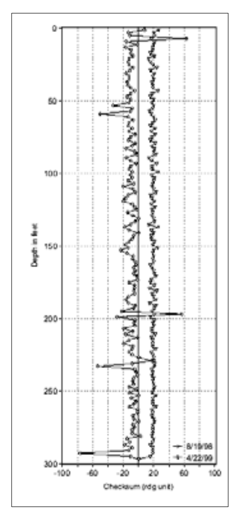




This graph shows the deviation at each depth. This represents the curvature of the casing. The drawing at left shows deviation. The angle of tilt is measured by the inclinometer, the hypotenuse is the measurement interval (typically the distance between the wheels) and the side opposite the angle is the deviation.

In error analysis, this graph is used to show the potential for systematic error due to casing curvature and settlements or inaccurate depth control.

Checksum and Difference Checksum



Checksums are the sum of the “0” and “180” readings at each depth.

In error analysis, this graph provides an indication of the potential for systematic error due to bias shift. A tilted plot may indicate problems with the electronics of the sensor.

The difference-checksum graph shows changes in checksum, and removes variations that are due solely to characteristics of the installed casing.

Save the Report

After you have selected a template and clicked Open, DigiPro displays the new report.

1. Choose File>Save from the menu or click the disk icon.
2. The Save As dialog appears. Enter a name for the report and click OK.

Naming a Report

- A simple name, such as “Cumulative Displacement” is sufficient, since it indicates the kind of graph that the report will produce.
- There is no need to make unique names for reports. Each installation has its own list of reports. For example, you can have a report named “cumulative displacement” for each of your installations. In fact, this is recommended.
- To rename a report, right-click on the report name and choose “Rename” from the pop-up menu.

Modifying Reports

Overview

The basic steps required to modify a report are:

1. Open the report.
2. Open the Report Properties dialog.
3. Modify the properties for each graph.
4. The settings that you have changed are saved with the report and are automatically retrieved the next time you open the report.

Open a Report

1. Start DigiPro.
2. Open a project database.
3. Choose an installation.
4. Click on the report that you want to modify.
5. Click on the Open button.

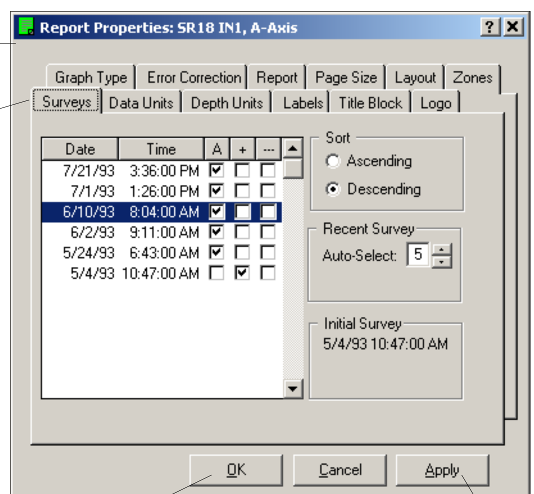
Open the Report Properties Dialog

1. Click on either graph. The report properties dialog appears.
2. The title bar shows which graph is active. To make the other graph active, just click on it.

The title bar shows which graph is active and can be modified.

Report properties are organized by tabs. Click on a tab to display its properties.

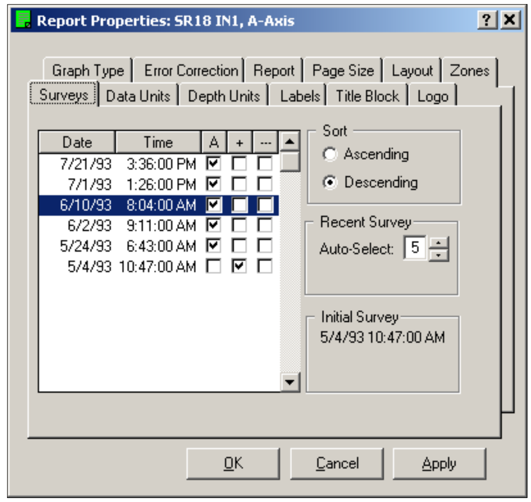
When you change a property, click Apply to see the effect.



Click OK to close the dialog. OK applies any remaining changes.

Click Apply to see the effect of your changes. The dialog stays open so that you can make more changes.

Surveys



What is a Survey?

A survey is the data from one inclinometer survey. Each survey is identified by date and time.

Survey Selection

DigiPro graphs only surveys that have been selected. Check boxes for each survey indicate its selection status.

- A check mark in the A column indicates that the survey is auto-selected. New surveys are auto-selected so that DigiPro can update graphs automatically. The Recent Surveys field controls the number of auto-selected surveys.
- A check mark in the + column indicates that the survey is selected permanently. It will be used every time you run a report. Click the box to check or uncheck.
- A check mark in the – column indicates that the survey is excluded permanently. Click the box to check or uncheck.
- Surveys with no checkmark are not selected. When you have many surveys, most of them will have this status.

Sort

Sorts the order of the surveys in the Selection window.

- Ascending displays oldest survey first.
- Descending displays newest survey first.

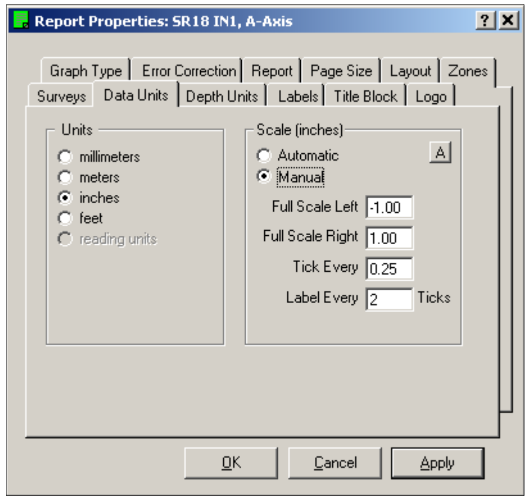
Recent Survey Auto-Select

Specifies the number of new surveys to be automatically selected for the report. To change the number, click the up and down arrows next to the number. Then click apply.

Initial Survey

Shows which survey is used as the initial. DigiPro automatically selects the oldest survey as the initial and puts a check mark in the + column. To choose a different initial survey, scroll the window until you can see it. Then right click on the + box and choose “Mark as Initial Survey” from the pop-up menu. Note that earlier surveys are ignored.

Data Units



Unit Conversion

The Unit conversion setting is provided for US users who need metric-unit reports from their English-unit inclinometer systems. These users should use the standard English-unit templates and make the conversion here by clicking the radio button for mm.

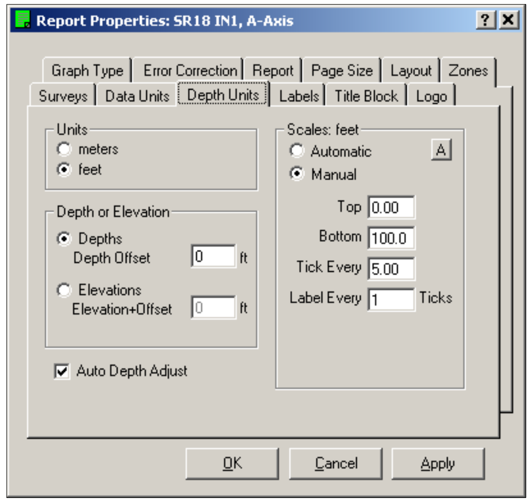
Other users will probably not need this setting because templates provide appropriate units automatically. Be sure to choose metric templates for metric inclinometer systems and English templates for English-unit inclinometer systems.

Troubleshooting Note: If you have used the correct templates but your units and values appear strange, don't try to correct the problem with the units conversion setting. Instead, go back to the Installation and Reports dialog, right-click on the installation, and choose "properties" from the pop up menu. Check that Units is properly set to English or Metric (the same units as your inclinometer system).

Scales

- Automatic: Sets full scale left and right to accommodate the maximum values found in the surveys.
- Manual: Allows manual control over the settings. Click on the Manual button to show the fields below:
- Full Scale Left: Enter a value to be used for full scale left.
- Full Scale Right: Enter the value to be used for full scale right.
- Tick every: Ticks are graduations on the data scale. For example, if you want a graduation every 10 mm, enter 10.
- Label every nth tick: DigiPro will label every nth tick. For example, enter a 2 to label every second tick. For example, if ticks are 10 mm apart, labels will appear every 20 mm.

Depth Units



Unit Conversion

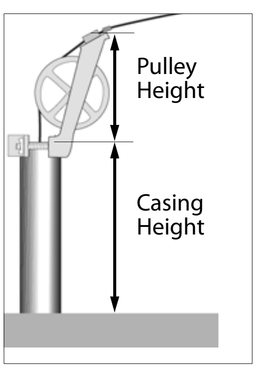
The Unit conversion setting is provided for US users who need metric-unit reports from their English-unit inclinometer systems. These users should use the standard English-unit templates and make the conversion here by clicking the radio button for m.

Other users will probably not need this setting because templates provide appropriate units automatically. Be sure to choose metric templates for metric inclinometer systems and English templates for English-unit inclinometer systems.

Depth or Elevation

You can show depth-axis labels as depths or elevations. Click the appropriate radio button. If you choose elevations, you must also enter the elevation at the top of the casing. See depth offset and elevation offset below.

Depth Offset



During a survey, depths are read from the control cable, which is referenced to the top of the casing or (preferably) to the top of the pulley assembly. If you want the depth-axis labels referenced to ground level, enter an offset:

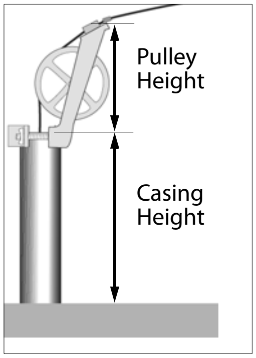
Depth Offset = casing height + pulley height

Casing height is the height of the casing above ground level. Pulley height is 1 foot or 0.3 meters.

Metric Example: The top of the casing is 0.5 meters above ground level. The pulley assembly adds 0.3 meters. Enter 0.8 meters for the depth offset. Now the depth-axis label scale will be referenced to ground level.

English Example: The top of the casing is 14 inches (1.17 ft.) above ground level. The pulley assembly adds 1 foot. Enter 2.17 feet for the depth offset.

Elevation + Offset



If you want the depth-axis label referenced to elevations, first click the radio button for elevations, then enter an offset:

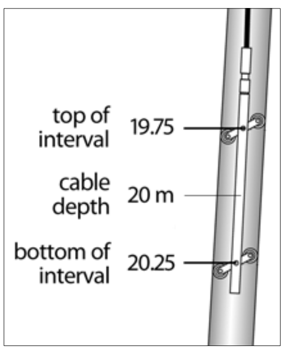
Elevation Offset = ground elevation + casing height + pulley height

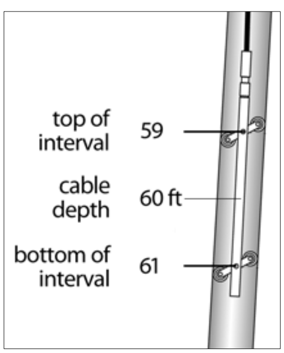
Casing height is the height of the casing above ground level. The pulley assembly adds 0.3 meters (1 foot).

Metric Example: Ground elevation is 200 meters above sea level. The top of the casing is 0.4 meters above ground level. The pulley assembly adds 0.3 meters. Enter 200.7 meters for the elevation offset. Labels will be referenced to ground elevation.

English Example: Ground elevation is 1200 feet above sea level. The top of the casing is 1.5 feet above ground level. The pulley assembly adds 1 foot. Enter 1202.5 feet for the elevation offset.

Auto Depth Adjustment





With auto-depth adjustment turned on, DigiPro correctly plot data points at the top (or bottom) of the measurement interval. Auto-depth is turned on by default.

Why is an adjustment provided? Depth marks on Digitilt control cable are measured from the middle of the inclinometer probe, but deviations and displacements are calculated for the top (or bottom) of an interval.

Metric example: The depth stored with the inclinometer reading is the cable depth of 20 meters, but the top of the interval is actually at 19.75 meters. With auto-depth adjust turned on, the plotted point will be placed correctly on the graph at 19.75 meters, not at the cable depth of 20 meters.

English example: The depth stored with the inclinometer reading is the cable depth of 60 feet, but the top of the interval is actually at 59 feet. With auto-depth adjust turned on, the plotted point will be placed on the graph at 59 feet, not at the cable depth of 60 feet.

On the graph, these adjustments are visually quite small, but if you print out the data, you will see the adjusted depths.

Scales

DigiPro sets the depth axis scales automatically, or lets you specify values for the top and bottom of the depth-axis scale.

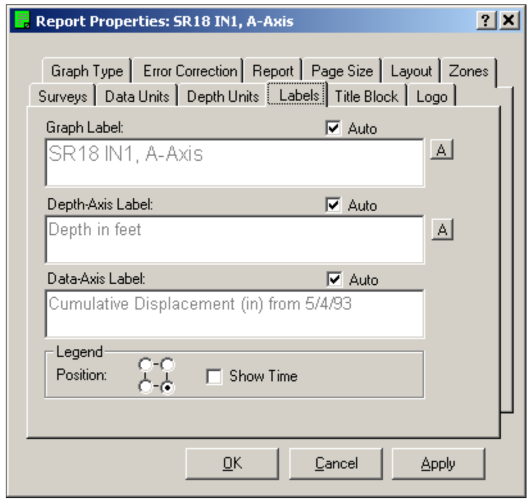
Automatic: Automatically displays the entire depth-axis and applies labels and ticks at multiples of 10.

Manual: Allows manual control of scales. Click on the Manual button and enter the desired values in each field. If your report shows elevations rather than depths, be sure to enter elevations for top and bottom. Click Apply when finished.

- Top: Enter a value for the top of the depth-axis scale.
- Bottom: Enter a value for the bottom of the depth-axis scale.
- Tick every: Ticks are graduations on the depth-axis scale. If you want a graduation every 5 meters, enter 5.
- Label every nth tick: DigiPro will label every nth tick. For example, enter 2 to label every second tick. For example, if ticks are 5 meters apart, labels will appear every 10 meters.

Tip: If you frequently zoom in to inspect a particular zone, you might find it useful to make a report that shows only that zone. Use manual scales to specify the top and bottom of the zone, then save the result as a new report.

Labels Tab



Editing a Label

DigiPro creates graph labels and legends automatically. This dialog lets you change the automatic labels. If you want these labels changed for all subsequent reports, save the report as a template (See page 8).

1. Click to remove the check mark from the Auto box above the Label field. When the check is removed, you can edit the text.
2. Enter text in the Label field. The Graph Label field accepts up two lines of text. The Depth-Axis and Data-Axis fields accept one line of text. The A button lets you choose a font.
3. Click Apply to see your changes.

Note: If your Windows display is set for Large Fonts, text appears larger on-screen than it prints on paper. Print the report to see the true effect, then modify as needed.

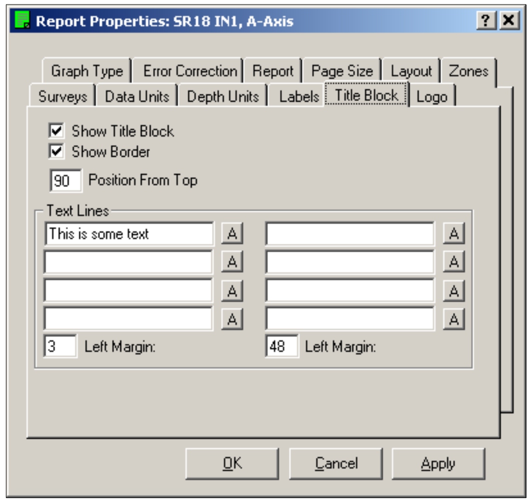
Legend Position

DigiPro can place the legend in one of the four corners of the graph. For example, if you click the upper right button in the square, the legend will appear in the upper right corner of the graph when you click Apply.

Show Time

DigiPro can append time to the date in the legend. Normally time is not required, but if you need it, click in the checkbox.

Title Block



Function

The title block provides a place to enter information about the graph. You can also include a company name, address, and company logo in the title block. If you want to add a logo to the title block, use the Logo tab before setting the title block text.

Text Lines

DigiPro provides eight cells for text arranged into two columns. Click in one of the eight fields to enter text. When finished, tab to the next field. Click Apply to see the result on screen.

Note: The screen display of text is not accurate, especially if your display is set for Large Fonts. Print the report to see the true appearance of the text.

Tip: Save the report as a template so you can base future reports on the same style with very little additional work. (See page 8).

Left Margin

There are two left margin fields, one for each column of text. Enter a percentage value, estimated from the left side of the page. Then click Apply.

Show Title Block

When the box is unchecked, DigiPro shows the title block. If you hide the title block, you can enlarge your graphs using the Layout tab.

Show Border

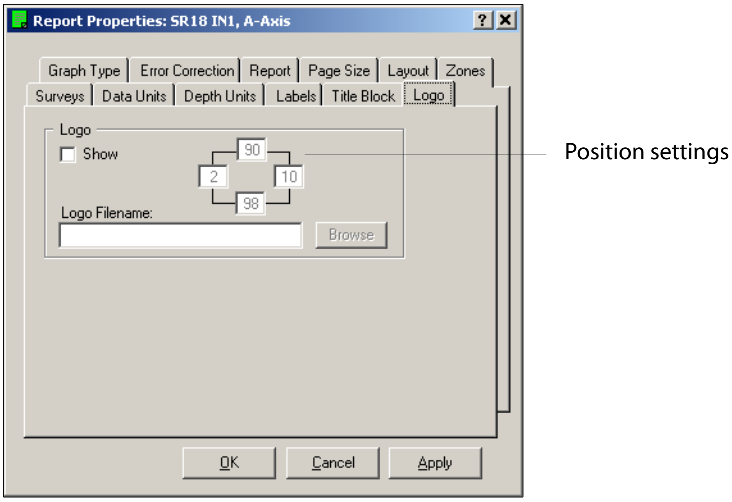
When the box is checked, DigiPro draws a line around the title block. You may find that hiding the rule provides a neater result.

Position from Top

Enter an estimated percentage value. By default, the title block appears at the bottom of the page. However, if you set the value to zero, it will print at the top of the page.

Note: If you change the position of the title block, you must move the graphs down using the Layout tab.

Logo



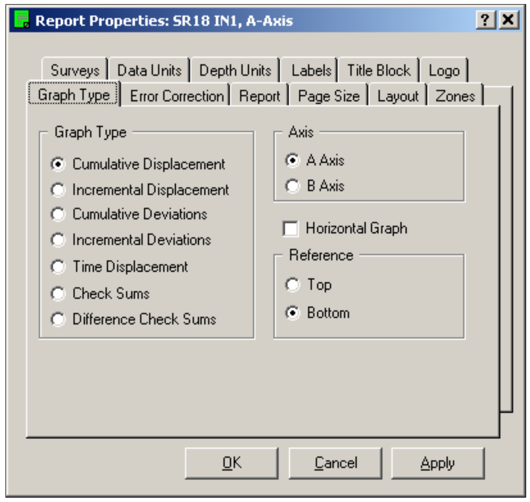
Displaying a Logo

DigiPro has a simple facility to print a bitmap (.bmp) image of your logo on the report.

1. Click (check) the Show check box.
2. Enter the path and file name of your logo. You can use the browse button to do this for you.
3. The position settings are percentages. They change the boundaries of the logo box and also the position of the logo box. You will probably need to make several adjustments to find the right setting.

Note: We recommend that you place the logo file in DigiPro's BMP folder so that it will not be accidentally lost during routine disk cleanups. The path will appear like this: C:\Program Files\DigiPro\BMP\myLogo.bmp.

Graph Type



Overview

This useful feature lets you change the type of graphs shown in the report. For example, you could place a graph of time displacement next to a graph of cumulative displacement. You could also show two versions of the same graph, one with error correction turned on and one with error correction turned off.

Graph Type

Graph types are explained in "Creating a Report." The radio button shows the type of graph currently displayed. To change, click a different radio button. When you click Apply, the graph is redrawn.

Axis

The sample templates use A-axis data for the left graph and B-axis data for the right graph, but you are not limited by this. You can show two A axis graphs or two B axis graphs, etc.

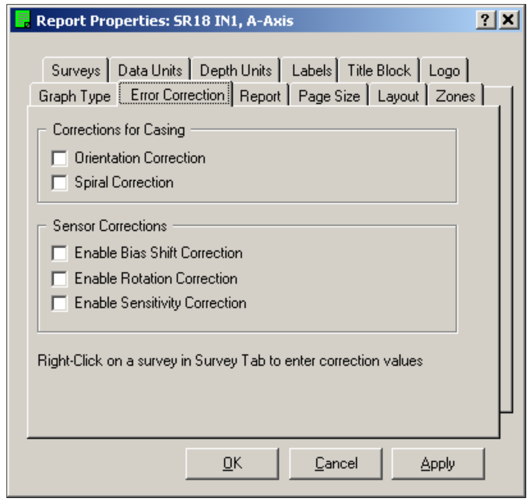
Horizontal

It is easier to use the Horizontal template to create a horizontal graph, but this checkbox is here for completeness.

Reference

Select top or bottom of the casing as the starting point for calculations of cumulative displacement and cumulative deviation. Bottom reference is the default.

Error Correction

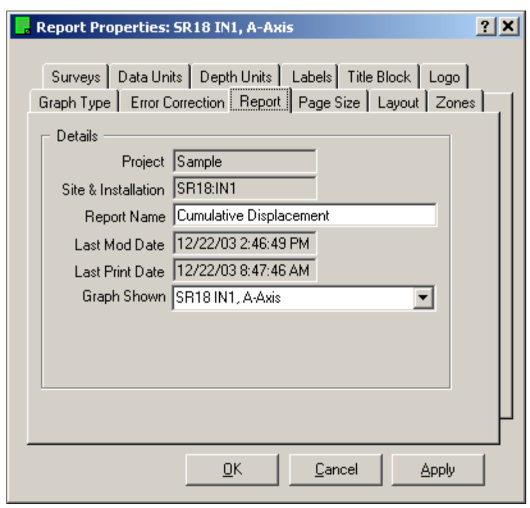


Overview

This dialog lets you enable and disable correction routines. Except for the orientation correction, values used by the routines are entered elsewhere. For information on corrections, see the chapter on error correction.

- To enable a correction routine, put a check in its checkbox.
- To disable a correction routine, remove the checkmark.

Report



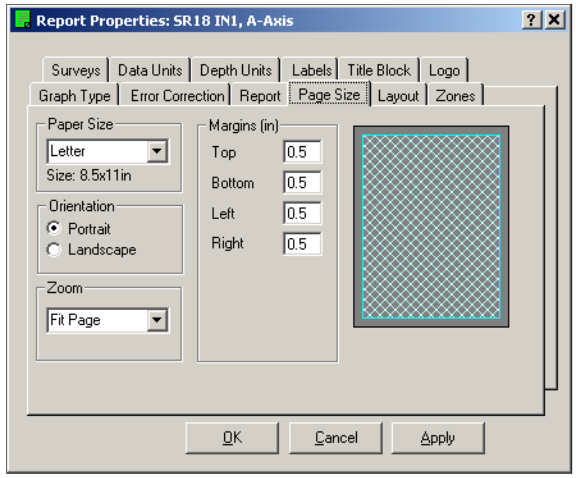
Overview

This dialog is generally not used. Only two fields can be manipulated: report name and graph shown.

Report Name: You can rename a report here. Note that you can also rename a report by right clicking on the report in the installations and reports dialog.

Graph Shown: This can be used to show a graph that was previously hidden.

Page Size



Overview

Page size and orientation are generally set by report templates. Global defaults are controlled by settings in the File > Options and Defaults dialog. The settings here affect only the current report.

Paper Size

Controls paper size.

Orientation

Controls the page orientation for the report. Choices are portrait (long side is vertical) or landscape (long side is horizontal).

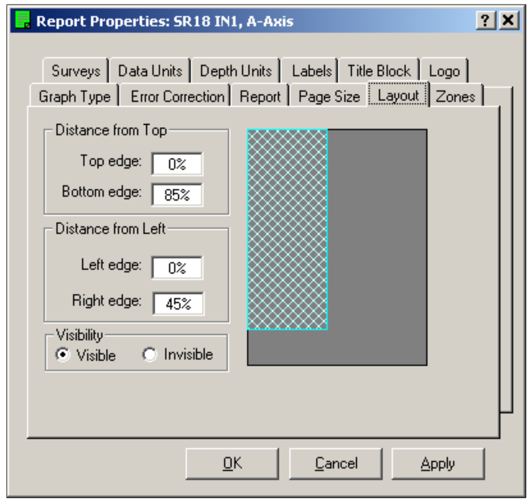
Margins

Controls the page margins for the report. The default margin values are in inches. If you select the A4 or B4 paper sizes, the margin values automatically convert to centimeters.

Zoom

Controls the screen size of the report. The default is “Fit Page,” which allows the report and report properties to be displayed on-screen simultaneously (with no overlap) on a monitor set to a resolution of 800x600 or better.

Layout



Overview

Layout settings determine the placement and size of each graph.

Distance from Top

This controls the vertical size and placement of a graph.

1. Click on a graph. An image of the graph appears in the dialog box.
2. Enter values for the top and bottom edges of the graph in percent from top of page.

Distance from Left

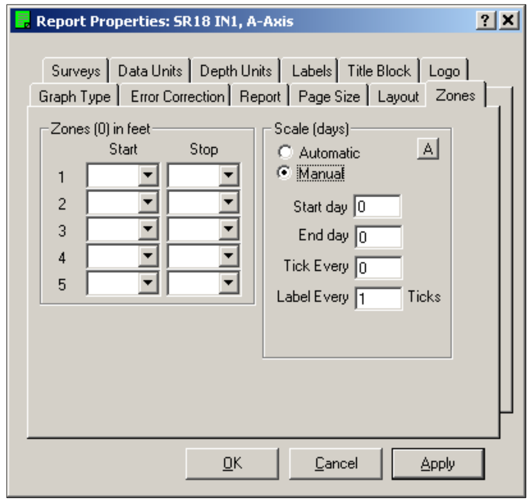
This controls the horizontal size and placement of the graph.

1. Click on a graph. An image of the graph appears in the dialog box.
2. Enter values for the left and right edges of the graph in percent from left side of page.

Visibility

This controls whether a graph is visible or not. For example, if you want only one graph on the page, you can hide the other graph and then adjust size and placement of the visible graph as needed.

Zones



Overview The zone tab is used to select zones for time-displacement graphs.

Zones You can graph up to five zones by specifying a start and stop depth for each zone. Click the drop list to choose a valid depth or elevation. The stop depth must be deeper than the start depth.

The value that DigiPro plots is the difference between cumulative displacement at the start depth and cumulative displacement value at the stop depth.

Scales The automatic setting shows the number of days from the initial survey. The manual setting lets you choose a start and an end day to show only a portion of the available time span. You can also set the frequency of tick marks (in days) and labels (numbers). The current version of DigiPro does not allow display of dates.

Printing a Report

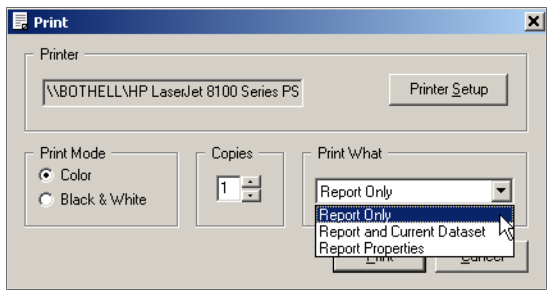
Overview

DigiPro offers the following options

- Print report only or report with current survey data.
- Print plotted data
- Write plotted data to a file

Printing a Report

1. Open a report.
2. Choose File>Print from the file menu, or click on the printer icon located on the tool bar. The Print dialog appears.



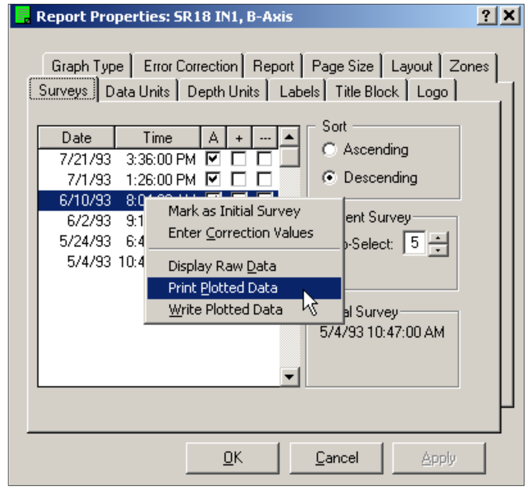
3. Click in the “Print What” field. Choose Report Only or Report with Current Survey.
4. Check the Printer window to be sure it displays the printer you want. To change printers or adjust the printer setup, click on the Printer Setup button.

   Note: If you change the printer in DigiPro’s Print dialog, the new printer becomes the Windows default printer.
5. Click in the Copies field and enter the number of copies you want.
6. Select a print mode: color or black and white. (If you are using a black and white printer but choose the color print mode, the report will print in grayscale.)
7. Click Print to print the report.

Note: You can change the colors that DigiPro uses, if some plots are hard to see. Choose File>Options and Defaults>Preferences. You will see a band of eight colors. click on the color that you want to change and choose a different color from the pop up menu.

Printing Plotted Data

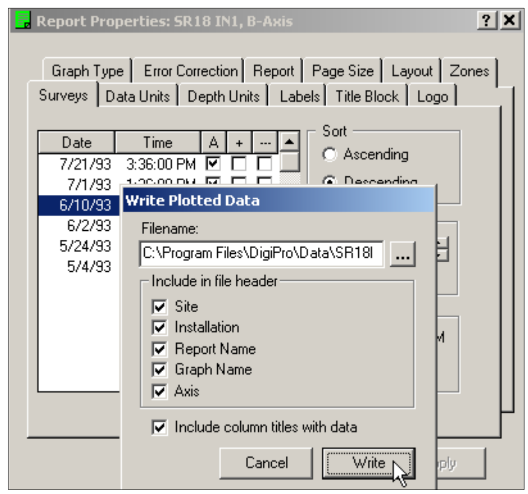
Plotted data are the data points plotted on the graph. DigiPro can print a maximum of 8 columns of data.



1. Open a report and click to open the report properties dialog.
2. Place the pointer in the Survey window and right click.
3. Choose Print Plotted Data from the pop-up menu.

Writing Plotted Data

You can write plotted data to a file for use in a spreadsheet. You can write a maximum of 8 columns of data



1. Open a report and click to open the report properties dialog
2. When the Report Properties dialog appears, click in the survey window.
3. A menu appears. Choose Write Plotted Data.
4. A submenu appears. Choose the items that you want to appear in the file header. You can also specify a filename and location if the default filename is not suitable.
5. Click Write to write the data to the file. The file is placed in the same folder as your project database. It has a .txt extension.

Error Correction

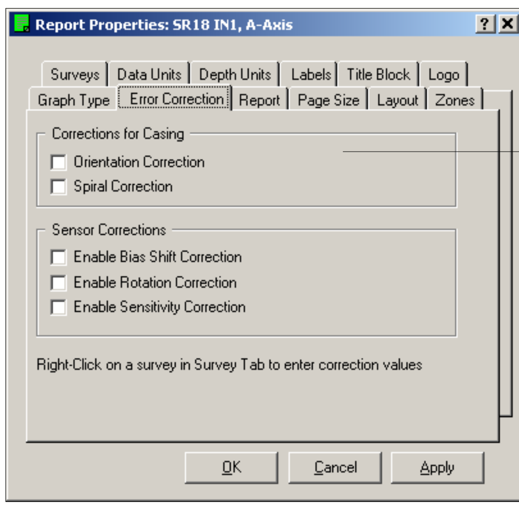
Introduction

The error correction routines that are built into DigiPro were requested by expert users. Error correction is not a simple subject, and applying corrections appropriately requires knowledge and experience.

In this chapter, we provide an brief introduction to some aspects of error correction. Those who need to know more should consider attending Slope Indicator's short course on Data Reduction and Error Correction. The course schedule is listed in the Training section at www.slopeindicator.com.

Enable or Disable Corrections

Correction values are stored separately from readings and are applied on-the-fly when the graphs are generated. Thus corrections can be enabled and disabled at any time



Use the report properties dialog to enable or disable corrections.

- Correction routines are disabled by default.
- If you want to use correction routines, use the report properties dialog to enable them.
- Correction routines apply at the graph level. Thus a report can show one graph with corrections turned on and another graph with corrections turned off.
- Corrections values for casing are entered once for each installation and are applied to any survey selected for the graph.
- Corrections values for sensors (inclinometer probes) are entered for each survey that requires them. A special dialog is used for this.

Corrections for Casing

Corrections for casing are accessed with the report properties dialog.

Orientation Correction

If casing grooves are not oriented to the direction of movement, you can use DigiPro to mathematically rotate the orientation of the measurement axes into the direction of interest.

1. Enable the Orientation Correction. An entry field appears.
2. Enter an orientation correction in degrees. For example, enter 10 to rotate the orientation 10 degrees clockwise.
   Enter -10 to rotate orientation 10 degrees counterclockwise.

Spiral Correction

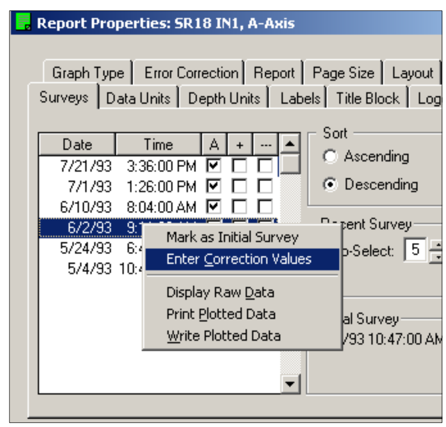
A spiral survey, obtained with a spiral sensor, provides measurements that can be used to correct for spiraled (twisted) casing. The spiral survey is processed and placed in the database by DMM for Windows. DigiPro has no entry fields for spiral data.

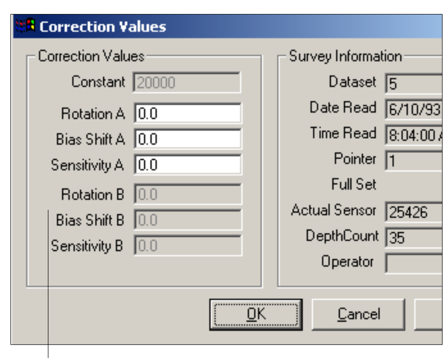
DigiPro automatically recognizes the spiral survey if it is present. If DigiPro cannot find a spiral survey, the checkbox is grayed out and cannot be enabled.

Corrections for Sensors

These corrections must be entered for each survey.

1. Enable the correction.
2. Click on the Surveys tab.
3. Right click on the survey that requires correction. A dialog appears.
4. Choose Enter Correction Values. The Correction Values dialog appears.
5. Enter a value in the appropriate field.
6. Click Apply to see the effect on the graph.
7. Repeat steps 5 and 6 until the correction value is correct.





To enter values for the B axis, you must click on the B-axis graph.

Bias-Shift Error

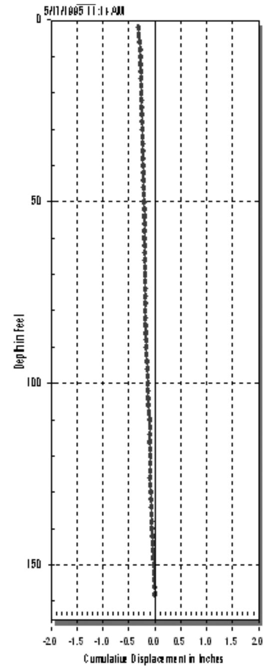
Bias shift values are entered in reading units. Here is a simple introduction to bias shift error. More information can be found in the "Training" section of www.slopeindicator.com.

What is Bias Shift

Bias: If you hold your inclinometer probe absolutely vertical and check the reading, you will typically see a non-zero value. This is the probe's bias. The bias value is normally eliminated in the data reduction process when the 0 readings are combined with the 180 readings.

Bias-Shift Error: If the bias value changes during a survey, the data reduction process cannot eliminate all of the bias. The remaining value is error that is embedded in the reduced data.

The straight, but leaning plot at right is the result of bias-shift error.



Identifying Bias Shift Error

Appearance: A straightened, but leaning cumulative displacement plot is a signature of bias shift error. The embedded error grows larger at each interval, so the plot leans to the left or right.

Unlikely Behavior: The graph above shows rotation of the entire 150 foot span of soil or rock. This unlikely behavior suggests error in the data.

Site Knowledge: The plot shows movement where there should be no movement. Typically, the bottom 5 depths (or more) of the casing are anchored in stable ground. Any movement appearing there is generally error. In our example, we know that the casing entered rock below 80 feet, and that no movement has occurred from 80 feet downwards. This again suggests error in the data.

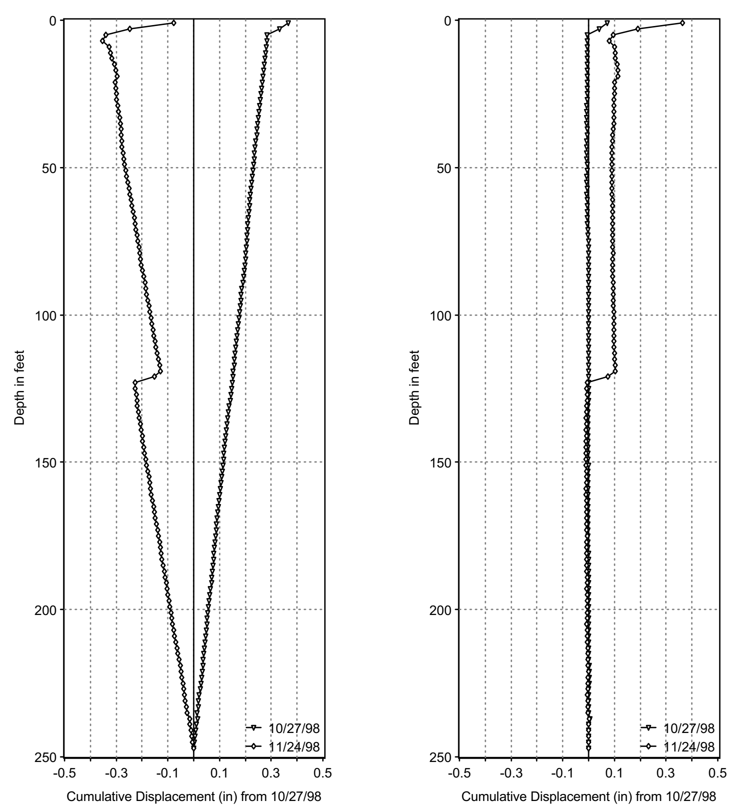
Quantifying Bias Shift Error

DMM for Windows has a routine for quantifying bias shift error. It suggests an value that you can enter in DigiPro's correction routine. Refer to the DMM manual for details.

Visual Correction

You can also arrive at an correction value visually.

1. Display a cumulative displacement graph.
2. Identify displacements that are produced by bias-shift error. For example, if you know that the bottom 20 feet of the casing are installed in rock, then any displacement seen there is probably error. If the error appears as a straight line tilted away from vertical, then it is probably due to bias-shift.
3. Enable bias-shift corrections. Then right click on one of the surveys, and choose Enter Correction Values.
4. In the Corrections Value dialog, enter a value, typically less than 20. If the tilt is to the right, enter a positive value. If the tilt is to the left, enter a negative value.
5. Click Apply and observe the graph. The tilted line should be vertical when the error has been corrected. Experiment with different values until you have found the correct one.



This example shows uncorrected and corrected graphs. You can see the typical linear pattern of bias-shift error. The second survey was obtained on the same day as the initial survey, so any movement is certainly false. The second survey was taken a month later and apparent displacement is in the wrong direction. When corrected, both surveys make sense and we can see that some real movement has occurred at about 125 feet.

Rotation

Rotation corrections are entered in radians. Here is a simple introduction to "rotation" error. More information can be found in the "Training" section of www.slopeindicator.com.

What is Rotation Error?

Rotation is a small change in the alignment of the measurement axis of the inclinometer probe. The change is usually less than one degree.

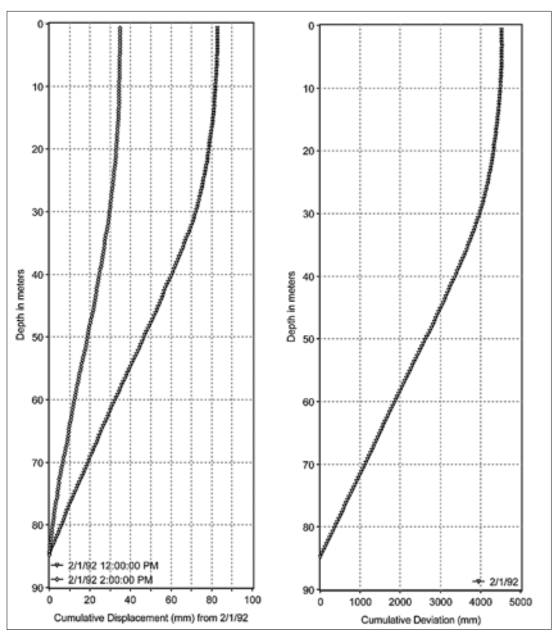
Ideally, the mechanicals of the probe are aligned so that the A-axis accelerometer measures tilt only in the A-plane. If the mechanicals of the probe are rotated slightly towards the B-plane, the A-axis accelerometer becomes slightly sensitive to tilts in the B-plane, too.

Rotation error is the cross-axis component in a reading, for example, the B-axis tilt in the A-axis reading. Rotation error becomes noticeable when two conditions combine:

- There is significant inclination in the cross axis.
- The change in the alignment of the probe occurs after the initial set was taken.

Identifying Rotation Error

- The cumulative displacement plot shows a curved line, when the line should really be straight.
- The cumulative deviation plot shows significant tilt in the cross axis.
- The two plots have a similar shape, as shown below.

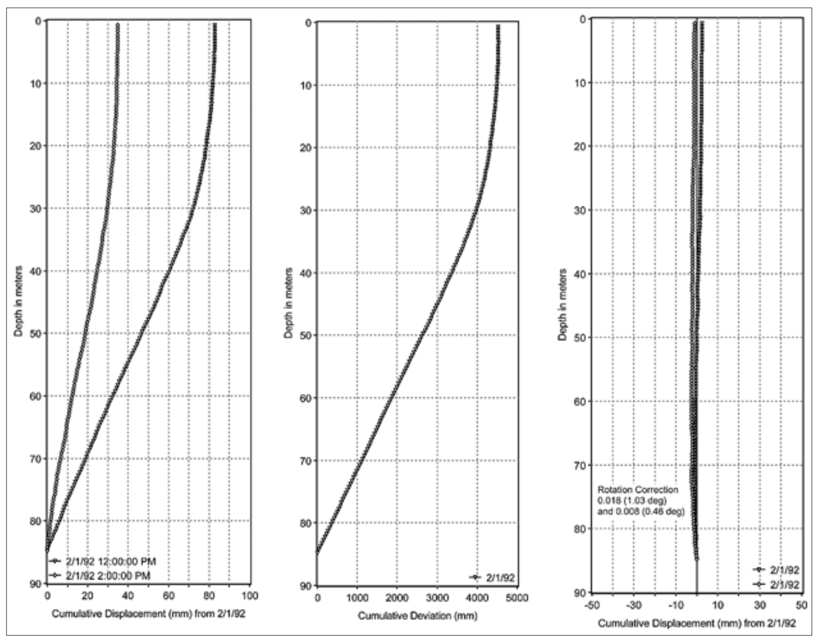


Cumulative Displacement A-Axis

Cumulative Deviation B-Axis

Correcting Rotation Error

1. Display a cumulative displacement graph. Use surveys that contain the error.
2. Identify displacements that are produced by rotation error. Find the depth of the maximum error.
3. Display a cumulative deviation plot of the cross axis. Find the deviation value at the same depth noted above.
4. Divide the displacement value by the deviation value. The result is a starting value for correcting rotation.
5. In DigiPro, enable rotation corrections and enter the rotation value.
6. Apply the correction and inspect the redrawn plot. The curve in the line should straighten..



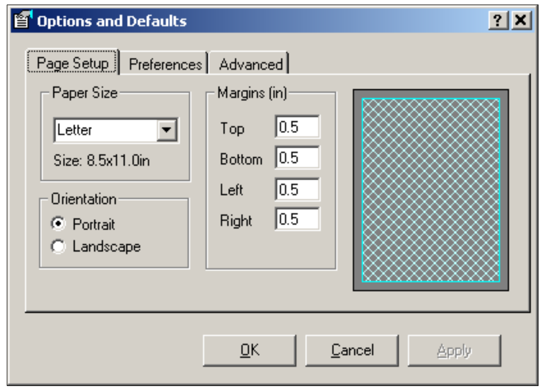
Cumulative Displacement A-Axis | Cumulative Deviation B-Axis | Cumulative Displacement Corrected

This example was a comparison test of three inclinometer probes. Readings from two probes are plotted against the third probe. All readings were taken on the same day. The casing was tilted about 4 degrees in the B-axis. The similarity between the A displacements and the B profile signals rotation error. The corrected displacement are shown at right.

Options and Defaults

Overview Some of DigiPro’s default settings can be changed by using options and defaults dialog: File > Options and Defaults.

Page Setup

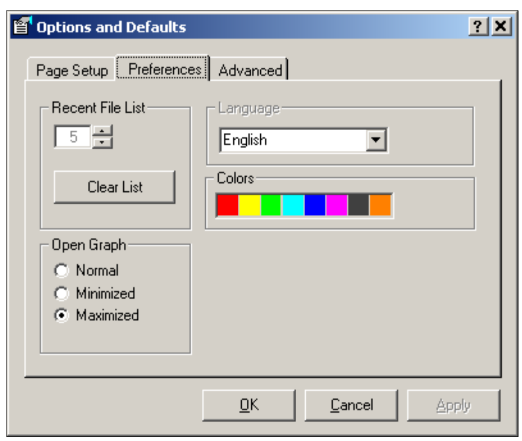


Paper Size Set the default paper size for all new reports.

Orientation Normally, you will allow report templates to take care of this.

Margins Set page margins. Choose paper size first.

Preferences



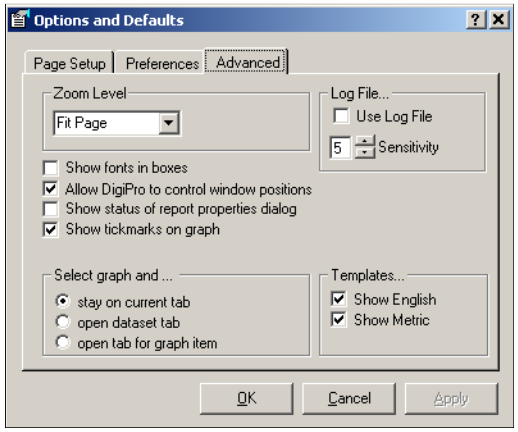
Recent File List Sets the number of recent files displayed on the File menu.

Language Currently, the only choice is English. Sorry.

Colors Set colors for DigiPro graphs by clicking on a color patch and choosing a different color from the pop-up pallet.

Open Graph Sets DigiPro’s window: normal is resizable, minimized is a task on the task bar, maximized is full screen.

Advanced Tab



Zoom Level

Sets the initial size of all displayed reports. We recommend using the default “Fit Page.”

Show Fonts in Boxes

If unchecked, the text fields in the Title Block and Labels tabs will display text in DigiPro’s default display font (Arial 10). If the box is checked, the text fields will display text in the font you select using the A button.

Allow DigiPro to Control Window Positions

Starts the report window in the upper left corner of the screen and the Report Properties dialog to the top edge of the screen.

If the box is not checked, the Windows system controls placement. This may be the preferred setting if you open multiple windows.

Show Status of Report Properties

If this box is checked, a grid appears at the bottom of the Report Properties dialog. The grid lists the tabs in which changes have been made. When you click Apply, the grid resets.

Show Tickmarks on Graph

When this box is checked, DigiPro displays tick marks on the borders of the graphs. When the box is unchecked, the tick marks do not appear. You can set the tick mark positions in the Data Units and Depth Units tabs of the Report Properties dialog.

Select Graph and...

Sets what happens when report properties dialog is closed and then reopened.

- Stay on Current Tab: This is the default. Report Properties displays the same tab as you switch back and forth between graphs.
- Open Survey Tab: Report Properties shows the Survey tab each time you switch between graphs.

Open Tab for Graph Item: Report Properties opens to the tab that corresponds to the part of the graph that you clicked on.

Appendix A: Project Databases

What is a Project Database?

Slope Indicator's project databases contain:

- Information about inclinometer installations, such as their ID and depth. The database can contain any number of installations.
- Surveys of the installations above. The database can contain any number of surveys.
- Reports created by DigiPro. A report is a collection of parameters that tell DigiPro how to create a graph. The database can contain any number of reports.

Use DMM to Create the Database

Project databases are created by DMM for Windows. DMM also imports or converts older data formats. DigiPro simply uses the data in the database.

If you don't have DMM for Windows, you can download it from Slope Indicator's website: www.slopeindicator.com or install it from Slope Indicator's Resource CD. DMM for Windows is free.

Use DMM to Convert or Import Data

Project databases created by DMM for Windows have a ".mdb" extension. If you have been using the Windows version of DMM, your data are already in this format, so no conversion is necessary.

Converting .hdr Databases

Project databases created by DMM for DOS consisted of a number of files. The main file had an ".hdr" extension. DMM for Windows provides a utility to quickly convert any of your old .hdr files to the .mdb Windows format. See Appendix 3 of the DMM manual: "Converting DOS DMM databases."

Importing GTilt, RPP, and PCSLIN Files

DMM for Windows can import RPP, PCSLIN, or GTilt files. It will also accept manually-entered data. See Appendix 5 and 6, "Importing Data" and "Manual Entry of Data."

If you are switching from some other inclinometer system to Slope Indicator's system, you can usually export your data in one of these formats.

Note: DMM does not import spreadsheet files.

Appendix A7 - DigiPro2 for Windows

DigiPro2

User Manual

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SLOPE INDICATOR

12123 Harbour Reach Drive
Mukilteo, Washington, USA, 98275
Tel: 425-493-6200 Fax: 425-493-6250
E-mail: solutions@slope.com
Website: www.slopeindicator.com

Contents

Introduction

About DigiPro

DigiPro2 creates databases, manages inclinometer data, and generates plots and reports. It also provides advanced routines for identifying and correcting systematic errors.

DigiPro2 works with both the Digitilt Classic system and the Digitilt AT system. It replaces the original DigiPro for Windows and it also replaces DMM, since it can retrieve surveys from the DataMate directly.

Compatibility

DigiPro2 runs on XP and later versions of Windows. It features a new database engine and a new database format. It can import surveys from the mdb databases created by DMM, so there is no loss of data when you switch to DigiPro2. However, plots and reports must be recreated because DigiPro2 uses a new graphics library with support for many more features.

DigiPro 2 can also import import surveys from GTILT and other formats and export processed data in several formats.

Installing DigiPro2

1. Direct your browser to www.slopeindicator.com.
2. Click Downloads > Software > DigiPro2.
3. Run the “digipro2setup.exe” program after it downloads.

About DigiPro2 Licenses

DigiPro2 starts with advanced features enabled for 45 days. After 45 days, it reverts to a basic version, unless a license is purchased. See Appendix 1 for information about purchasing and installing a license.

The basic version has no time limits and is free to use.

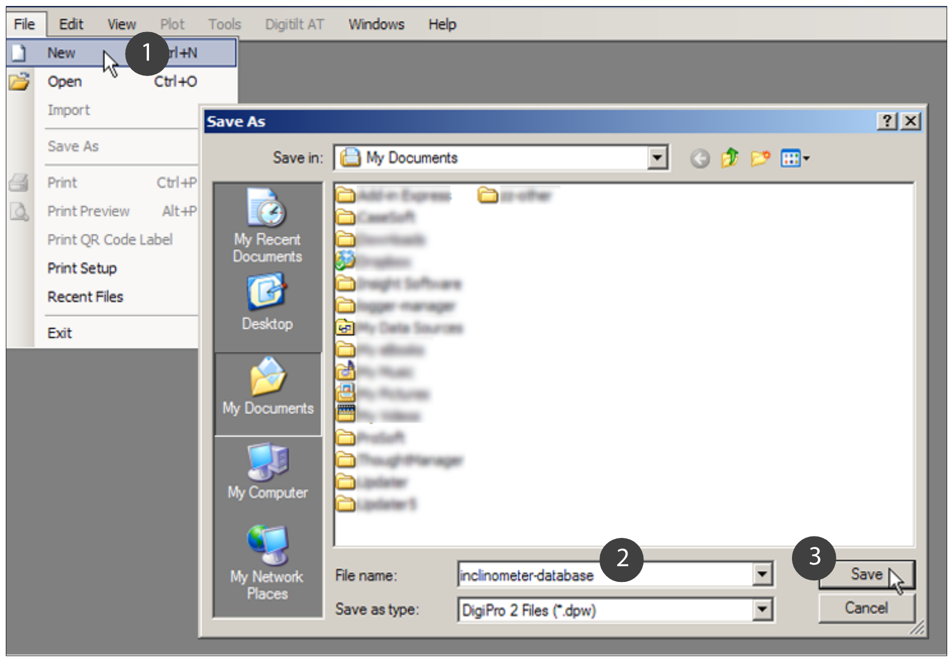
Creating a Database

Introduction

DigiPro2 creates a database to keep inclinometer surveys neatly indexed by name and date.

Creating a Database

1. Start DigiPro. The File menu appears.
2. Click New.
3. Enter a name for the database.
4. Click Save.



Notes

- The default folder is "My Documents" or "Documents."

  To set a different default folder, click Edit > Preferences > Database Folder. Be sure to create your new database in that folder.
- Choose your own filename for the database. All DigiPro2 databases have a .dpw extension.

Next Steps

The new database is empty. To fill it, you can:

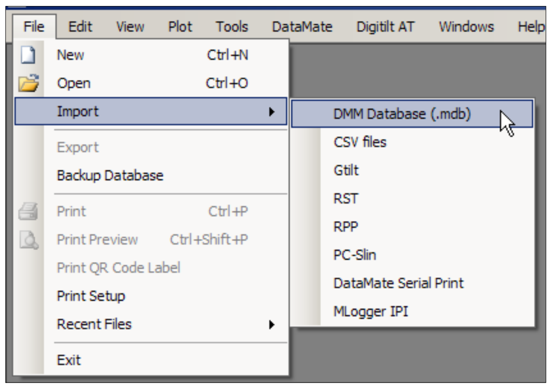
- Import DMM data.
- Retrieve surveys from a Digitilt DataMate readout.
- Import dux files from the Digitilt AT system.
- Import inclinometer data from other formats.

Importing DMM Data

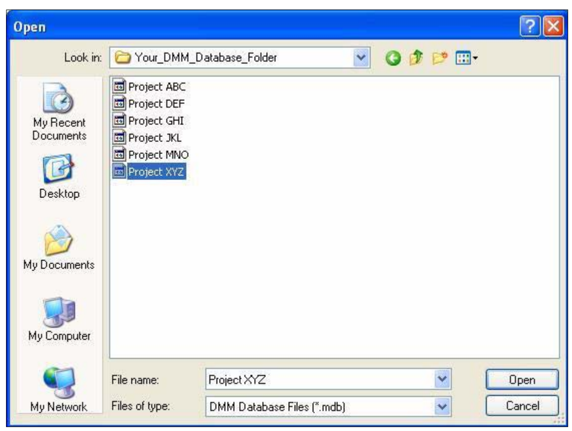
Importing DMM Data

DigiPro2 can import surveys from .mdb databases created by DMM. Note that plots and reports must be recreated.

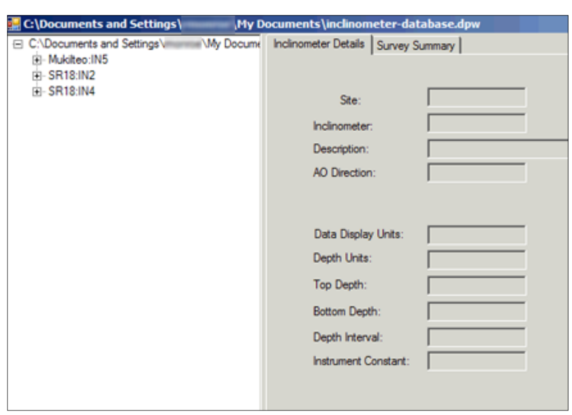
1. Create a database to hold the DMM data.
2. Click File > Import > DMM database (.mdb).



3. Navigate to the mdb file, select it, and click Open.



4. The screen refreshes to show the imported inclinometers and surveys



Inspecting a Database

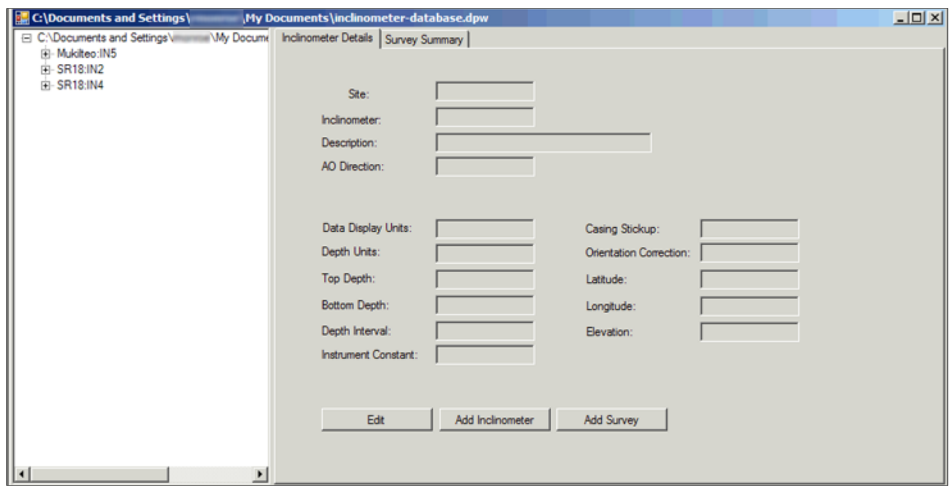
Opening a Database

Open the dpw database that you just created. Or, if you have no data yet, open the sample database, as explained below.

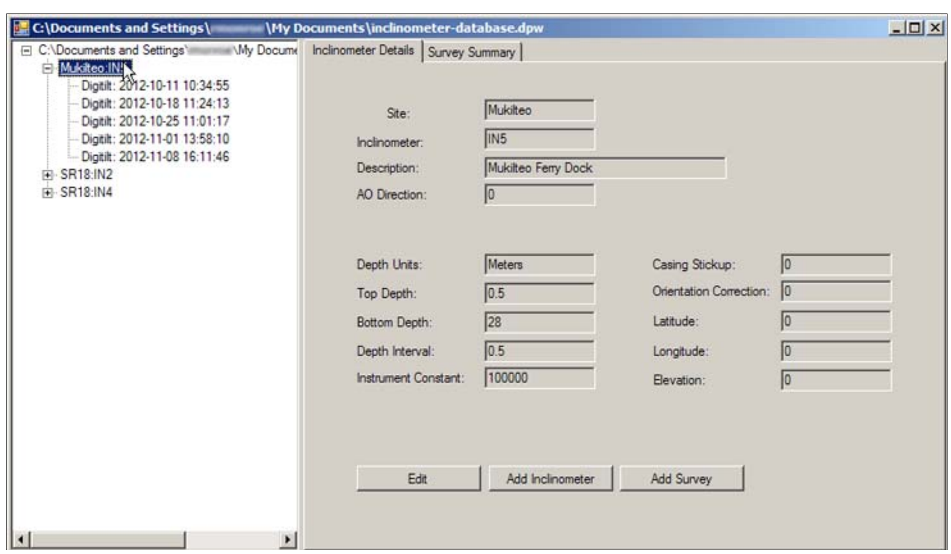
1. Start DigiPro2 from the desktop icon or the start menu.
2. The File menu appears. Choose Open.
3. Click My Documents (left side) or navigate to My Documents.
4. Double-click the folder named “Inclinometer-Data.”
5. Choose “sample.dpw.”

Inclinometer List

A list of inclinometers appears on the left.

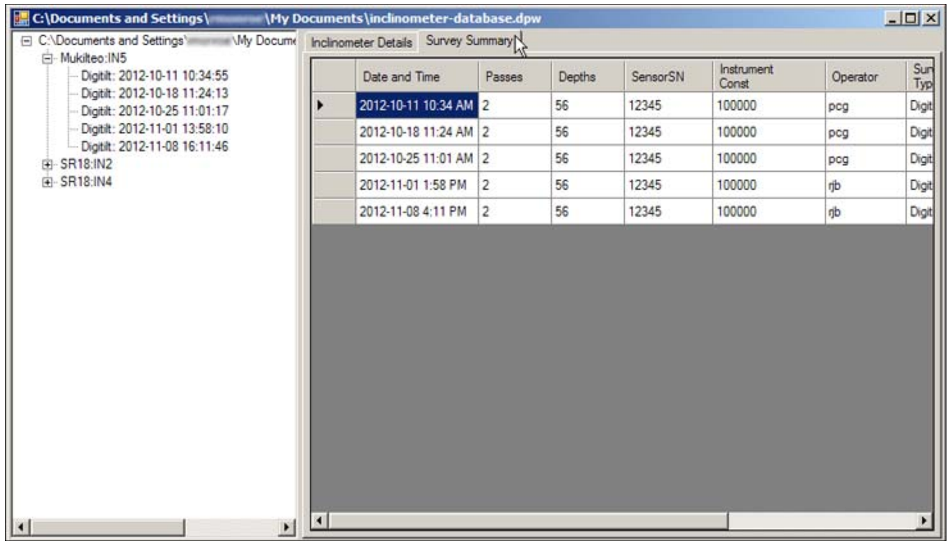


Double-click any inclinometer to see its details on the right. To modify any of the details, click the Edit button.



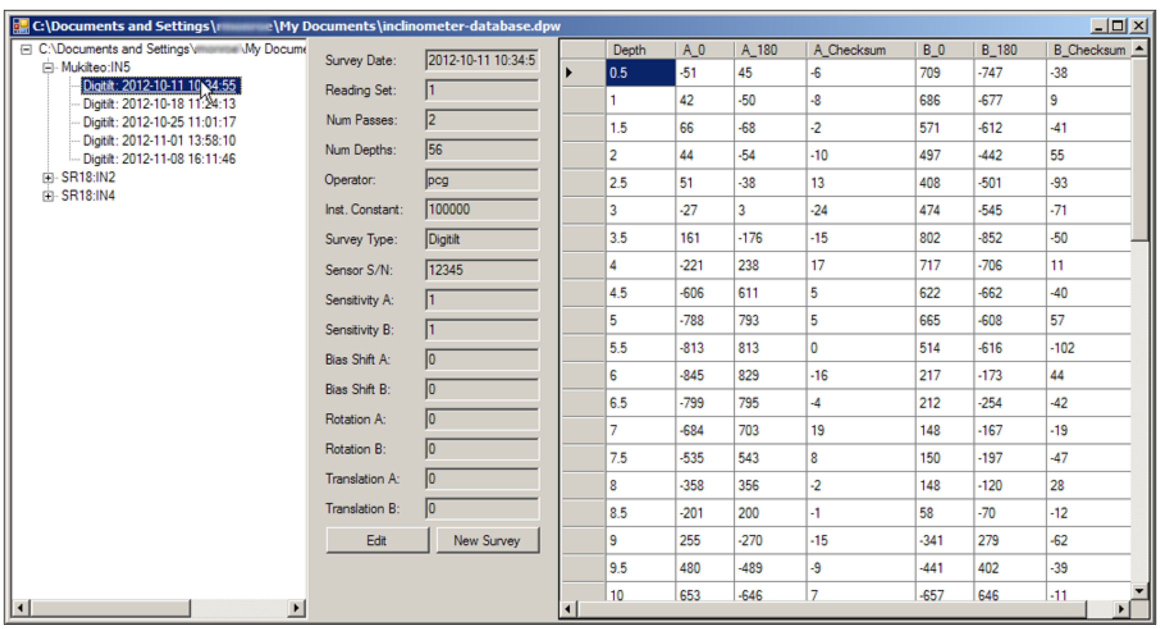
Survey Summary

Click the survey summary tab to see a summary of the surveys for this inclinometer. Double-click any date (left side or right side) to see data values, as shown in the next screen shot.



Survey Data

Double-click a survey (date) to see readings and checksums. Readings from the Classic system are shown in the traditional sine units. Readings from the AT system are shown in the units set by the AT Reader.



Working with the DataMate

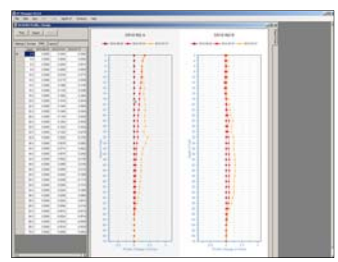
System Workflow

1. Survey the inclinometers with the Digitilt Classic system. The Digitilt DataMate readout stores the surveys in memory.

2. Connect the DataMate to a PC.

3. Open a database (.dpw only), establish a connection with the DataMate, and then retrieve surveys from the DataMate.

4. Use DigiPro2 to display and print inclinometer plots.

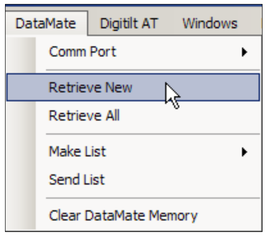


Terminology

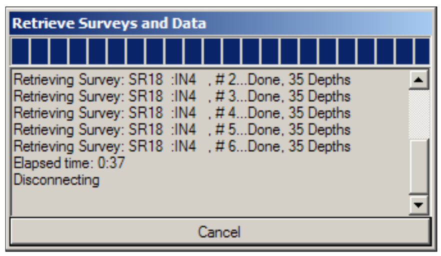
DigiPro2 uses “inclinometer” to refer to the installed portion of the inclinometer system. The DataMate, DMM, and the previous DigiPro use “installation” to refer to the same thing.

Retrieving Surveys

1. Connect the Datamate to the PC.
2. Switch on the DataMate.
3. Choose "Comm." The DataMate displays "Waiting for PC."
4. Start DigiPro2 and open the appropriate database.
5. Click DataMate > "Retrieve All" or "Retrieve New."



6. DigiPro2 shows a progress bar as it imports data.



Communications Problems

1. If DigiPro reports a communications problem,
   click DataMate > Comm Port to choose a different comm port.
2. Additional help is available at www.slopeindicator.com. Go to: Support > Tech Notes > DataMate Communications FAQ.

Managing the DataMate

The DataMate holds a list of installations. It is convenient to create the list in DigiPro2 and send it to the DataMate. Please remember the following:

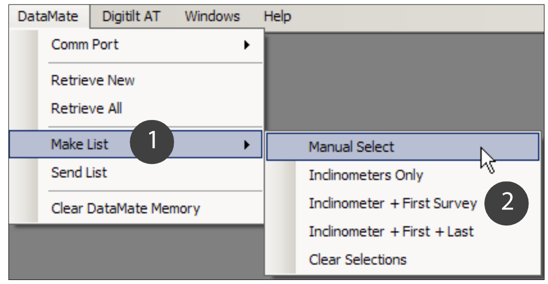
- DigiPro2 completely replaces the list held in the DataMate and also clears all surveys from the DataMate's memory.
- First you create the list. Then you send the list.

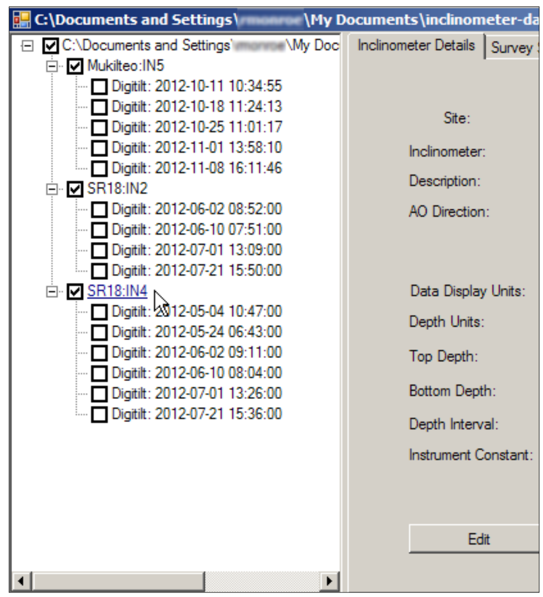
Create the List

1. Open a database and click DataMate > Make List.
2. Choose one of the options. DigiPro2 places checks next to the items selected for the list. In the example at right, only inclinometers were selected for the list.

   The original DataMate has room for 40 inclinometers. Keep as memory free for new surveys.

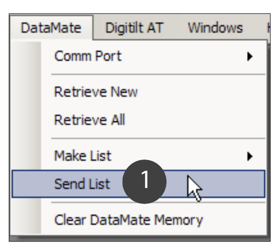
   The DataMate II has room for 160 installations and 320 surveys.

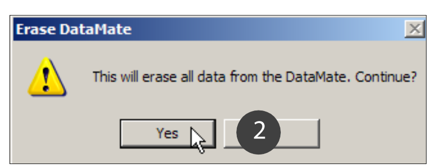




Send the List

1. Click DataMate > Send List.
2. DigiPro shows a warning. This is normal. Click Yes to continue.

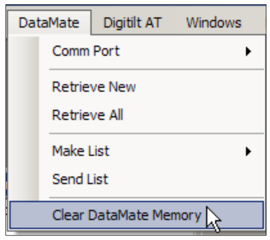




Clearing Memory

DigiPro2 offers an erase command that can clear the memory of the DataMate, if necessary. This erases all installations and surveys.

Click DataMate > Erase Memory.

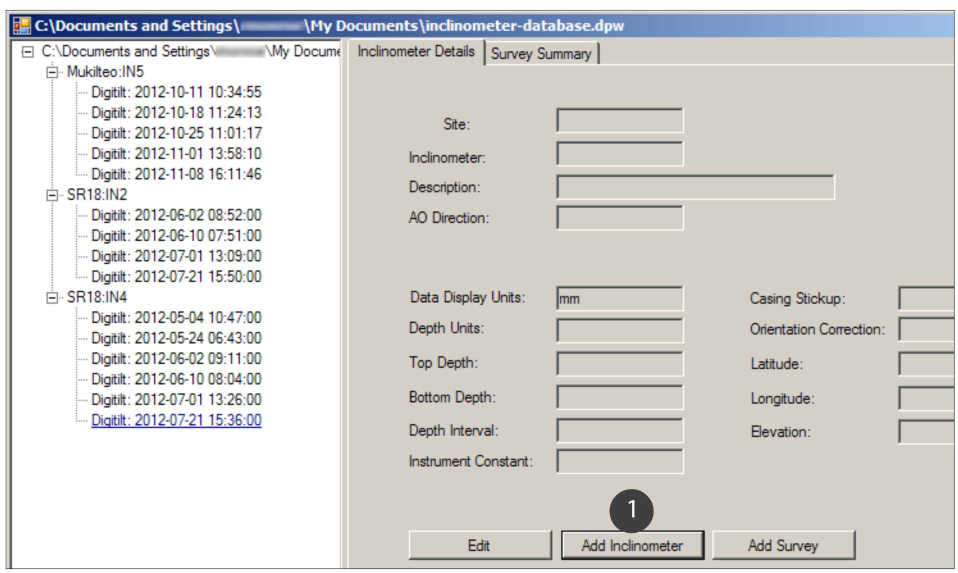


Adding Inclinometers to the Database

If you are in the field, you can create a new "installation" on the DataMate. Then, when you retrieve surveys with DigiPro2, the new installation will appear as an inclinometer in the database.

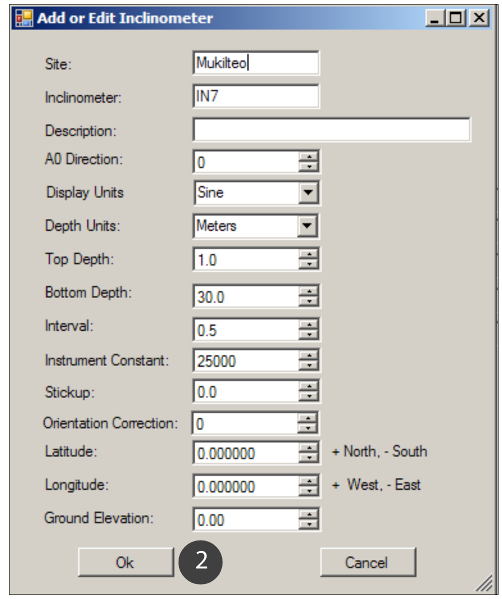
If you are in the office, you can use DigiPro2 to create new inclinometers. Afterwards, you make a list that includes the new inclinometers and send the list to the DataMate, as explained above. Here are instructions for creating an inclinometer in the database:

1. Open the database and click "Add Inclinometer." DigiPro2 clears the fields and starts a new inclinometer



Adding Inclinometers continued

2. Enter the information. Starred fields are required.



***Site:** The Site and Inclinometer fields together make a unique ID for the inclinometer. DigiPro2 allows 12 characters for the Site ID but sends only 6 characters to the DataMate.

***Inclinometer:** Enter an ID for the inclinometer. Again DigiPro2 allows up to 12 characters (for the Digitilt AT system) but sends only 6 to the DataMate.

Description: Optional field that does not appear in the DataMate. Accepts up to 35 characters.

AO Direction Optional field for the compass heading (0-359) of the inclinometer "A" grooves. Not used in calculations.

Display Units: Choose sine, mm, or inches. Sine refers to the units displayed by the DataMate readout. Millimeters assumes a .5m gauge length. Inches assumes a 2-foot gauge length. Default is sine units.

***Depth units:** Choose feet or meters.

***Top Depth:** Typically 0.5 for metric-unit systems or 2 for English-unit systems.

***Bottom Depth:** Depth of deepest reading. With English-unit systems, use an even number to match the two-foot cable graduations.

***Depth Interval:** Typically 0.5 for metric-unit systems or 2 for English-unit systems.

***Instrument Constant:** Enter 25000 for metric-unit systems , 20000 for English unit systems, 100000 for AT system.

Reserved Fields

Casing Stickup: Distance from the top of the casing to ground level. Allowed values from -10 to + 10. Used by DigiPro.

Elevation: The elevation of the ground surface. Used by DigiPro.

Orientation Correction: Range is -180 to +360. Used by DigiPro.

Latitude, Longitude: Information field not used by DataMate.

Working with the Digitilt AT

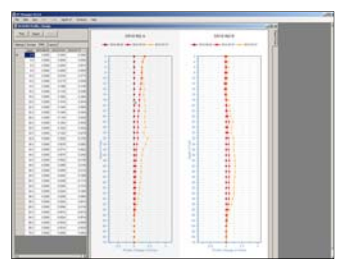
System Workflow

1. Use the Digitilt AT system to to survey the inclinometers. The Reader stores the surveys in inclinometer files.

2. Use the Reader to send the inclinometer files to the PC, where they are saved in an import folder for easy access by DigiPro2.

3. Use DigiPro2 to import the inclinometer surveys.

4. Use DigiPro2 to display and print inclinometer plots.

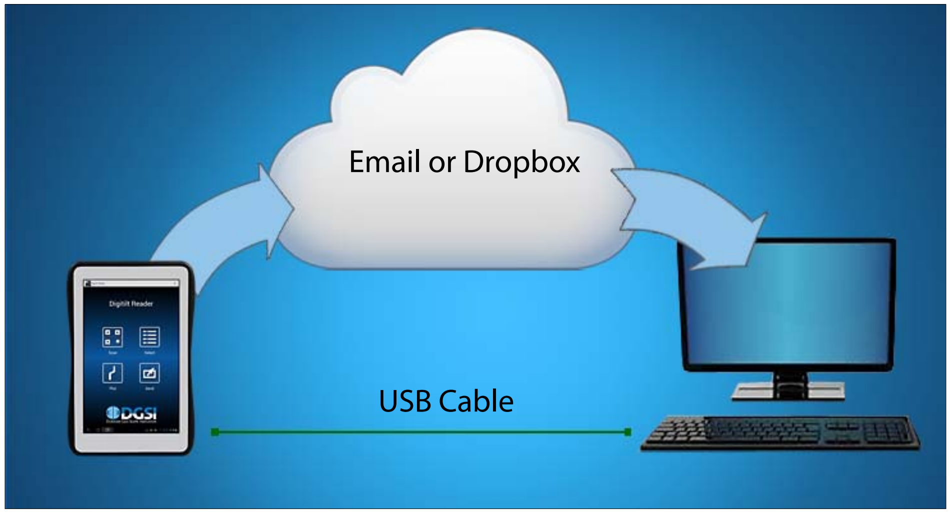


Transfer of Dux Files

The Reader stores surveys in inclinometer files. For convenience, we call these “dux” files because they have a .dux extension. (dux mean DigiPro Uniform eXchange).

Transfer Methods

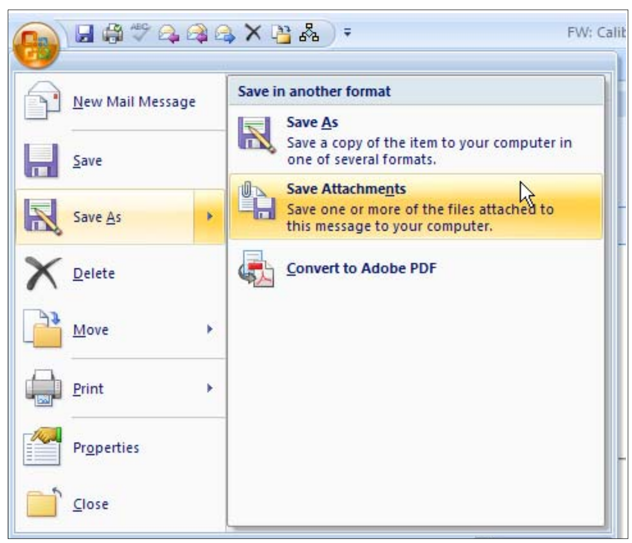
The Reader can send dux files to the PC by email or Dropbox. If the internet is not available, you can use a USB cable and the Windows file manager to copy files from the Reader to the PC.



Email Transfers

The Reader sends dux files as attachments to an email message.

1. Use Outlook, Gmail, or some other email program to open the email message.
2. Save the attached dux files into the import folder. (The import folder is explained in the next chapter.)



Dropbox Transfers

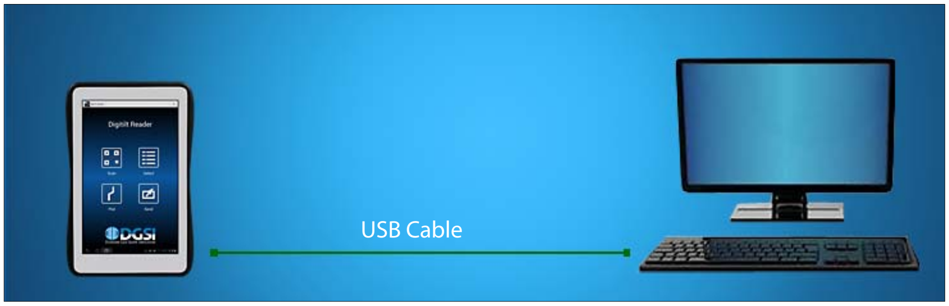
The Reader sends dux files to Dropbox. A few minutes (or seconds) later, the files appear in the Dropbox folder on the PC. No user actions are required.

The convenience of Dropbox is well worth the time that it takes to set up. Other cloud services such as Google Drive can be set up in a similar way.

1. Visit Dropbox.com using your web browser. Create a free Dropbox account. Enter an email address for the User ID, then create a Dropbox password. User ID and password are used again in the next steps
2. Download Dropbox for Windows. Run the setup program and then log in to Dropbox, using your User ID and password. Now your PC is linked to Dropbox in the cloud.
3. Start DigiPro2 and create a default import folder in Dropbox, as explained in the next chapter.
4. Visit the Google Play store using your Android device. Search for Dropbox and install it. You already have a Dropbox account, so login using your User ID and password. Now the Android device is linked to Dropbox, too.
5. The Dropbox listing on your Android device now shows the default import folder. That is where the Reader app will send dux files.

USB Transfers

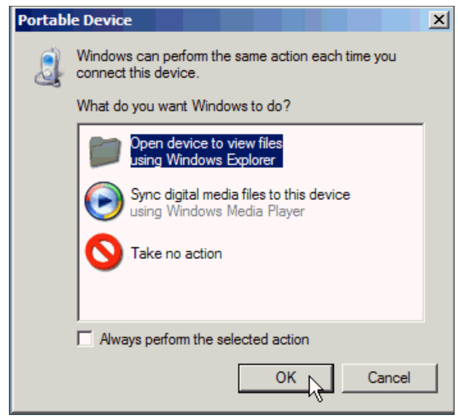
Use the Windows file manager and the USB cable supplied with your Android device. No USB drivers are required.



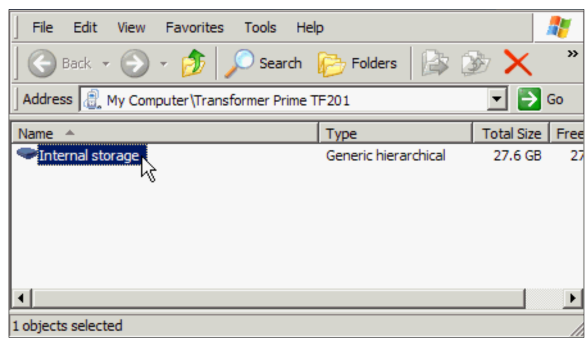
1. Connect the Reader to the PC using the USB cable.

   Switch on the Reader.

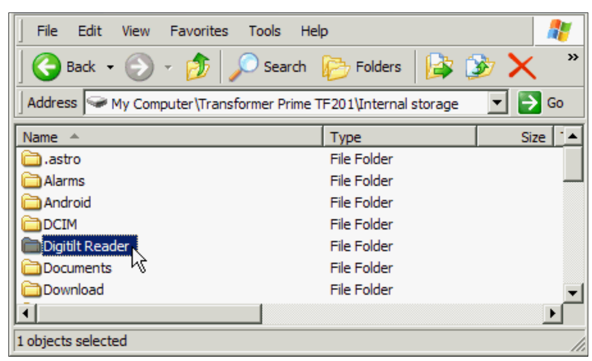
   A dialog appears on your PC. Choose “Open device ...”



2. Windows opens the device. Click on “Internal storage.”

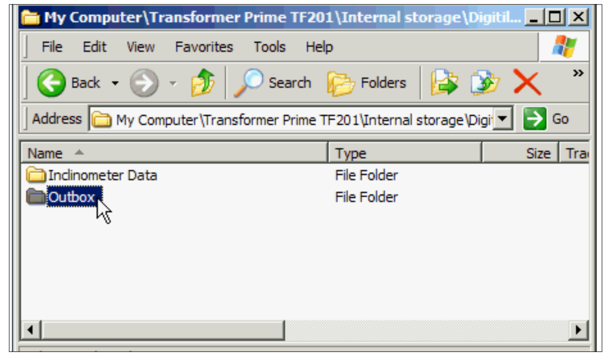


3. .Windows displays list of folders. Click on the “Digitilt Reader” folder.

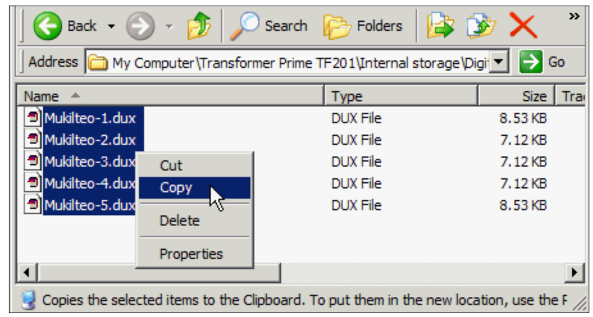


USB Transfers continued

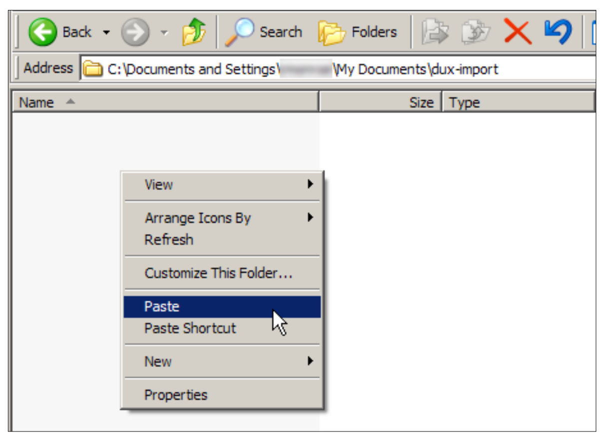
4. Click on the Outbox folder. This folder holds the dux files that should be transferred.



5. Select all the dux files in the Outbox, then right-click, and choose Copy.



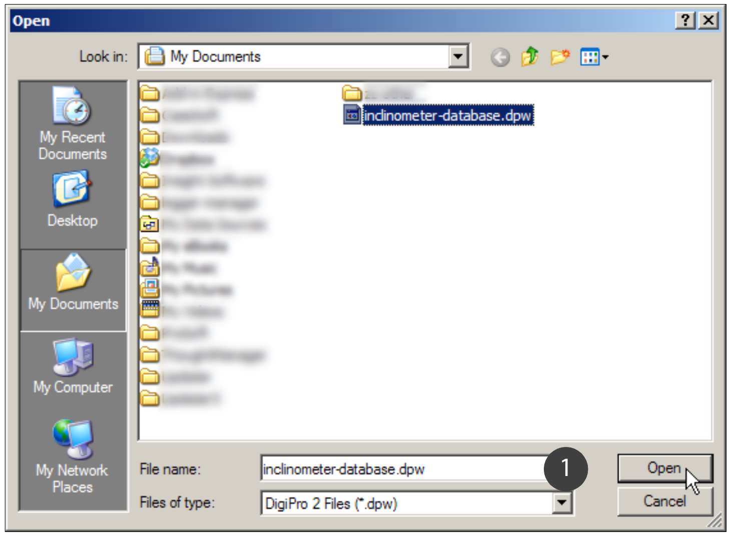
6. Now paste the dux files into the default import folder (which is explained in the next chapter).



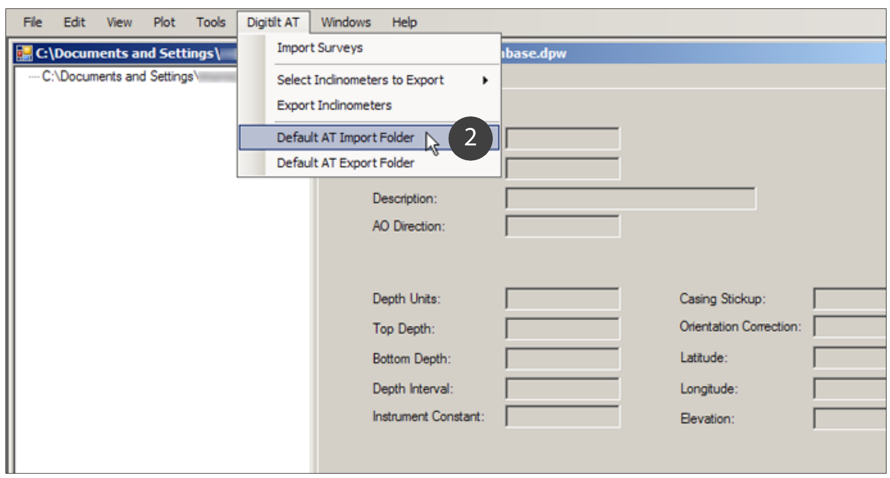
Create an Import Folder

Use DigiPro2 to create an import folder for dux files transferred from the Digitilt Reader. That will simplify importing the data into DigiPro.

1. Start DigiPro. Open the database that you just created.



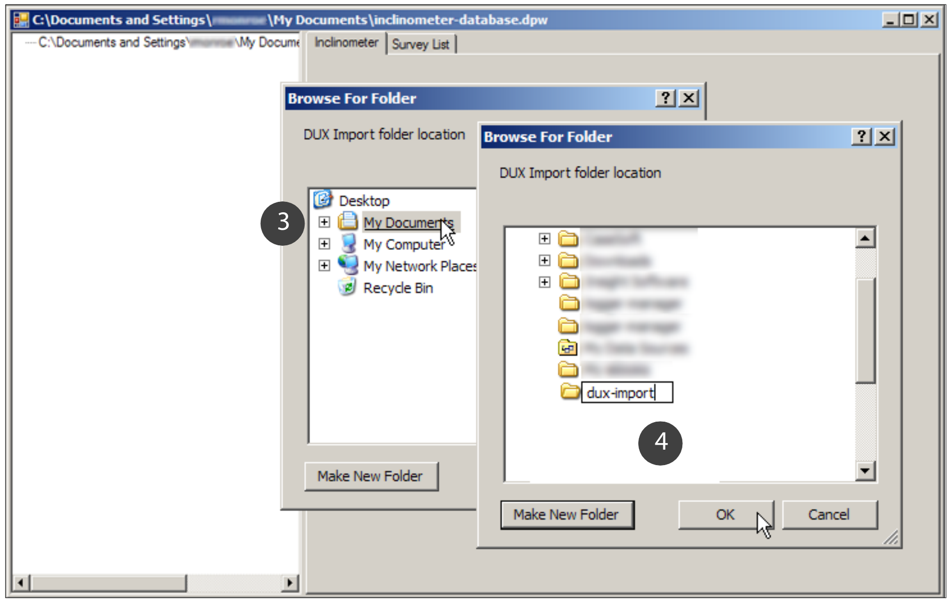
2. Click Digitilt AT > Default Import Folder.



...for Email or USB Transfers

3. Click "My Documents" (XP) or "Documents" (Win 7 & 8).

4. Click "Make New Folder," enter a name for the folder, and click OK. In the example below, the folder is named "dux-import," but you can choose your own name.



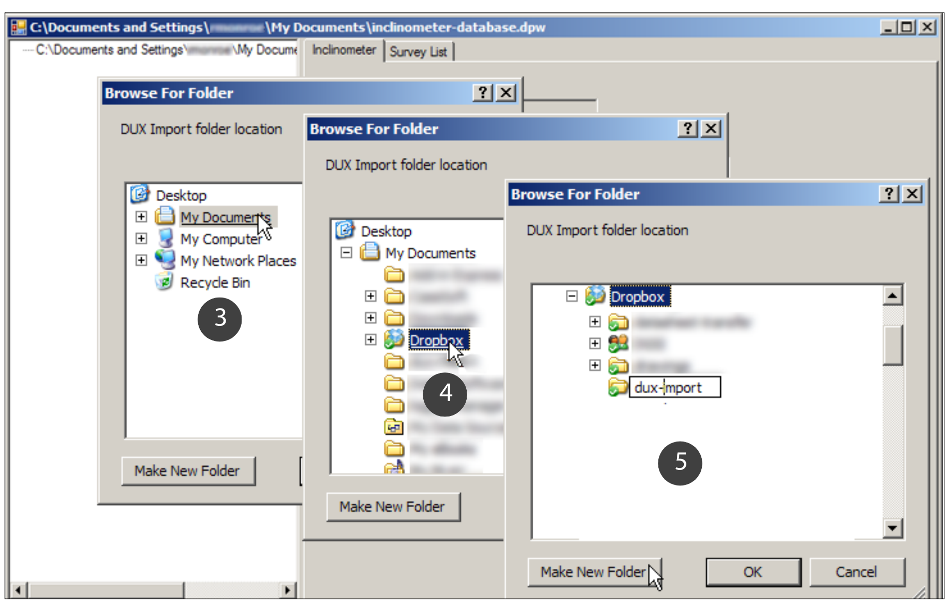
... or for Dropbox Transfers

After you install Dropbox, you can see a Dropbox folder in My Documents.

3. Click My Documents.

4. Click the Dropbox Folder.

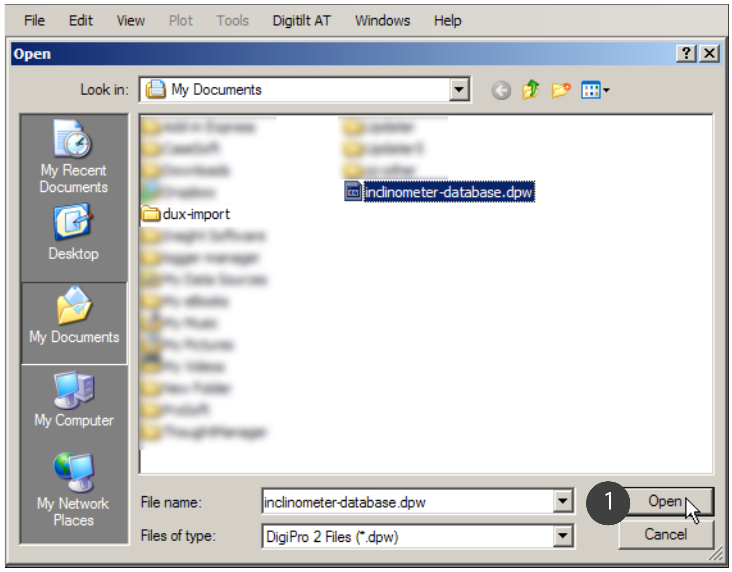
5. Click "Make New Folder," enter a name for the folder, and click OK. In the example, the folder is named "dux-import," but you can choose your own name.



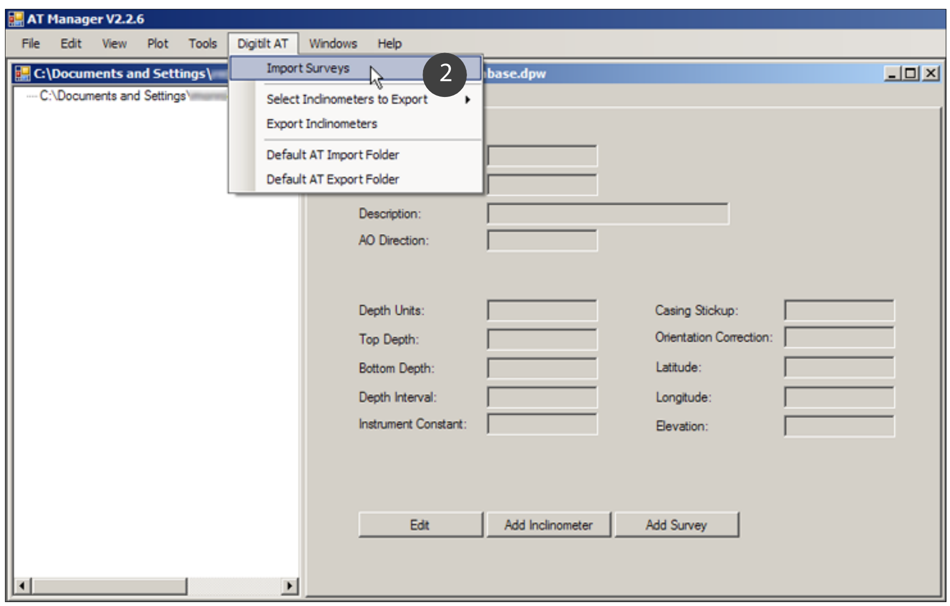
Import AT Surveys

Now it is time to import data from the dux files.

1. Open the .dpw database.



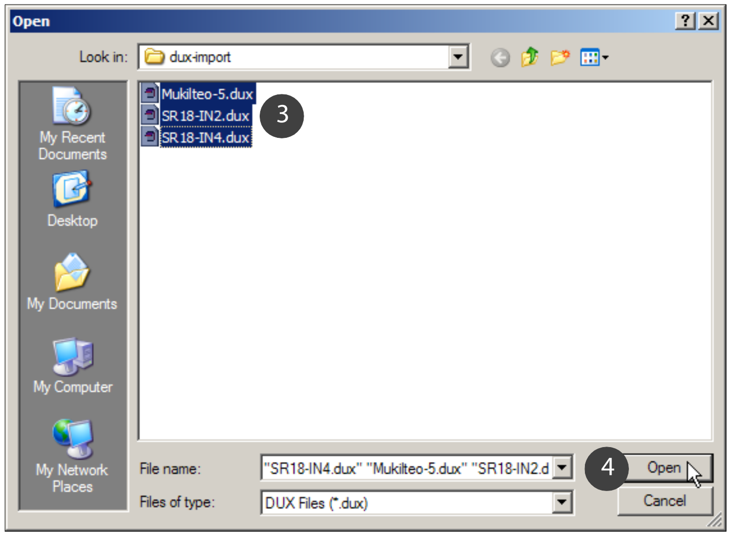
2. Click Digitilt AT > Import Surveys. DigiPro2 opens the default import folder.



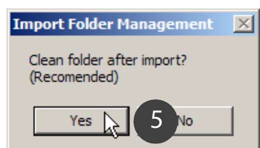
Import continued

3. Select the dux files that you want to import (Ctrl-A for All).

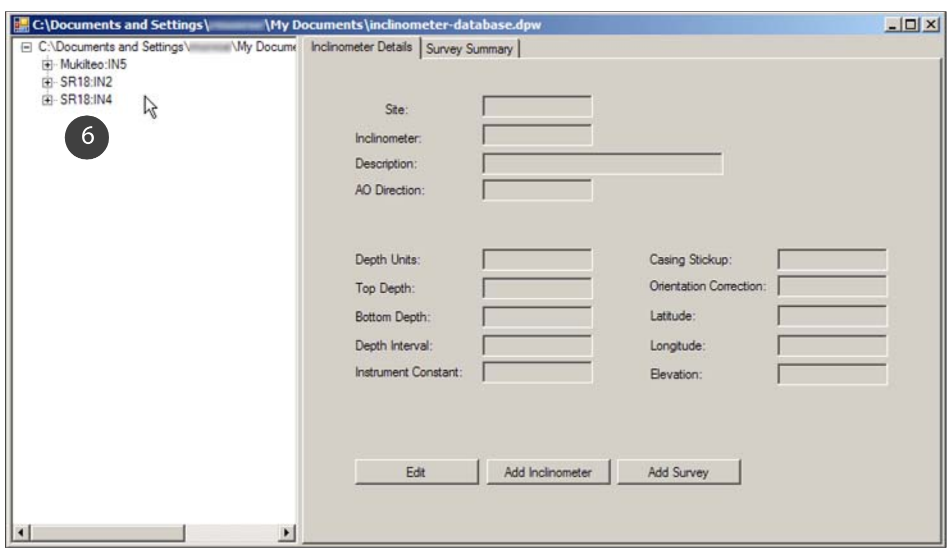
4. Click Open.



5. Click “Yes” to allow DigiPro2 to delete dux files that are imported successfully. These are no longer needed. The Reader keeps the original files and the database has the transferred readings.



6. DigiPro2 imports the surveys and clears the imported files from the folder.



Generating Plots

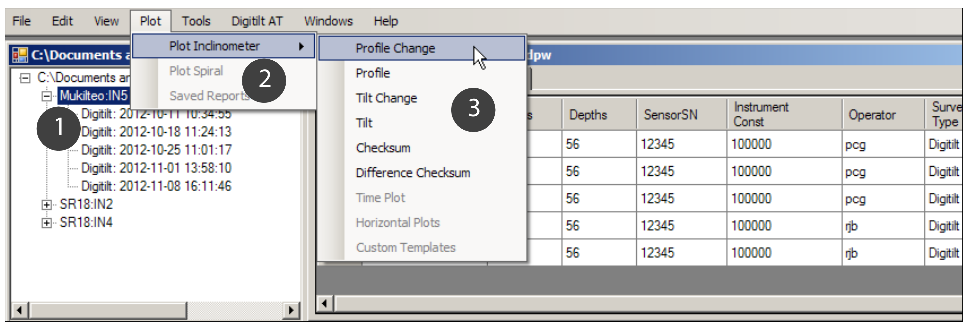
Overview

DigiPro2 can generate, print, and export a variety of plots. Plots can be saved as reports and reused with new surveys. DigiPro2 can also apply a variety of corrections to inclinometer data.

Some features explained below exist only in the Advanced version of DigiPro2, which requires purchase of a license key. The appendix presents a comparison of features available in the basic and advanced versions.

Plotting

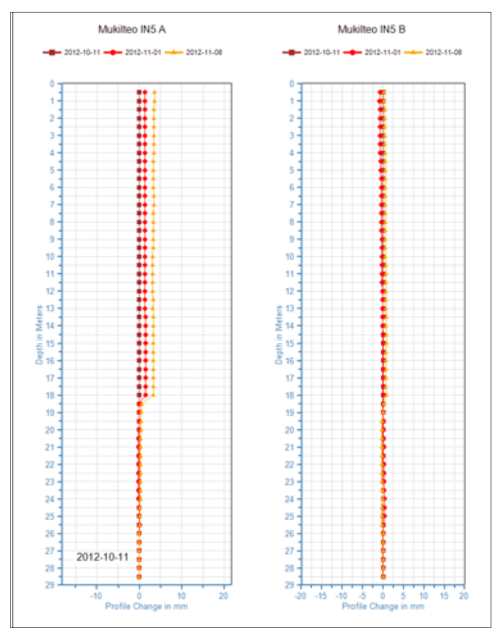
1. Click on an inclinometer
2. Click Plots
3. Choose a plot. Plot types are discussed below.



Profile Change Plot

This change plot is most common way to present inclinometer data. The plot compares compares the current profile to the initial profile. Changes are understood to be movement (displacement).

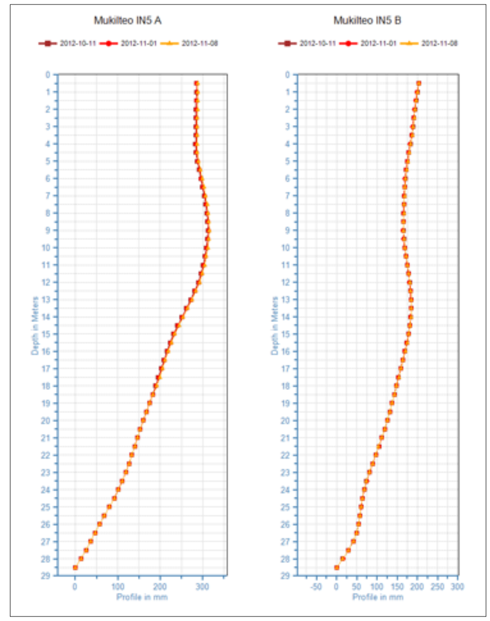
The previous name for this plot was "Cumulative Displacement."



Profile Plot

This is a diagnostic plot. It accumulates tilt readings (in mm or inches) to show the profile of the installed casing. The plot is used to evaluate borehole verticality and is also used in diagnosing and correcting error.

The previous name for this plot was "Cumulative Deviation." It is also known as an "absolute position" plot.

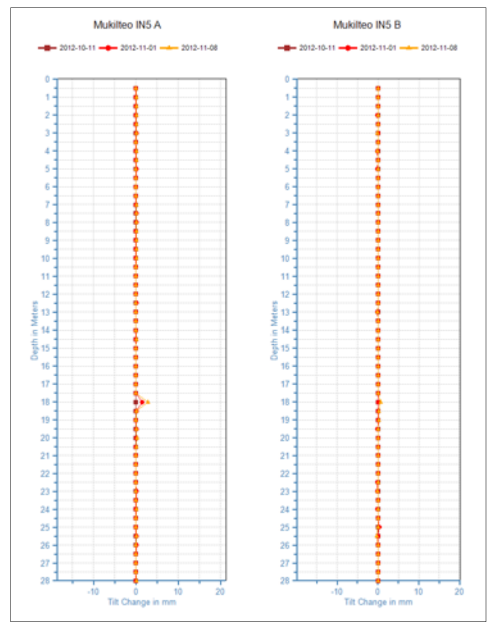


Tilt Change Plot

This change plot compares the current tilt reading at a given depth to the initial reading at the same depth. Changes are understood to be movements (displacement).

Tilt change plots do not accumulate values, so are immune to systematic error. Movement appears as a growing spike, typically centered on one or two depths.

The previous name for this plot was "incremental deviation."

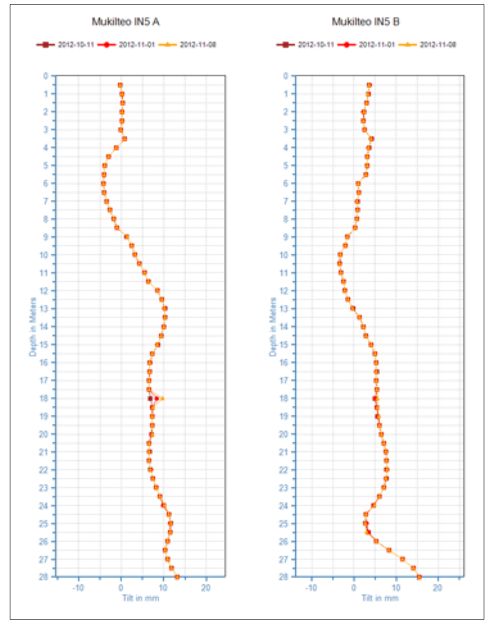


Tilt Plot

This is a diagnostic plot that shows tilt in mm or inches at each depth.

It can be used to evaluate the installed "straightness" of an inclinometer and the potential for depth control errors.

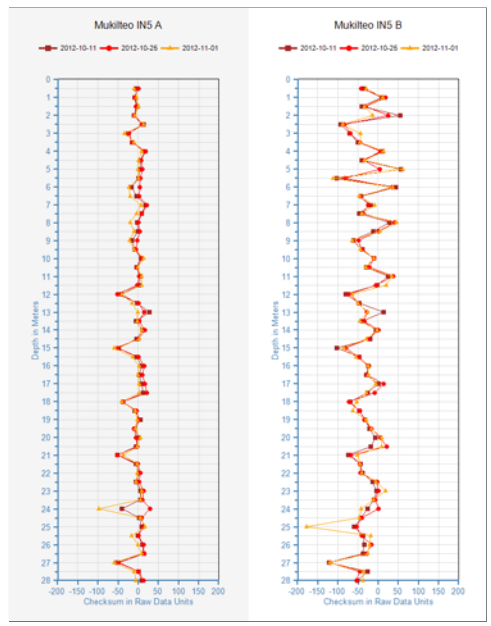
The previous name for this plot was "Incremental Deviation."



Checksum Plot

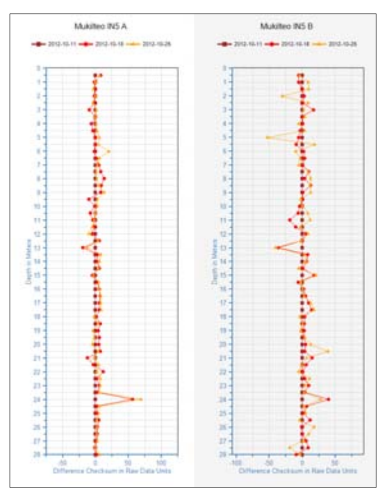
This is a diagnostic plot that shows the checksum at each depth. A checksum is the sum of the 0 and 180 readings.

Generally speaking, the magnitude of the checksums is less important than the uniformity of checksums within a survey. In that regard, you would hope to see plots that are straight and vertical rather than curved and off vertical.



Difference Checksum Plot

This is a diagnostic plot that attempts to remove casing irregularities from the analysis of checksums. The initial checksum is subtracted from the current checksum. This eliminates variations that are due to characteristics of the casing, such as telescoping couplings.

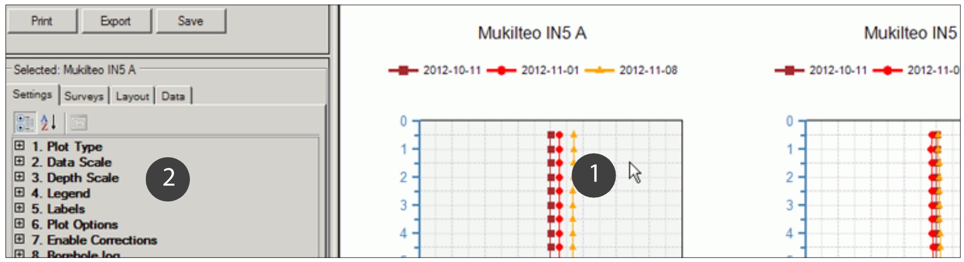


Modifying Plots

Overview

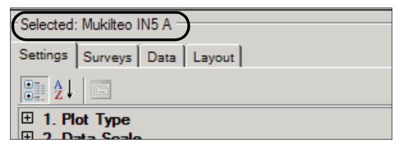
A tabbed control panel provides access to settings, surveys, and layout.

1. Click to select a plot. The plot background turns gray.
2. Double-click to open a settings.

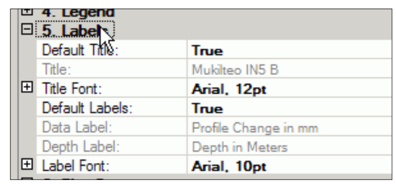


Helpful Hints

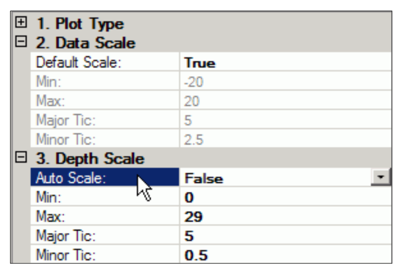
- The name of the selected plot appears above the settings tab.



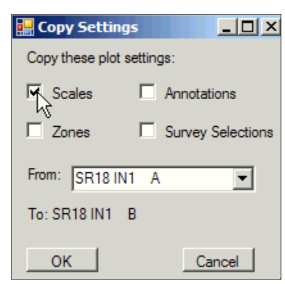
- To open a settings group, double-click on the name of the setting. You can also click the + mark.



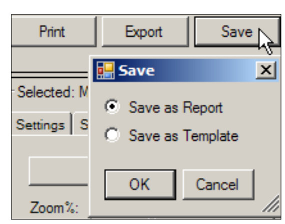
- To change default or automatic settings, first double-click the label to turn off the automation (false = off). Then you can edit the settings.



- To copy plot A settings to plot B, right-click on the B plot and choose “copy settings.” Then choose which settings to copy.



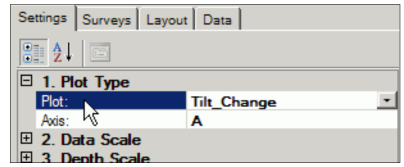
- To save settings, click the “Save” button and choose Save as Report. When you have new surveys, choose “Saved Reports” to plot the new surveys with all the same settings



Settings Tab

Use the Settings tab to control the appearance of the plots.

Plot Type



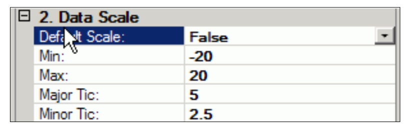
DigiPro normally plots A and B using the same type of plot. Use this setting if you want a different type for one of the plots.

Plot: Double-click on "Plot" to iterate through the available plot types.

Axis: Double-click on "Axis" to iterate through the following choices:

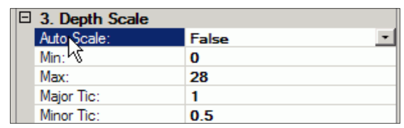
- A shows tilt in the plane of the wheels.
- B shows tilt in the plane rotated 90 degrees to the wheels.
- Magnitude shows the magnitude of the tilt vector: sqrt(A^2 + B^2).
- Angle shows the direction of the tilt vector: arctan(B/A).

Data Scale



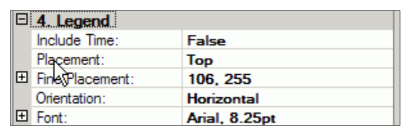
DigiPro2 sets default scale according to the depth of the inclinometer. To enter your own scales, turn off the default scale by double-clicking "Default Scale."

Depth Scale



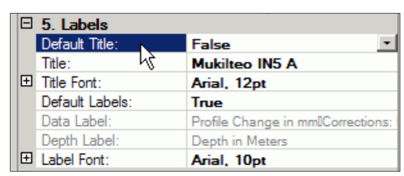
DigiPro2 sets depth scales automatically. To enter your own depth scales, turn off the autoscaling by double-clicking "Auto Scale."

Legend



Legends usually show a date only. If time is important, double-click "Include Time." Double-click "Placement" to view available locations for the legend. Fine Placement adjusts X Y placement of the plot starting from top left corner of the page. This adjustment is useful for printed plots. Double-click "Orientation" to place dates vertically or horizontally.

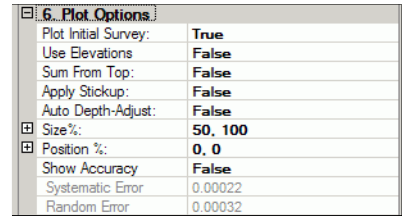
Labels



DigiPro2 automatically generates titles and labels.To turn off automation, double-click "Default Title" or "Default Labels," and then enter your own text.

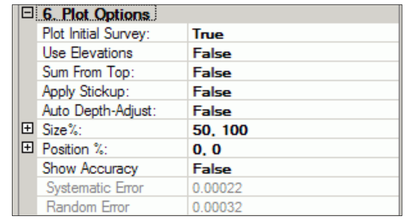
Plot Options

Plot Initial Survey: DigiPro2 automatically shows the initial survey in all plots. Double-click if you want to hide the initial survey.



Use Elevations: DigiPro2 shows depths by default. If you have entered elevation in the inclinometer header, double-click to show elevations.

Sum from Top: Profile plots are created by summing values. Summing from bottom is the default, since the bottom is normally assumed to be stable. To sum from top, double-click to change the value to "true."



Apply Stickup: Double-click to enable or disable. When enabled, and a stickup value has been entered in the inclinometer header, DigiPro2 plots values at their real depths (or elevations) rather than at cable depths.

We record readings at depths indicated by depth marks on the cable. We align depth marks to an index, such as the top of the casing or the top of a pulley assembly. Stickup is the distance from the index to the surface of the ground. If the index is 0.5m above the ground, the real depth of the probe is 0.5m shallower than the depth indicated by the cable. Applying a stickup of 0.5m will cause values to be plotted at their real depth (or elevation).

Auto Depth-Adjust: This adjustment is sometimes used with Classic systems, which have cabled marked from the middle of the probe. When turned on, readings are plotted at the depth of the top wheels rather than at cable depth. Auto depth-adjust should be off (false) for AT systems.

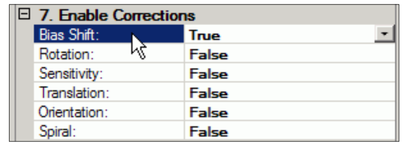
Size: This setting controls the width and height of the chart area (the area including the white space around the plot). It may be useful when you display only one plot. Double-click to make entries. Value are percent of page.

Position: This setting moves the chart area. It may be useful when you display only one plot. Double-click to make entries. Value are percent of page.

Show Accuracy: Field accuracy generates lines showing the approximate "Field Accuracy" of profile change plots, assuming systematic error increasing with the number of readings and random error increasing with the square-root of the number of readings. Double-click to toggle the accuracy lines on and off.

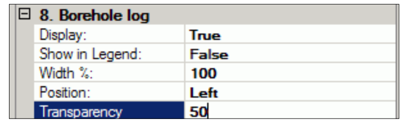
Enable Corrections

This settings group allows corrections to be double-clicked on and off. True is on, False if off. Corrections are discussed in a later chapter.



Boring Log

This settings group shows or hides a graphic representing a boring log. The graphic appears in the background of the plot.



Display: Double-click to show or hide the boring log graphic. Note that the details of the boring log are entered elsewhere: Edit>Add/Edit Boring Log.

Show in Legend: Double-click to show or hide boring log labels in the legend area.

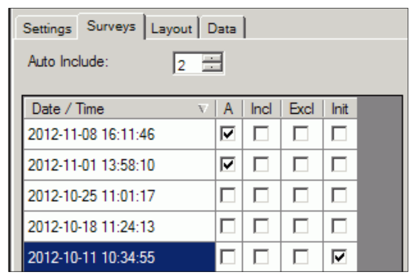
Width: Set width of the graphic. 100% is the full width of the plot. Try 10 for a narrow graphic.

Position: Move the graphic to the right side or left side of the plot.

Transparency: Make the graphic more transparent with a smaller number.

Survey Tab

Click the "Surveys" tab to select surveys to include in the plot.



Auto-Include: Automatically includes this number of recent surveys in the plot.

A: Shows which surveys are included by the Auto-Include setting.

Inc (Include): Check the box to always include this survey in the plot.

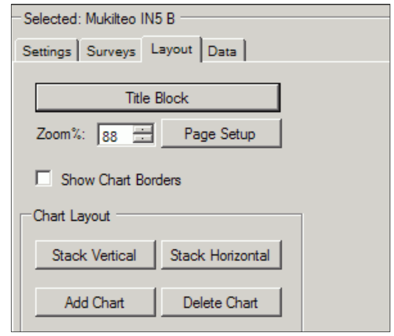
Exc (Exclude): Check the box to always exclude this survey.

Init (Initial): Check this box to choose the initial survey.

Note

DigiPro2 Basic is limited to three surveys: the initial plus two others.

Layout Tab



The layout tab provides mostly page-related settings.

Title Block: Click to add a title block. Details are explained below.

Zoom: This is a display setting. DigiPro2 sizes plots for your display automatically. Use zoom to adjust, if necessary.

Page Setup: DigiPro2 displays settings related to printing, such as paper size and margins. These are discussed in the next chapter.

Show Chart Borders: Check the box to draw borders around each chart. A chart includes the white space around each plot.

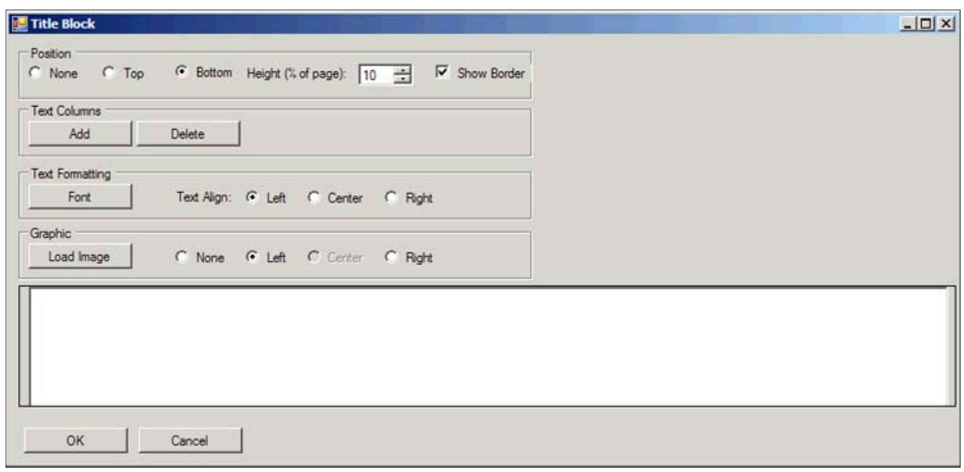
Stack Vertical / Stack Horizontal: Controls layout of charts. Click to see the effect. Horizontal is the default. Vertical may be useful for horizontal inclinometers.

Add Chart: Click to add an additional chart (and plot) to the page. It is not possible to add plots from other inclinometers.

Delete Chart: Removes a chart from the page.

Title Block Details

The title block dialog lets you add a logo and descriptive text to the plot.

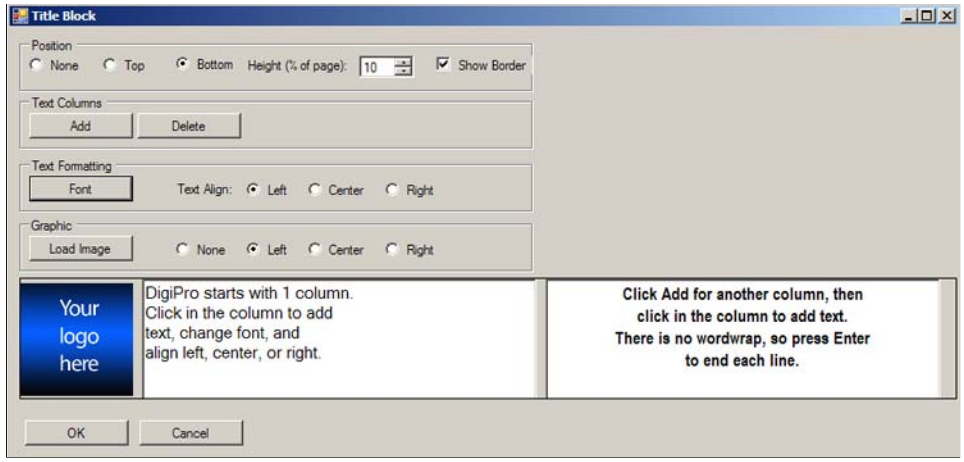


Position: Controls visibility, location, and size of the title block:

- None hides the title block but does not delete it. You can set the title block to none while inspect the plots and then set to top or bottom before you print.
- Top places the title block at the top of the page.
- Bottom places the title block at the bottom of the page.
- Height sets the vertical size of the title block.
- Show Border draws a line around the title block, if checked.

Title Block Details continued

Add columns, text, and a graphic:



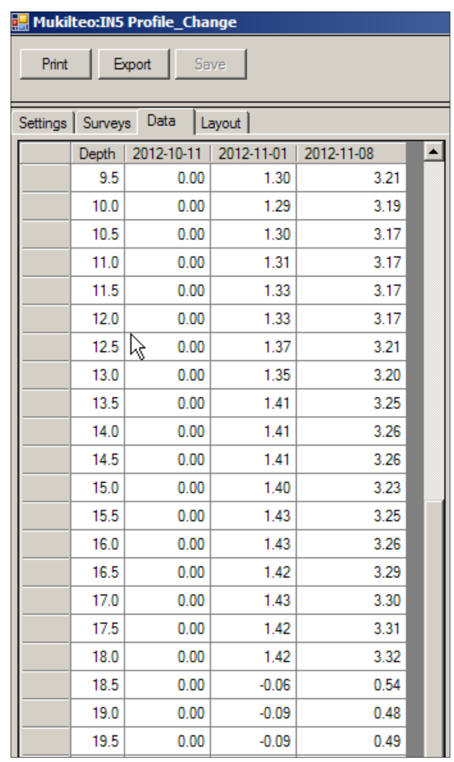
Text Columns: DigiPro starts with one column. Click in the column to enter text. Press Enter to end each line. There is no wordwrap. Click Add if you want more columns.

Text Formatting: Click in a column first, then adjust the font and alignment of the text. You cannot adjust individual lines within a column. The printed page is not the same as the displayed page, so you may need to experiment with line lengths and font sizes for a good appearance.

Graphic: Click the Load Image button to browse for a jpeg, gif, png, emf, or bmp graphic file. DigiPro resizes the graphic to fit the vertical space. You can choose left, center, or right alignment.

Data Tab

Click the “Data” tab to display values used in the plot. Survey dates appear at the top of each column. Use the scroll bar to see other depths.

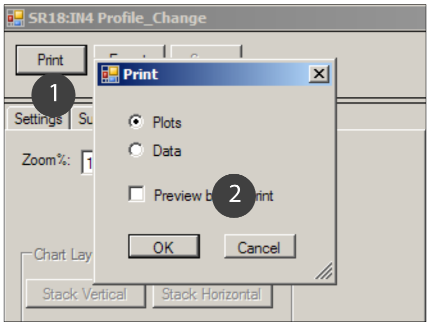


Depth	2012-10-11	2012-11-01	2012-11-08
9.5	0.00	1.30	3.21
10.0	0.00	1.29	3.19
10.5	0.00	1.30	3.17
11.0	0.00	1.31	3.17
11.5	0.00	1.33	3.17
12.0	0.00	1.33	3.17
12.5	0.00	1.37	3.21
13.0	0.00	1.35	3.20
13.5	0.00	1.41	3.25
14.0	0.00	1.41	3.26
14.5	0.00	1.41	3.26
15.0	0.00	1.40	3.23
15.5	0.00	1.43	3.25
16.0	0.00	1.43	3.26
16.5	0.00	1.42	3.29
17.0	0.00	1.43	3.30
17.5	0.00	1.42	3.31
18.0	0.00	1.42	3.32
18.5	0.00	-0.06	0.54
19.0	0.00	-0.09	0.48
19.5	0.00	-0.09	0.49

Printing & Exporting Plots

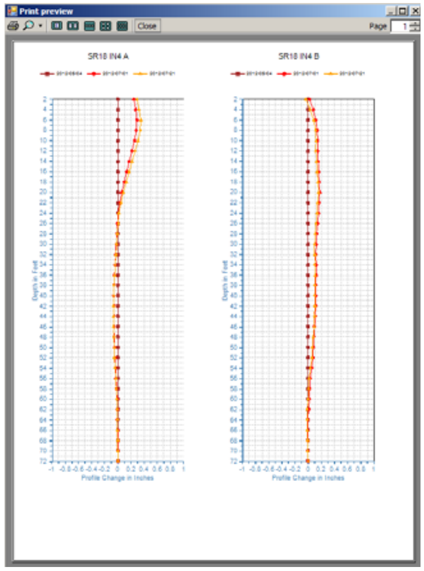
Printing Plots

1. Click the "Print" button.
2. Choose "Plots" or "Data." Click the checkbox for a print preview. Then click OK.



Preview

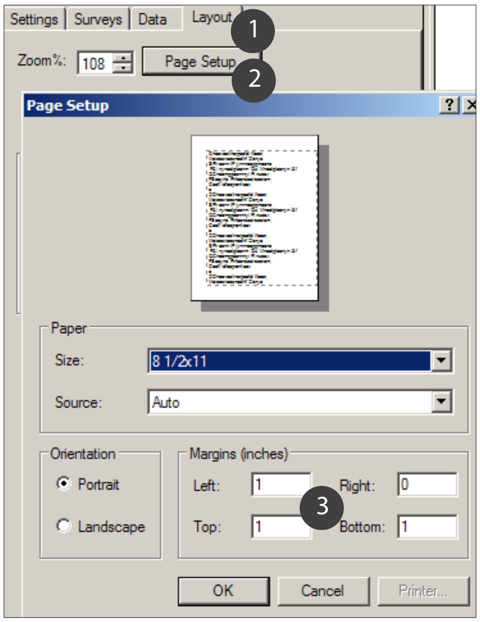
Print preview lets you inspect the page before you print it. Click the print button to print.



Page Layout

To adjust page margins:

1. Click the "Layout" tab.
2. Click the "Page Setup" button.
3. Adjust margins as required, then click OK.

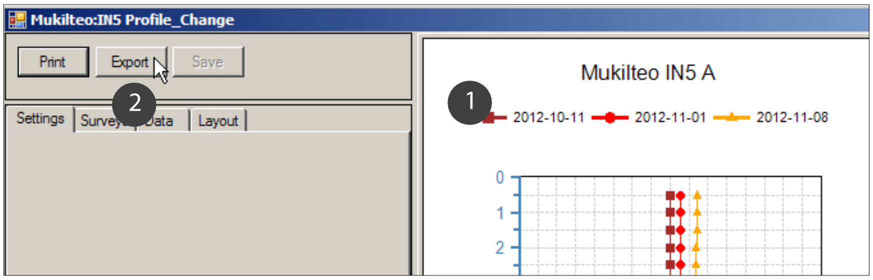


Exporting Plots

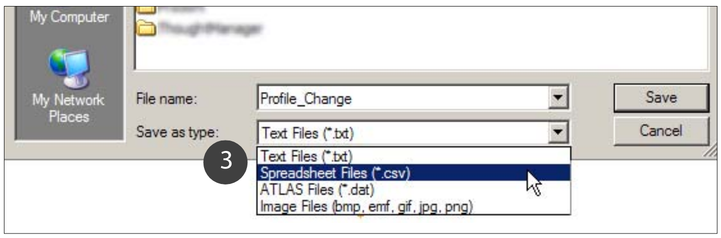
DigiPro2 can export plots as text files or graphic files.

1. Generate the plot.

2. Click the Export button.



3. The Save-As dialog appears. Choose a file type from the drop menu.

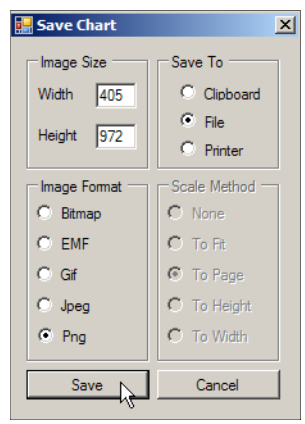


Text File: Printable file with tab separated values.

Spreadsheet File: Spreadsheet-ready file with regionalized field separators and decimals.

Atlas File: Data arrays formatted for Atlas. Each array has a date stamp followed by depth-value pairs. A values first, then B values.

Image File: First select the A or B plot, and then click Export. Choose an image format and click save. PNG and GIF provide the sharpest results.



Using Reports & Templates

What is a Report?

Reports are customized plots that are saved for reuse. You create a plot, modify scales, labels, title blocks, survey selections, etc. as needed, and then save it. Each inclinometer can have any number of reports.

When you have new surveys, you open the report rather than create a new plot. When the report is displayed, the new surveys are automatically included (according to the auto-select setting) and the plots are generated with all the saved settings.

Creating a Report

Modify the plot as needed, then click Save, enter a name, and click OK.

Using a Report

Open: Choose the inclinometer. Click Plot>Saved Reports. Select the report and click OK.

Modify: You can modify a report if necessary. Click Save when you are done.

Delete: The report dialog provides a delete button. Select the report that is no longer needed, then click "Delete."

What is a Template?

A template is similar to a report, in that it saves certain settings, but it is not dedicated to a particular installation.

- You may want all of your plots to include a standardized title block with the company logo.
- You may want a different combination of plots on the page.

Creating a Template

Generate a plot. Modify the plot as necessary and then click Save. Choose "Save as Template" and click OK.

Using a Template

1. Choose an inclinometer.
2. Click Plot > Plot Inclinometer >Custom Templates.
3. Choose a template and click OK.
4. After the template loads, make any extra modifications needed and save as a report.

Applying Corrections

Introduction

DigiPro2 provides correction routines that can improve the presentation and understanding of data. There are two categories of routines: those that apply to single surveys, and those that apply to all surveys of a particular inclinometer.

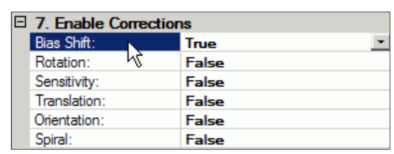
- Routines that affect single surveys are bias-shift, rotation, and sensitivity corrections, which are related to the inclinometer probe, and translation corrections, which are related to the inclinometer casing.
- Routines that affect all surveys are orientation correction and spiral correction. Orientation correction can help when casing grooves are not aligned with the real direction of movement. Spiral correction can help when casing was twisted during installation.

Most corrections routines involve a minimum of three steps:

1. Generate a plot.
2. Enable corrections in the plot settings panel.
3. Enter a correction value and check the result. This may be an interative process with different values entered until a satisfactory plot is generated.

Enabling Corrections

DigiPro2 stores correction values separately from readings. Correction routines apply these values on-the-fly when plots are graphs are generated. Thus corrections can be enabled and disabled at any time. To enable correction routines.



1. Generate a plot.
2. Double-click to open Enable Corrections.
3. Double-click on the particular correction that you want to enable. In the example, Bias-Shift correction has been enabled.
4. To disable a correction, double-click to toggle the value to false..

Bias-Shift Error

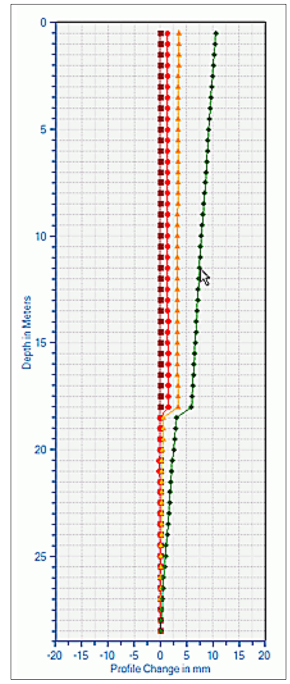
Here is a simple introduction to bias shift error. Refer to the support pages of www.slopeindicator.com for more information.

What is Bias Shift?

Bias: Bias is the value returned by the probe when it is held absolutely vertical. In theory, the value should be zero, but in practice, the value is non-zero. This non-zero value is embedded in every reading.

Bias Shift: It is normal for the bias of the probe to change from time to time. This is not a problem because the bias value is normally eliminated in the data reduction process, when 0 readings are combined with 180 readings.

Bias-Shift Error: If the bias shifts during a survey, the data reduction process cannot competely eliminate the bias. The remaining value is bias shift error. The error becomes visible when readings are accumulated, as in the profile change plot at right.



Identifying Bias-Shift Error

Appearance: The plot above shows the typical appearance of a bias-shift error: a straight-line that is tilted away from vertical. The tilt may be in either direction.

Unlikely Behavior: The plots above shows tilt over the entire span of the inclinometer. This unlikely behavior suggests error in the data.

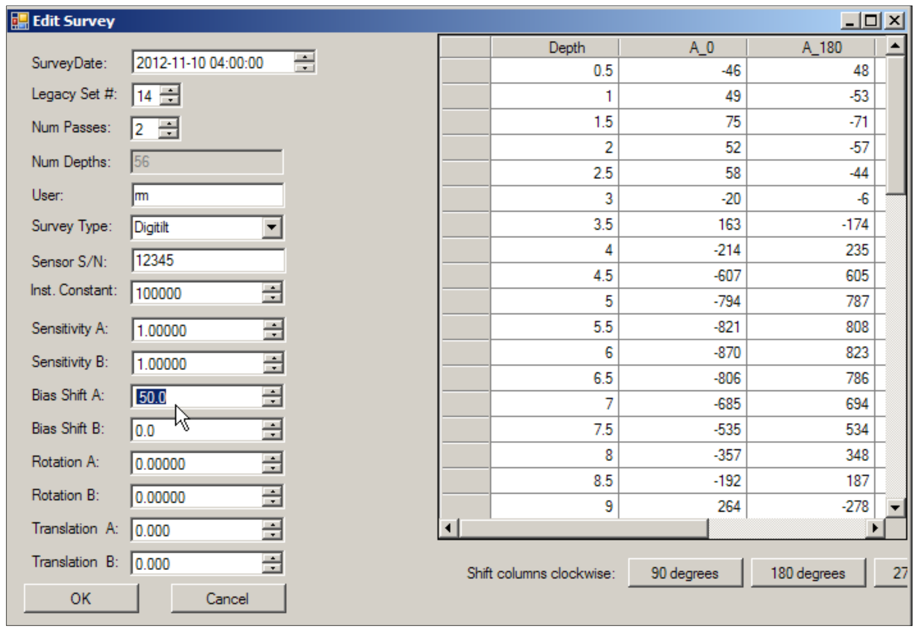
Site Knowledge: The plot shows movement where there should be no movement. Typically, the bottom 5 depths (or more) of the casing are anchored in stable ground. Any movement appearing there is generally error in the data.

Checksum Plots: Checksum plots show that a bias-shift has occurred.

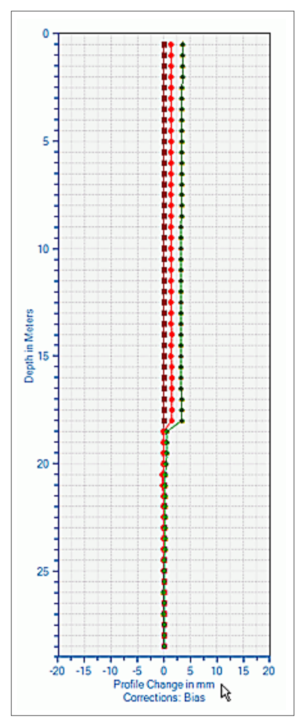
Correcting Bias-Shift Error

You identified bias-shift error in a profile change plot. Then you verified that a bias shift occured by plotting checksums. Now you want to correct for bias shift.

1. Generate the profile change plot again.
2. Enable bias-shift corrections in the settings panel.
3. Double-click the survey (the plot of the survey) that you want to correct.
4. DigiPro2 displays the Edit Survey dialog. Find the Bias-Shift field.



5. Enter a value. If the plotted survey was tilted to the right, try a positive value. If the tilt was to the left, try a negative value. The exact value doesn't matter yet. Click OK.



6. DigiPro2 redraws the plot. Inspect zones were no movement should have occurred (the bottom, for example). Have you eliminated the tilt in those zones?If necessary, double click the survey again and enter a different value. Continue until the tilt is eliminated.
7. The bias-shift error has been removed from the offending survey. The label for the data axis shows the type of correction that was applied.

Rotation

Here is a simple introduction to “rotation” error.

What is Rotation Error?

Rotation is a small change in the alignment of the measurement axis of the inclinometer probe. The change is usually less than one degree.

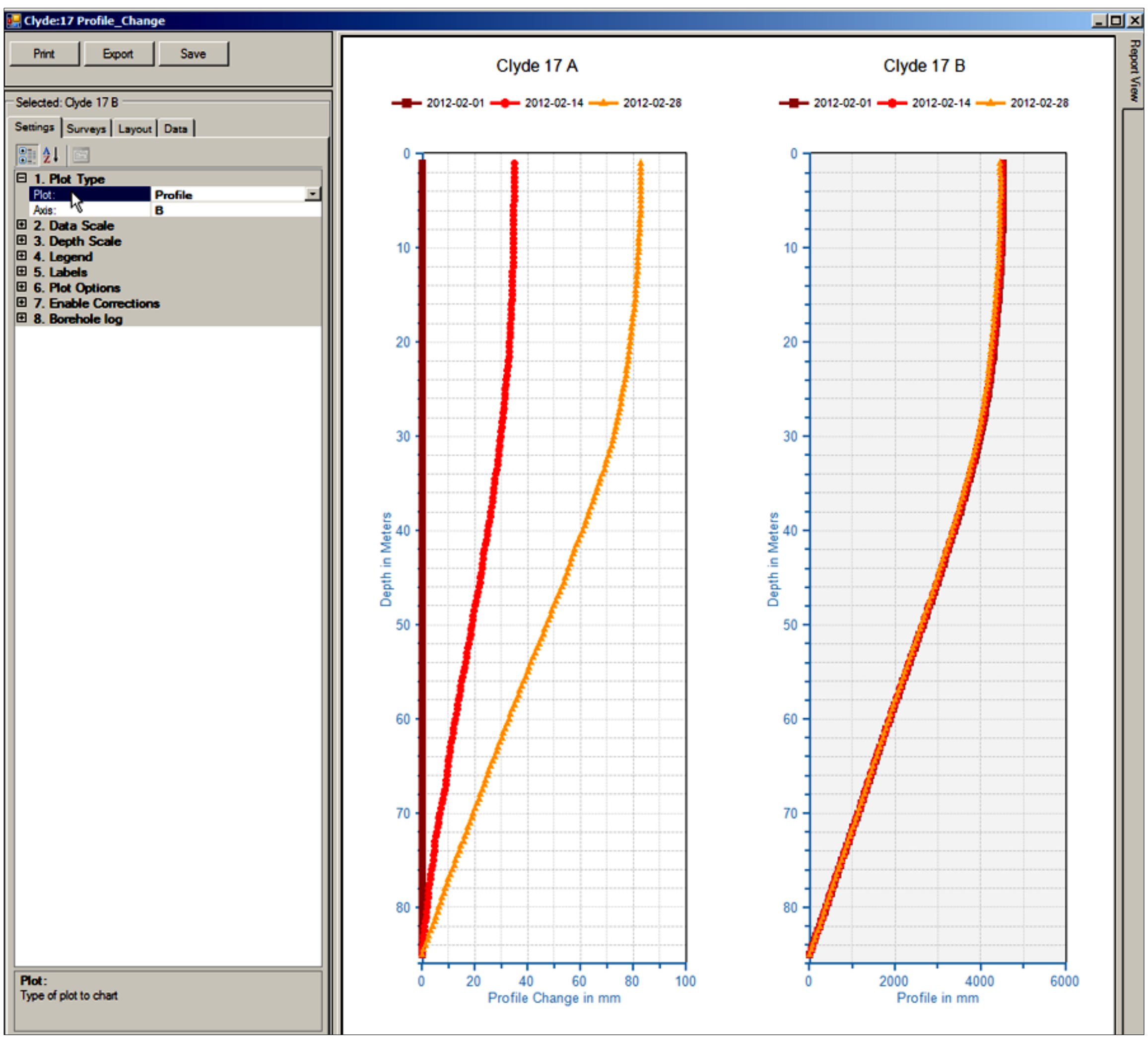
Ideally, each sensor is aligned to measure tilt in only one plane. If the mechanicals of the probe are rotated slightly towards the cross-axis plane, the A-axis sensor also measures some of the tilt in B and vice versa.

Rotation Error is the cross-axis component in a reading: for example, the B-axis tilt value that is embedded in the A-axis tilt reading. Rotation error becomes visibile when when two conditions combine:

- There is significant inclination in the cross axis.
- The change in the alignment of the probe occurs after the initial set was taken.

Identifying Rotation Error

- The profile-change plot is curved.
- The profile plot of the cross axis shows significant tilt.
- The two plots have a similar shape, as shown below.

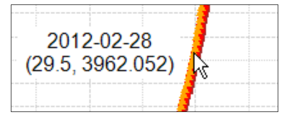


Correcting Rotation Error

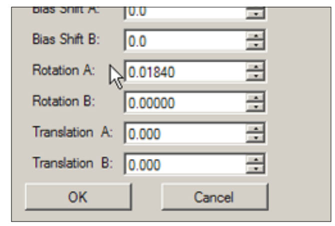
In the example on the previous page, a rotation error was identified in the profile change plot for A axis. To check, we selected the B plot and changed its plot type from profile change to profile. We saw that the A change plot looked similar to the B profile plot. Now we want to apply a correction.

1. Enable rotation correction in the settings panel.

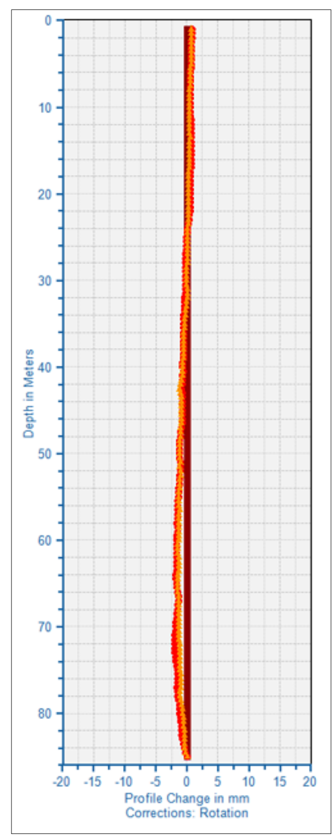
2. Move the cursor to the maximum profile change value in the A-axis plot. Note the depth and value that DigiPro displays: 29.5m and 73mm.
3. Move the cursor to the same depth on the B-axis plot. Note the profile value.



4. Find a starting correction value by dividing the the A profile-change value by the B profile value: 73 / 3962 = 0.0184. (Normally values are smaller than the sine of 1 degree: 0.01745).
5. Double-click the offending survey on the A plot. DigiPro2 displays the Edit Survey dialog. Enter the value into Rotation A field. Click OK.



6. Inspect the plot, and double-click to reopen the edit dialog as necessary.
7. Repeat these steps for any other surveys that show rotation error. The plots become useable, if not perfect.



Sensitivity Correction

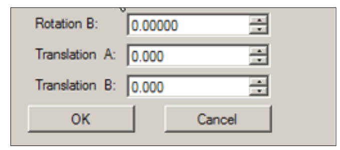
Sensitivity drift is not easy to recognize. It can easily be detected by the factory and is a reason for sending probes in for calibration at regular intervals. An example will appear in a future edition of this manual.

The error is directly proportional to reading magnitudes. Typical errors are 1 to 2 percent. Correction involves the same steps as others:

1. Generate a plot.
2. Click on a survey to call up the Edit Survey dialog.
3. Enter the sensitivity value and check the resulting plot.

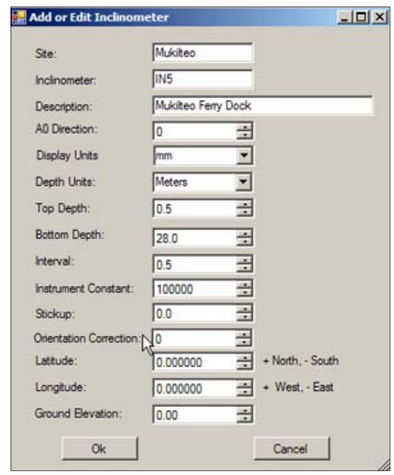
Translation Correction

This correction can be applied to shift all plotted values in the A or B direction. Values in inches or mm are determined by survey or other means and entered in the Edit Survey dialog.



Orientation Correction

Inclinometer casing is installed so that one set of grooves is aligned with the expected direction of movement. If the real direction of movement is some other direction, DigiPro2 can mathematically rotate the orientation of the measurement axes into the direction of interest.

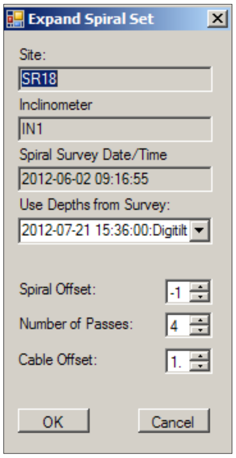


1. Select the inclinometer.
2. Click the Edit button to display the Edit Inclinometer dialog.
3. Enter a value in degrees into the Orientation Correction field. Enter a positive value to rotate orientation clockwise. Enter a negative value to rotate the orientation counter-clockwise.
4. When you plot the inclinometer, enable the Orientation Correction in the settings panel.

Spiral Correction

A spiral survey, obtained with a spiral sensor, provides measurements that can be used to correct for spiraled (twisted) casing. DigiPro2 retrieves the spiral survey from the DataMate.

Readings in the spiral survey are taken at 5 foot or 1.5m intervals. Readings in an inclinometer survey are taken at 2 foot or 0.5m intervals. DigiPro must "expand" the spiral survey to provide a correction value to be used with each inclinometer reading.



1. Select the inclinometer.
2. Select the spiral survey.
3. Click Tools > Expand Spiral Survey.
4. Enter the spiral offset, cable offset, and passes. The recommended number of passes is 4.

   The two offset values are important for calculations. This information must be obtained from the person who took the spiral survey.
5. DigiPro2 expands the spiral set.
6. Enable Spiral Correction in the settings panel. DigiPro will then automatically apply the spiral corrections to any surveys that you plot.

DigiPro2: Basic vs Advanced

DigiPro 2

DigiPro2 is distributed as a trial version with all the advanced features enabled. After 45 days, the advanced features are disabled and DigiPro reverts to a “basic” version unless you purchase and install a license key. The "basic" version is free to use and can be converted to the advanced version at any time. The table below provides a comparison between basic and advanced versions.

DigiPro2 Features	Basic	Advanced
Create dpw databases	●	●
Import dux files from Digitilt AT system	●	●
Retrieve surveys directly from Digitilt DataMate	●	●
Import mdb databases created by DMM	●	●
Import Gtilt and other file formats	●	●
Export surveys data to many formats	●	●
Export processed data to txt, csv, dat, and image file	●	●
Standard vertical plots	●	●
Surveys per plot	3	Unlimited
Spiral plot	●	●
Title block with multiple columns, graphic logo		●
Time displacement plot, Resultant plot		●
Horizontal plots		●
Copy settings from one plot to another		●
Mixed plot types, additional plots on page		●
Field Accuracy Indicator		●
Represent boring log on plot		●
Corrections for Inclinometer: Orientation, Spiral		●
Corrections for Surveys: bias shift, rotation, sensitivity, xy translation, settlement		●
Save plots for reuse on new surveys		●
Save plots as templates for use with other inclinometers		●

Licensing DigiPro2

Overview

DigiPro2 is distributed as a trial version with all the advanced features enabled. After 45 days, the advanced features are disabled unless you purchase and install a license key.

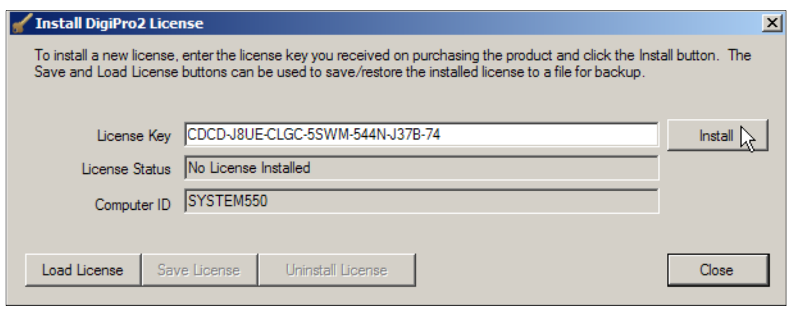
When you purchase DigiPro2, we make an entry in the license database and email the required number of keys to you. If you purchased DigiPro2 through a distributor, we typically email the keys to the distributor.

Installing a Key

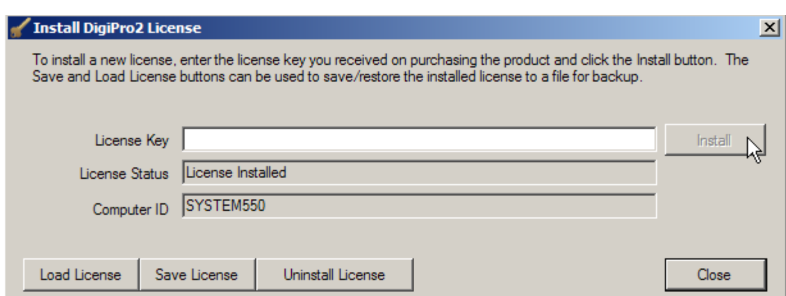
1. Start DigiPro2 and click “License.”

   In the example at right, DigiPro2 has reverted to the basic version.

2. DigiPro2 displays the license dialog. Cut and paste the key from your email into the License Key field. Then click “Install.

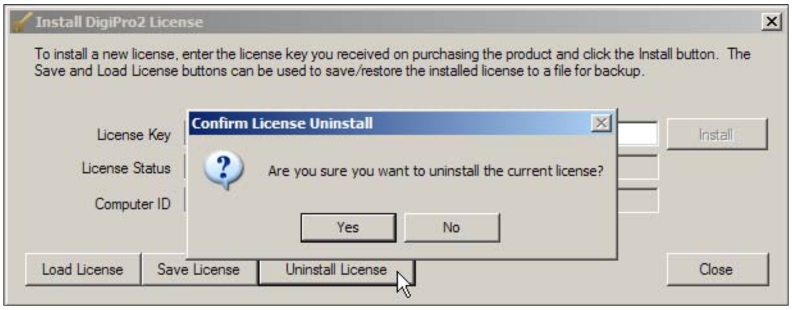


3. DigiPro2 activates the license via the internet. When the activation is successful, the License Key field goes blank, but the License Status field shows “License Installed.” Click “Close” to complete the process.



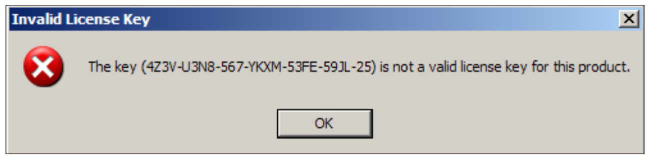
Uninstalling a Key

If you wish to move a key from one computer to another, you can uninstall a key and reinstall it on another computer. Click "Uninstall License" and then click "Yes." DigiPro2 then reverts to the basic version .



Invalid Key

If DigiPro2 cannot activate a key, it displays this message:.



Possible reasons for this message:

- The key has been used too many times. Perhaps the key was not uninstalled before it was reused on this PC.
- The internet connection was bad.

Contact DGSI or your distributor to correct the situation.

No Internet

If it is not possible to activate DigiPro via the internet, contact DGSI or your distributor. Other solutions are available.

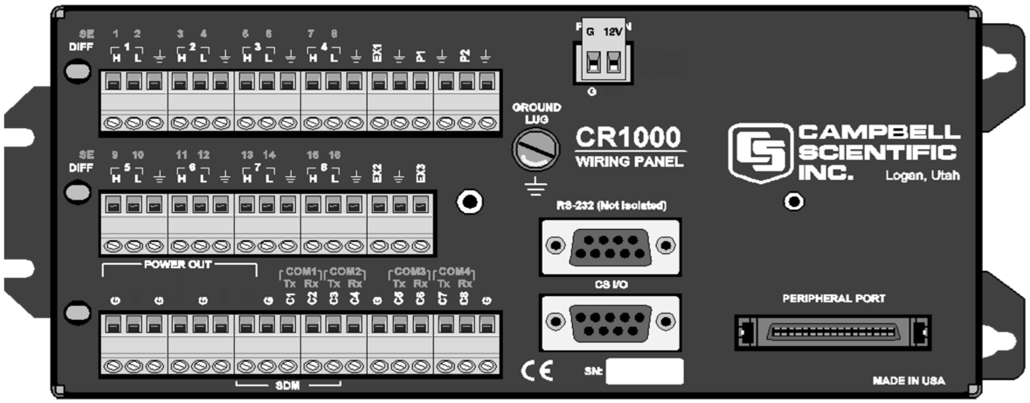
Appendix B - Wiring Diagrams

Appendix B1 - Datalogger Diagrams

CR1000 Wiring Diagram

Company:	Nuna Contracting / SRK Consulting
Project:	Hope Bay Dam project
Documented By:	Mike Ryder - Campbell Scientific Canada Corp.

CR1000 #1 Located in Node B



Ground	Black
12V	Red
Reset	White
Clock	Green
COM H (ODD)	White
COM L (ODD)	Green
COM H (EVEN)	Red
COM L (EVEN)	Black

	G
	5V
	G
	SW-12
AM16/32B #1,#2,#3 - G	**G**
AM16/32B #1,#2,#3 - 12V	**12V**
AM16/32B #4, #5, - 12V	**12V**
AM16/32B #4, #5 - G	**G**
AM16/32B#1, #5 Res	**C1 (COM1 Tx)**
AM16/32B#1, #5 Clk	**C2 (COM1 Rx)**
AM16/32B#2 Res	**C3 (COM2 Tx)**
AM16/32B#2 Clk	**C4 (COM2 Rx)**
	G
AM16/32B#3 Res	**C5 (COM3 Tx)**
AM16/32B#3 Clk	**C6 (COM3 Rx)**
AM16/32B#4 Res	**C7 (COM4 Tx)**
AM16/32B#4 Clk	**C8 (COM4 Rx)**
	G

Battery 12V (Red)	**12V**
Battery G (Black)	**G**

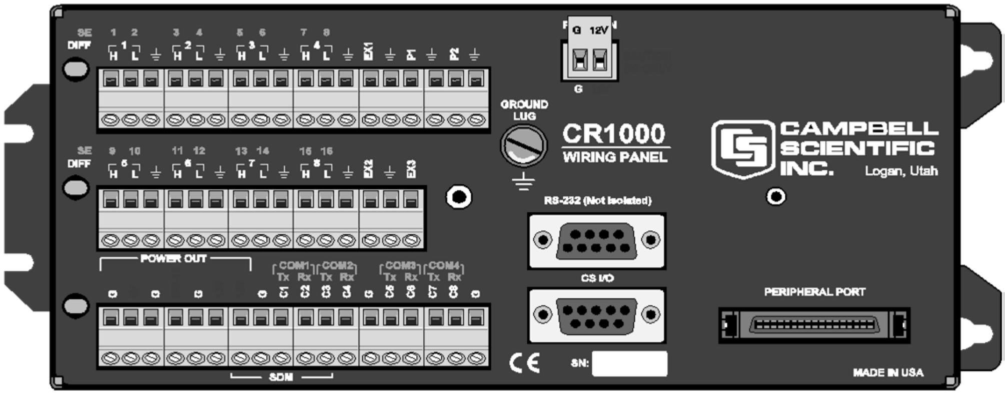
AM16/32B#3 COM L(EVEN) - RES to ⏚	**5H (SE9)**
AM16/32B#4 COM L(ODD) - RES to ⏚	**5L (SE10)**
RES to SE10, SE11, SE12	⏚
AM16/32B#4 COM H(EVEN) - RES to ⏚	**6H (SE11)**
AM16/32B#4 COM L(EVEN) - RES to ⏚	**6L (SE12)**
	⏚
AM16/32B#5 COM L(ODD) - RES to ⏚	**7H (SE13)**
AM16/32B#5 COM H(EVEN) - RES to ⏚	**7L (SE14)**
RES to SE13, SE14, SE15	⏚
AM16/32B#5 COM L(EVEN) - RES to ⏚	**8H (SE15)**
	8L (SE16)
	⏚
AM16/32B #3,#4 COM H(ODD)	**EX2**
	⏚
AM16/32B #5 COM H(ODD)	**EX3**

AM16/32B#1 COM L(ODD) - RES to ⏚	**1H (SE1)**
AM16/32B#1 COM H(EVEN) - RES to ⏚	**1L (SE2)**
RES to SE1, SE2, SE3	⏚
AM16/32B#1 COM L(EVEN) - RES to ⏚	**2H (SE3)**
AM16/32B#2 COM L(ODD) - RES to ⏚	**2L (SE4)**
RES to SE4, SE5, SE6	⏚
AM16/32B#2 COM H(EVEN) - RES to ⏚	**3H (SE5)**
AM16/32B#2 COM L(EVEN) - RES to ⏚	**3L (SE6)**
RES to SE7, SE8, SE9	⏚
AM16/32B#3 COM L(ODD) - RES to ⏚	**4H (SE7)**
AM16/32B#3 COM H(EVEN) - RES to ⏚	**4L (SE8)**
	⏚
AM16/32B#1,#2 COM H(ODD)	**EX1**
	⏚
	P1
	⏚
	P2
	⏚

CR1000 Wiring Diagram

Company:	Nuna Contracting / SRK Consulting
Project:	Hope Bay Dam project
Documented By:	Mike Ryder - Campbell Scientific Canada Corp.

CR1000 #2 Located in Node D



Ground	Black
12V	Red
Reset	White
Clock	Green
COM H (ODD)	White
COM L (ODD)	Green
COM H (EVEN)	Red
COM L (EVEN)	Black

	G
	5V
	G
	SW-12
AM16/32B #8, #9 - G	**G**
AM16/32B #8, #9 - 12V	**12V**
AM16/32B #6, #7 - 12V	**12V**
AM16/32B #6, #7 - G	**G**
AM16/32B #6 Res	**C1 (COM1 Tx)**
AM16/32B #6 Clk	**C2 (COM1 Rx)**
AM16/32B #7 Res	**C3 (COM2 Tx)**
AM16/32B #7 Clk	**C4 (COM2 Rx)**
	G
AM16/32B #8 Res	**C5 (COM3 Tx)**
AM16/32B #8 Clk	**C6 (COM3 Rx)**
AM16/32B #9 Res	**C7 (COM4 Tx)**
AM16/32B #9 Clk	**C8 (COM4 Rx)**
	G

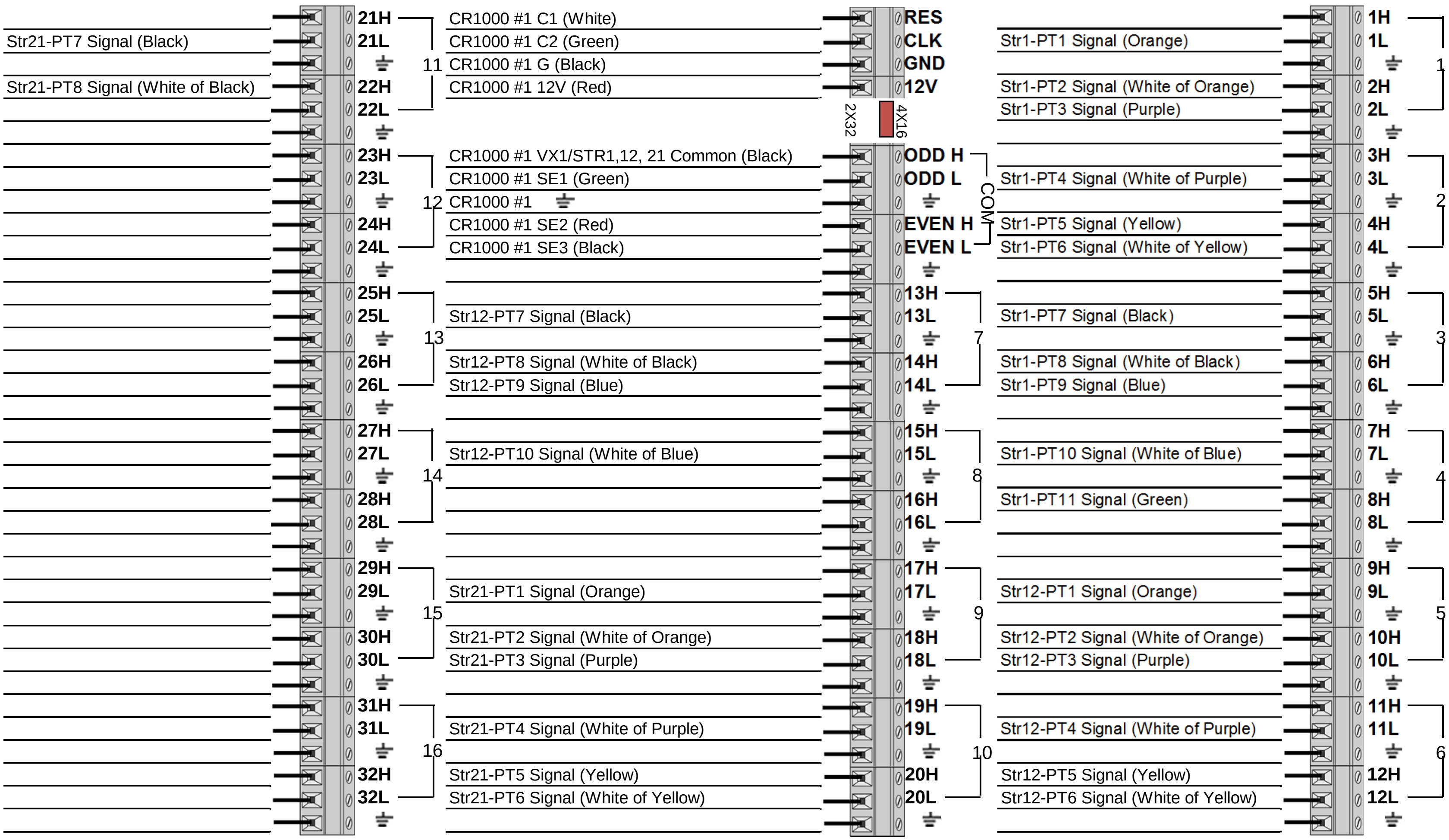
Battery 12V (Red)	**12V**
Battery G (Black)	**G**

AM16/32B#8 COM L(EVEN) - RES to ⏚	**5H (SE9)**
AM16/32B#9 COM L(ODD) - RES24.9 to ⏚	**5L (SE10)**
RES to SE10	⏚
	6H (SE11)
	6L (SE12)
	⏚
	7H (SE13)
	7L (SE14)
	⏚
	8H (SE15)
	8L (SE16)
	⏚
AM16/32B #8 COM H(ODD)	**EX2**
	⏚
AM16/32B #9 COM H (ODD)	**EX3**

AM16/32B#6 COM L(ODD) - RES to ⏚	**1H (SE1)**
AM16/32B#6 COM H(EVEN) - RES to ⏚	**1L (SE2)**
RES to SE1, SE2, SE3	⏚
AM16/32B#6 COM L(EVEN) - RES to ⏚	**2H (SE3)**
AM16/32B#7 COM L(ODD) - RES to ⏚	**2L (SE4)**
RES to SE4, SE5, SE6	⏚
AM16/32B#7 COM H(EVEN) - RES to ⏚	**3H (SE5)**
AM16/32B#7 COM L(EVEN) - RES to ⏚	**3L (SE6)**
RES to SE7, SE8, SE9	⏚
AM16/32B#8 COM L(ODD) - RES to ⏚	**4H (SE7)**
AM16/32B#8 COM H(EVEN) - RES to ⏚	**4L (SE8)**
	⏚
AM16/32B #6, #7 COM H(ODD)	**EX1**
	⏚
	P1
	⏚
	P2
	⏚

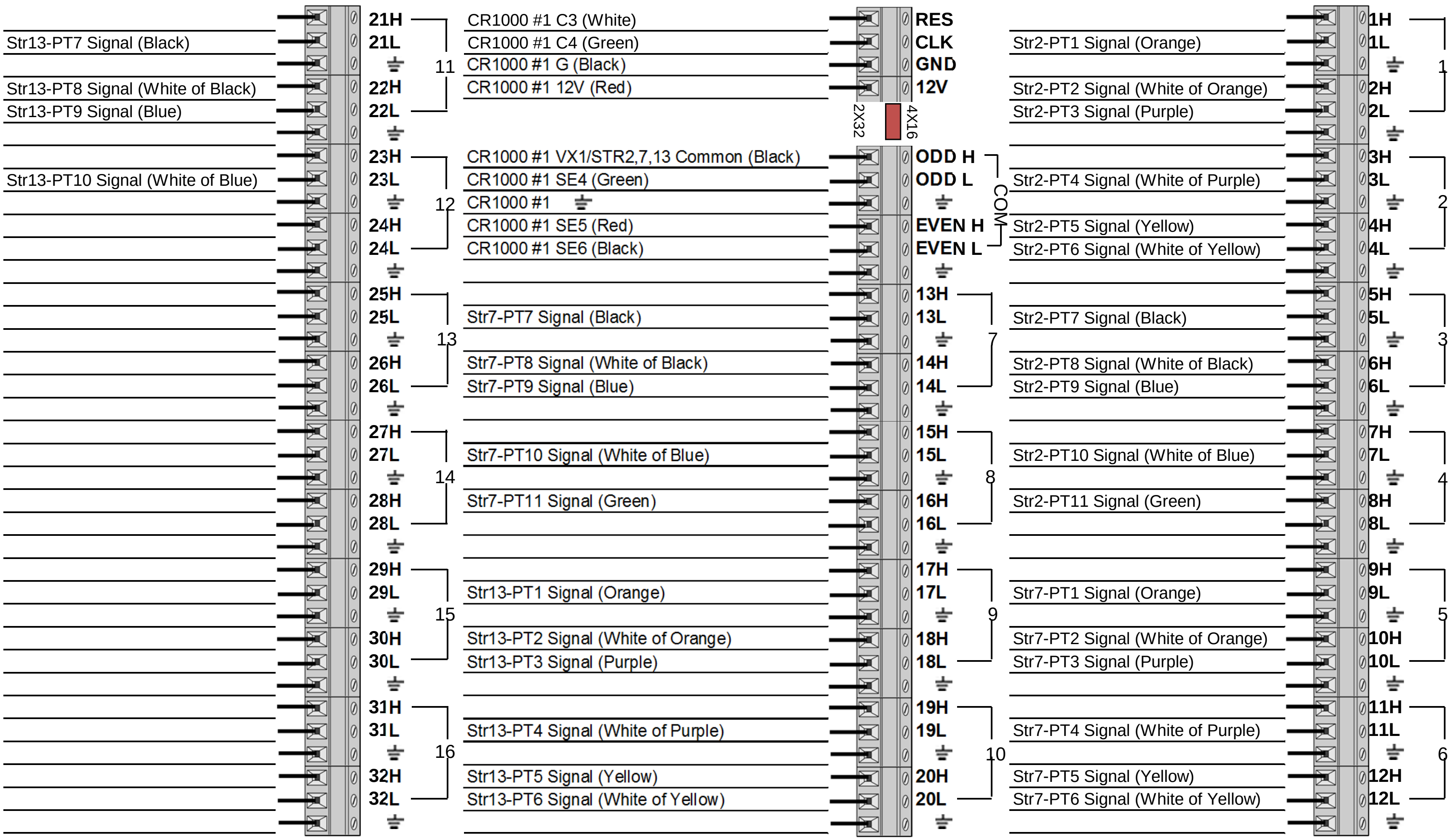
Appendix B2 - Multiplexer Diagrams

AM16/32 WIRING DIAGRAM	NODE A - Multiplexer #1
COMPANY:	Nuna Contracting / SRK Consulting
PROJECT:	Hope Bay Dam project
documented by:	Mike Ryder - Campbell Scientific Canada Corp.

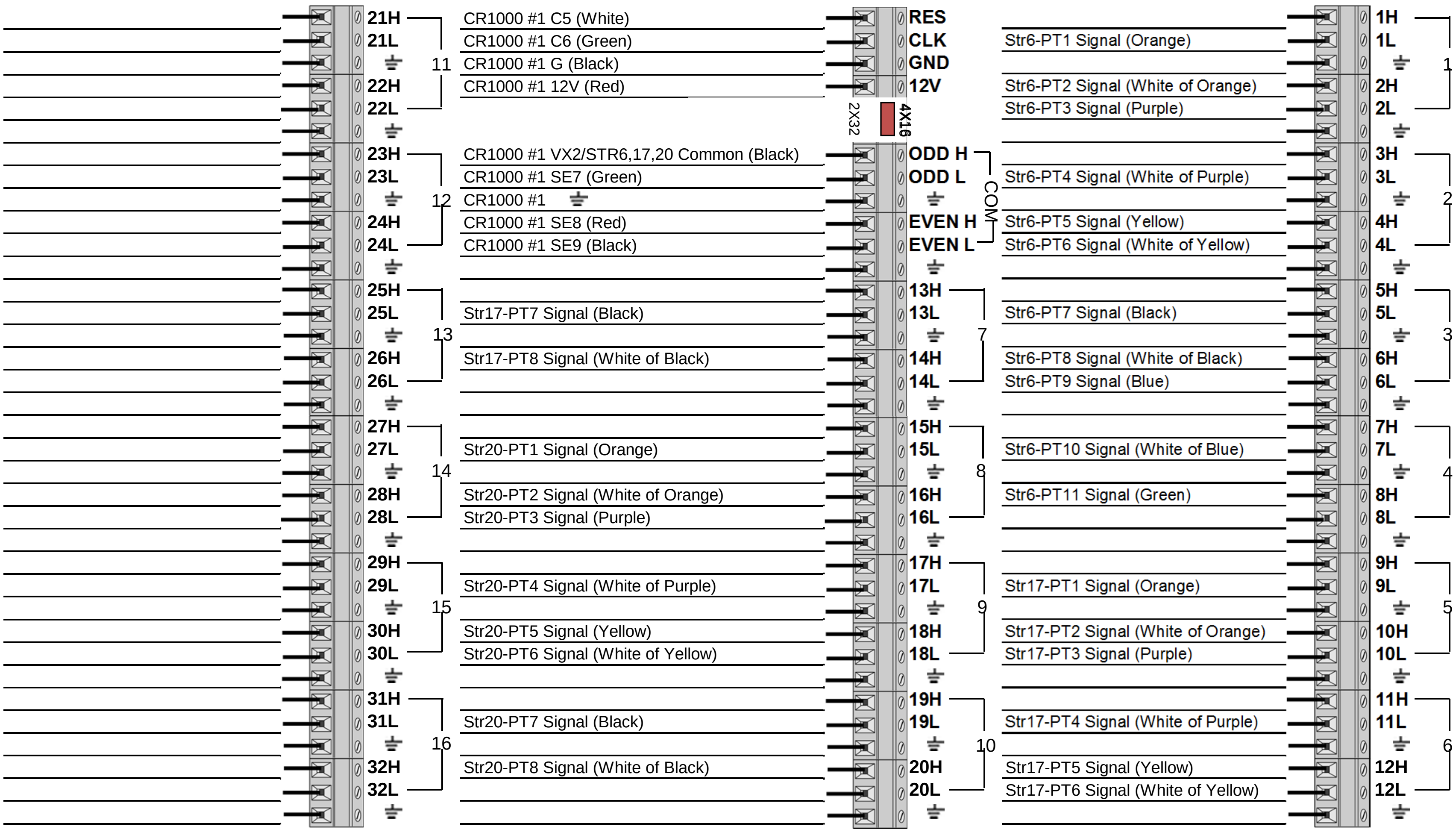


AM16/32 WIRING DIAGRAM NODE B - Multiplexer #2

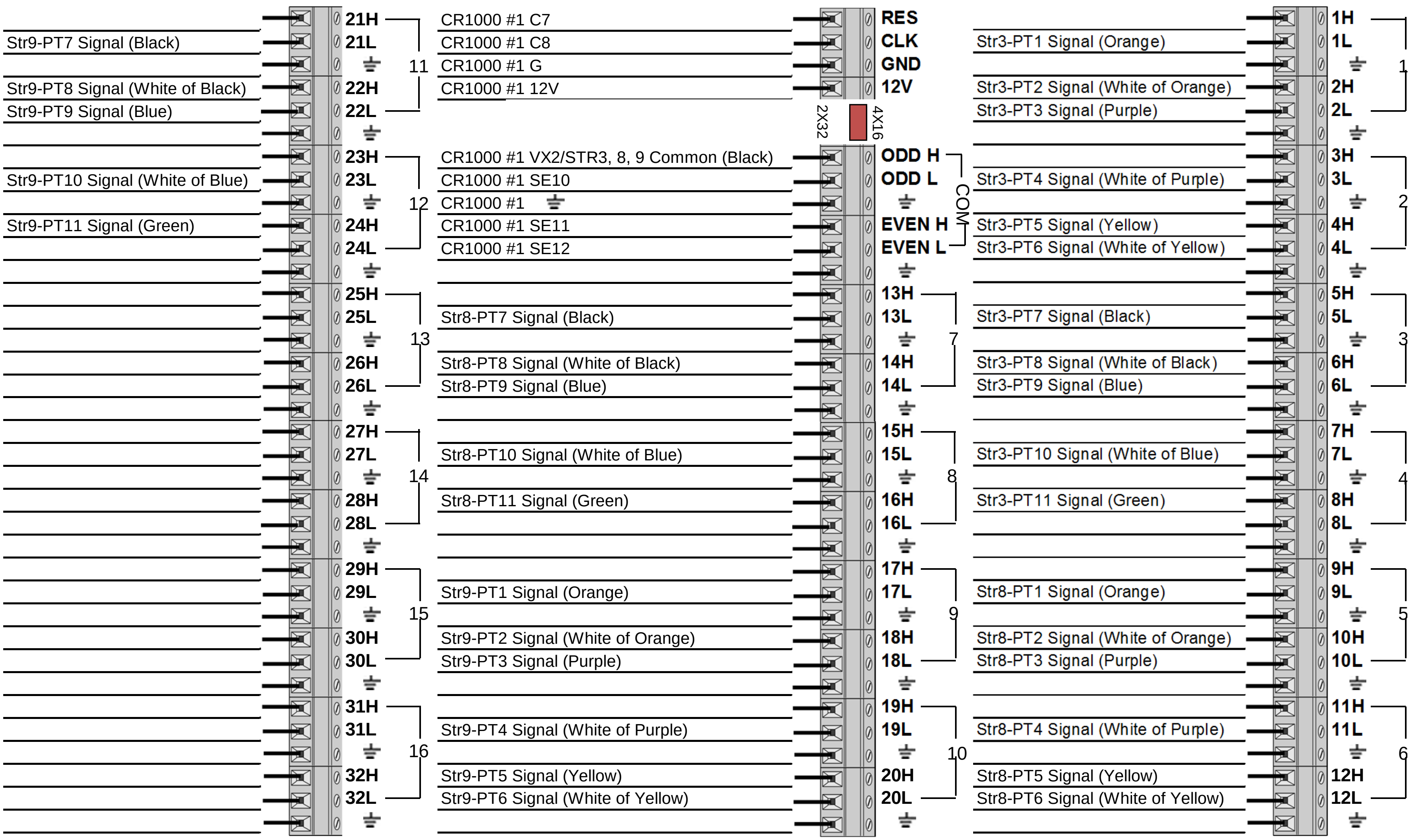
COMPANY: Nuna Contracting / SRK Consulting
PROJECT: Hope Bay Dam project
documented by: Mike Ryder - Campbell Scientific Canada Corp.



AM16/32 WIRING DIAGRAM	NODE B - Multiplexer #3
COMPANY:	Nuna Contracting / SRK Consulting
PROJECT:	Hope Bay Dam project
documented by:	Mike Ryder - Campbell Scientific Canada Corp.

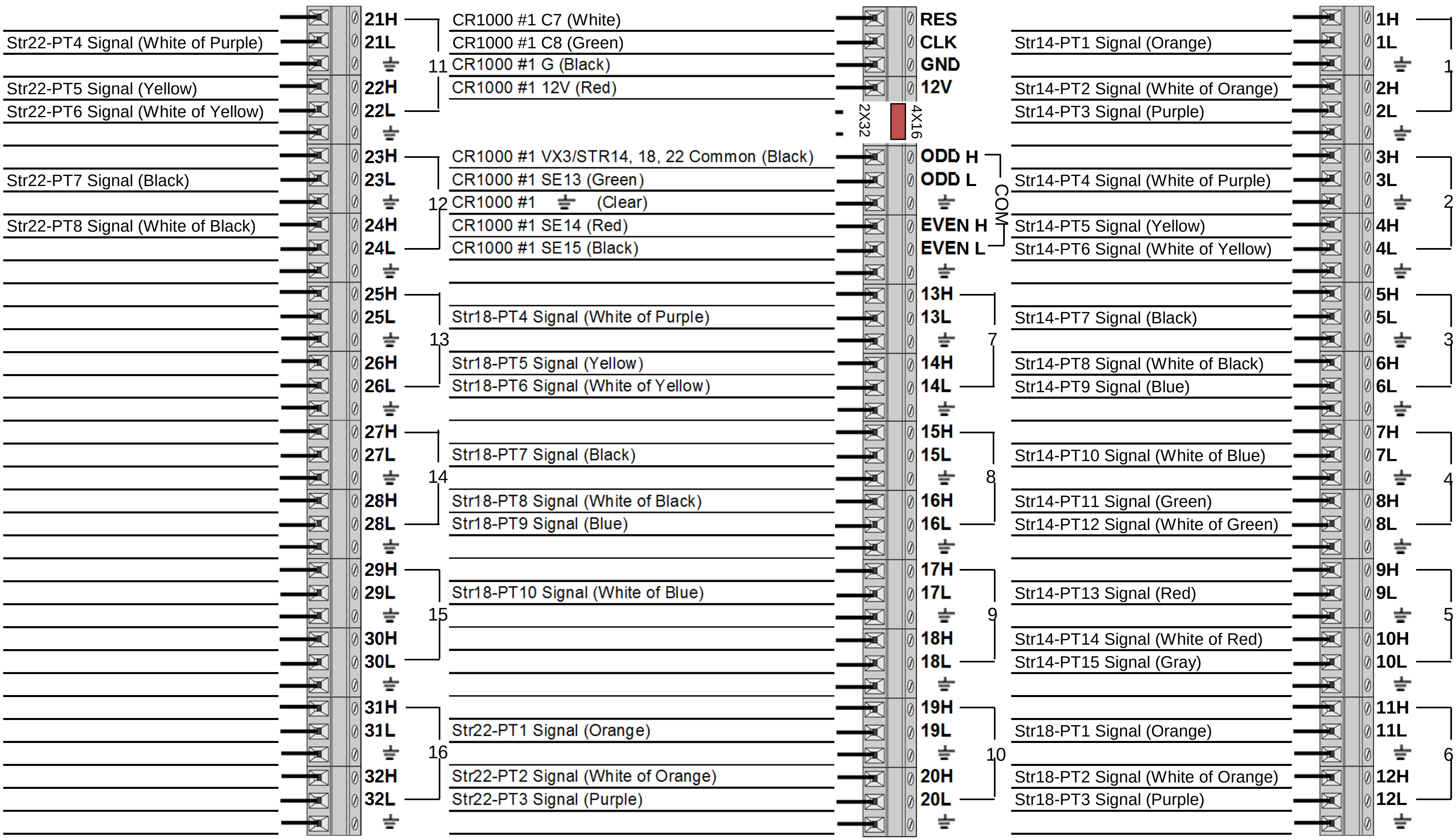


AM16/32 WIRING DIAGRAM	NODE C - Multiplexer #4
COMPANY:	Nuna Contracting / SRK Consulting
PROJECT:	Hope Bay Dam project
documented by:	Mike Ryder - Campbell Scientific Canada Corp.



AM16/32 WIRING DIAGRAM NODE C - Multiplexer #5

COMPANY: Nuna Contracting / SRK Consulting
PROJECT: Hope Bay Dam project
documented by: Mike Ryder - Campbell Scientific Canada Corp.



AM16/32 WIRING DIAGRAM	NODE D - Multiplexer #6
COMPANY:	Nuna Contracting / SRK Consulting
PROJECT:	Hope Bay Dam project
documented by:	Mike Ryder - Campbell Scientific Canada Corp.

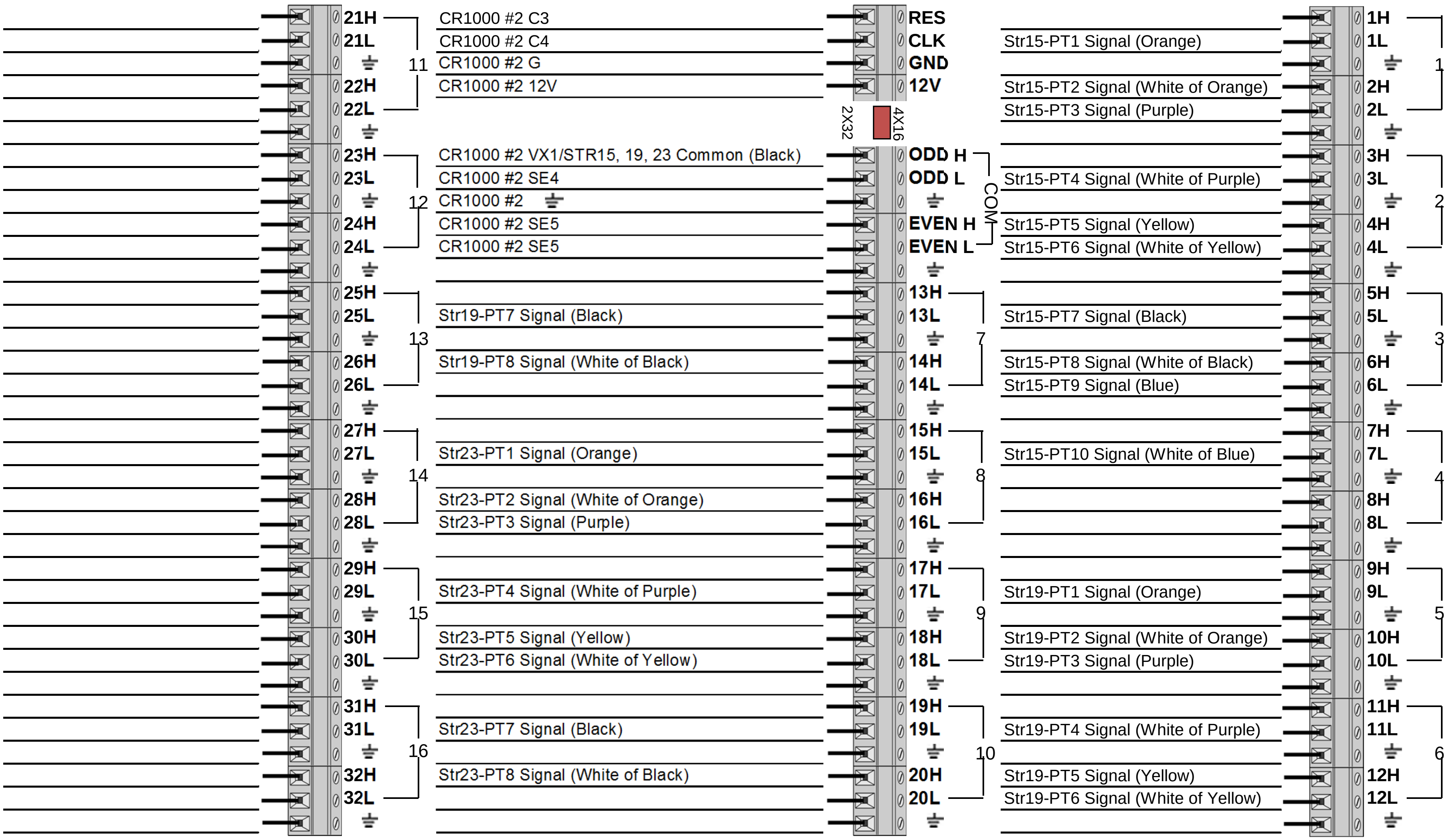
11	**21H**	
	21L	Str11-PT7 Signal (Black)
	⏚	
	22H	Str11-PT8 Signal (White of Black)
	22L	Str11-PT9 Signal (Blue)
	⏚	
12	**23H**	
	23L	Str11-PT10 Signal (White of Blue)
	⏚	
	24H	Str11-PT11 Signal (Green)
	24L	
	⏚	
13	**25H**	
	25L	
	⏚	
	26H	
	26L	
	⏚	
14	**27H**	
	27L	
	⏚	
	28H	
	28L	
	⏚	
15	**29H**	
	29L	
	⏚	
	30H	
	30L	
	⏚	
16	**31H**	
	31L	
	⏚	
	32H	
	32L	
	⏚	

2X32 4X16

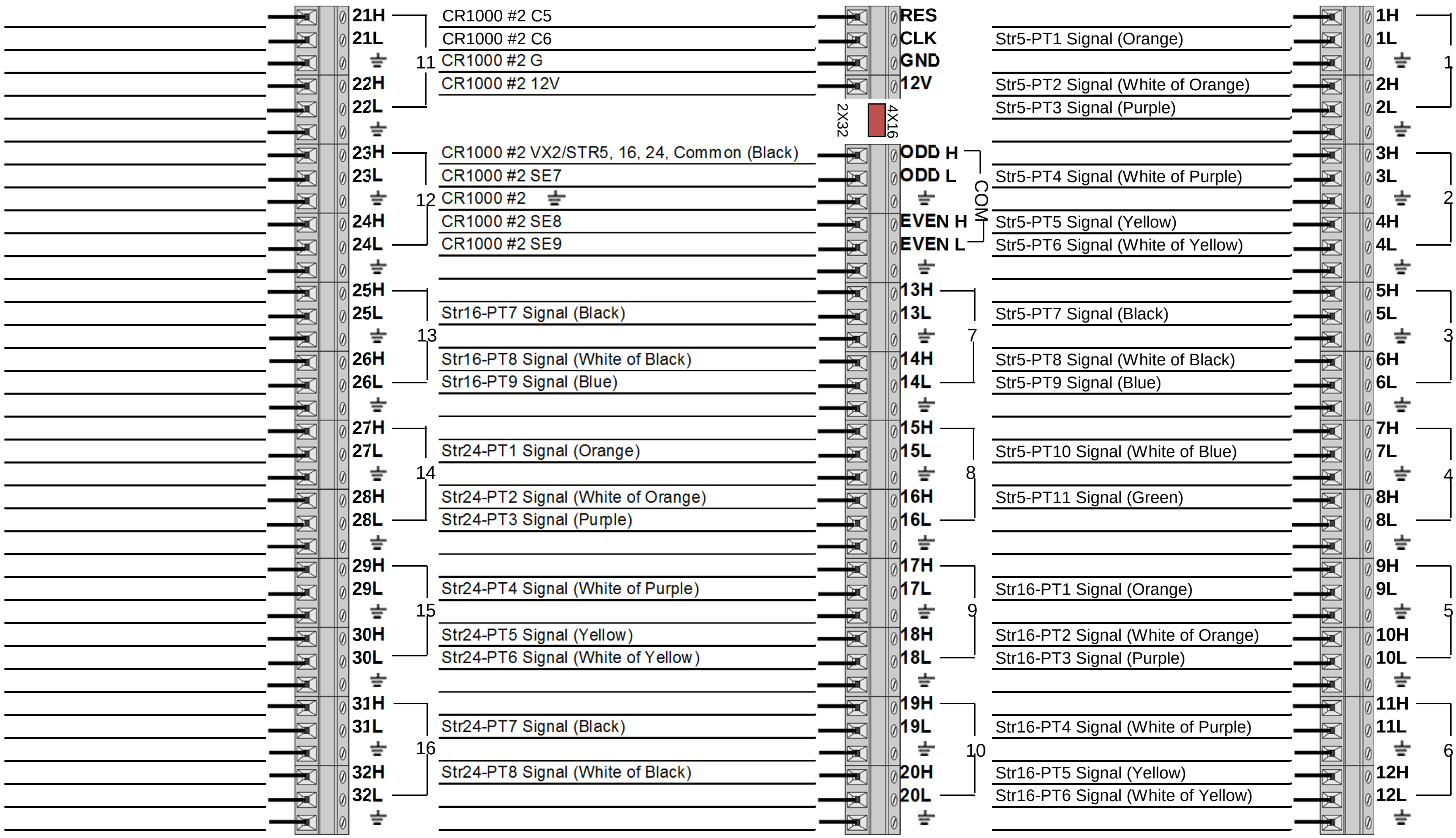
	RES	CR1000 #2 C1
	CLK	CR1000 #2 C2
	GND	CR1000 #2 G
	12V	CR1000 #2 12V
COM	**ODD H**	CR1000 #2 VX1/STR4, 10, 11 Common (Black)
	ODD L	CR1000 #2 SE1
	⏚	CR1000 #2 ⏚
	EVEN H	CR1000 #2 SE2
	EVEN L	CR1000 #2 SE3
	⏚	
7	**13H**	
	13L	Str10-PT7 Signal (Black)
	⏚	
	14H	Str10-PT8 Signal (White of Black)
	14L	Str10-PT9 Signal (Blue)
	⏚	
8	**15H**	
	15L	Str10-PT10 Signal (White of Blue)
	⏚	
	16H	Str10-PT11 Signal (Green)
	16L	
	⏚	
9	**17H**	
	17L	Str11-PT1 Signal (Orange)
	⏚	
	18H	Str11-PT2 Signal (White of Orange)
	18L	Str11-PT3 Signal (Purple)
	⏚	
10	**19H**	
	19L	Str11-PT4 Signal (White of Purple)
	⏚	
	20H	Str11-PT5 Signal (Yellow)
	20L	Str11-PT6 Signal (White of Yellow)
	⏚	

1	**1H**	
	1L	Str4-PT1 Signal (Orange)
	⏚	
	2H	Str4-PT2 Signal (White of Orange)
	2L	Str4-PT3 Signal (Purple)
	⏚	
2	**3H**	
	3L	Str4-PT4 Signal (White of Purple)
	⏚	
	4H	Str4-PT5 Signal (Yellow)
	4L	Str4-PT6 Signal (White of Yellow)
	⏚	
3	**5H**	
	5L	Str4-PT7 Signal (Black)
	⏚	
	6H	Str4-PT8 Signal (White of Black)
	6L	Str4-PT9 Signal (Blue)
	⏚	
4	**7H**	
	7L	Str4-PT10 Signal (White of Blue)
	⏚	
	8H	Str4-PT11 Signal (Green)
	8L	
	⏚	
5	**9H**	
	9L	Str10-PT1 Signal (Orange)
	⏚	
	10H	Str10-PT2 Signal (White of Orange)
	10L	Str10-PT3 Signal (Purple)
	⏚	
6	**11H**	
	11L	Str10-PT4 Signal (White of Purple)
	⏚	
	12H	Str10-PT5 Signal (Yellow)
	12L	Str10-PT6 Signal (White of Yellow)
	⏚	

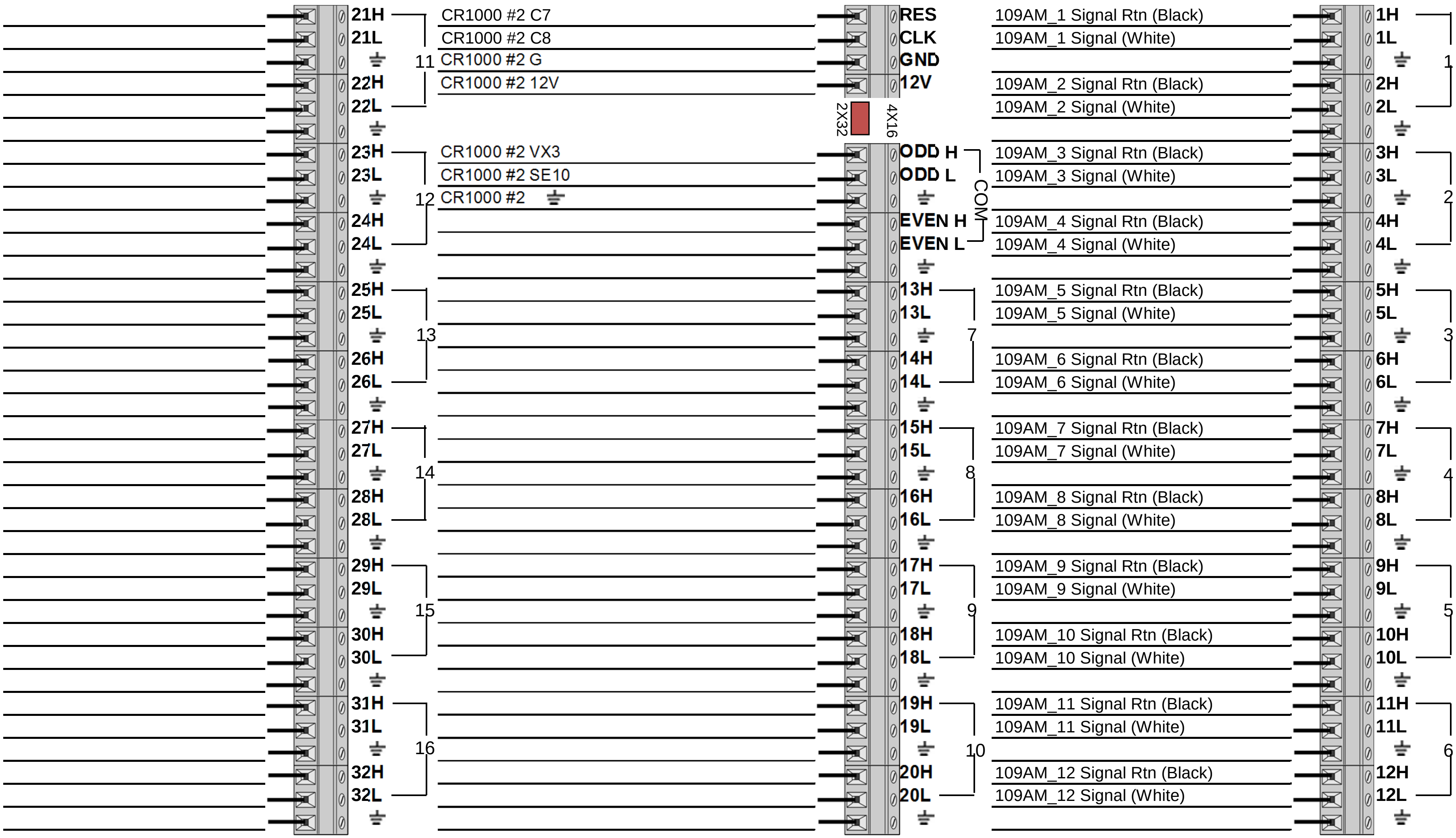
AM16/32 WIRING DIAGRAM	NODE D - Multiplexer #7
COMPANY:	Nuna Contracting / SRK Consulting
PROJECT:	Hope Bay Dam project
documented by:	Mike Ryder - Campbell Scientific Canada Corp.



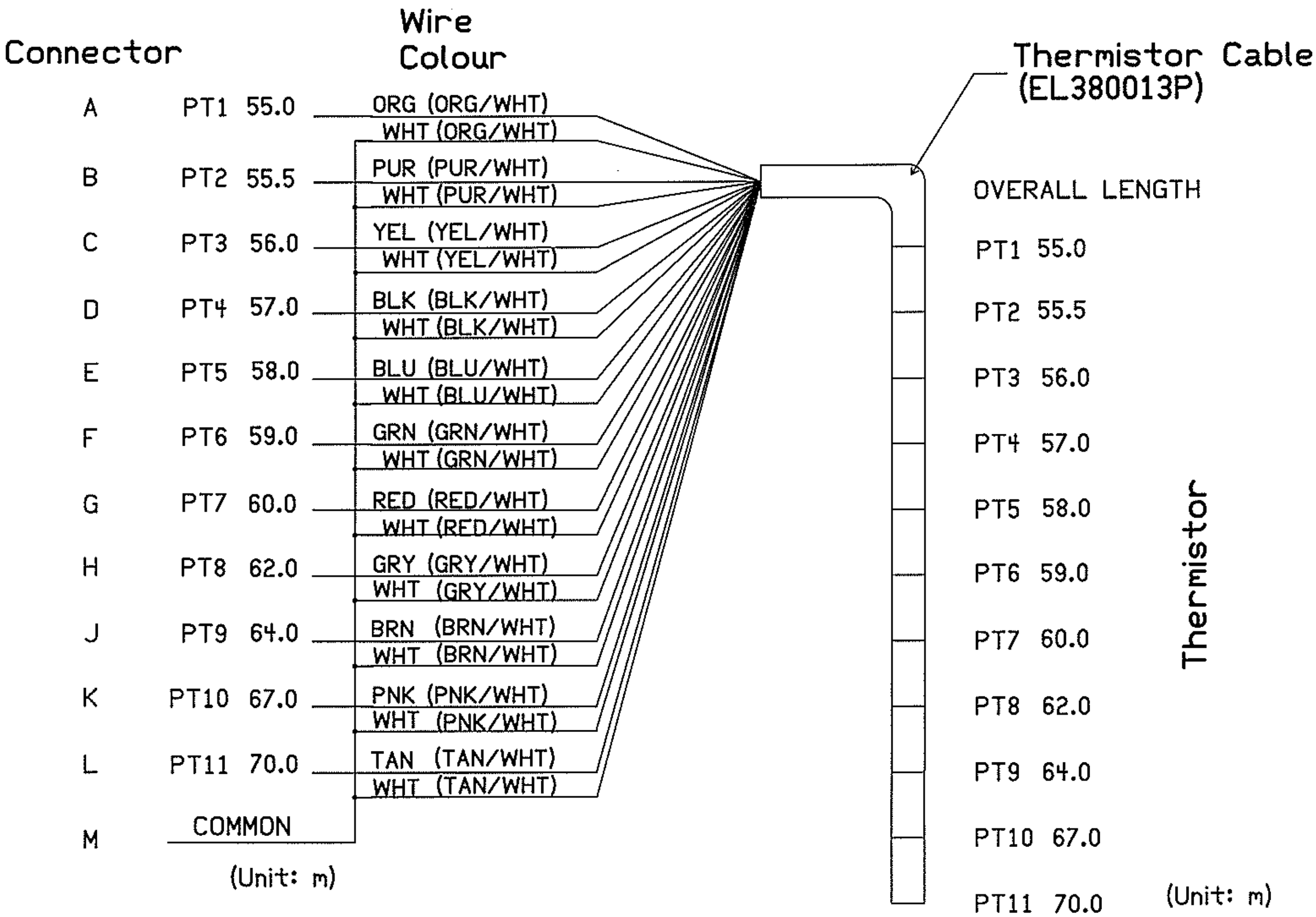
AM16/32 WIRING DIAGRAM	NODE E - Multiplexer #8
COMPANY:	Nuna Contracting / SRK Consulting
PROJECT:	Hope Bay Dam project
documented by:	Mike Ryder - Campbell Scientific Canada Corp.



AM16/32 WIRING DIAGRAM	NODE E - Multiplexer # 9
COMPANY:	Nuna Contracting / SRK Consulting
PROJECT:	Hope Bay Dam project
documented by:	Mike Ryder - Campbell Scientific Canada Corp.



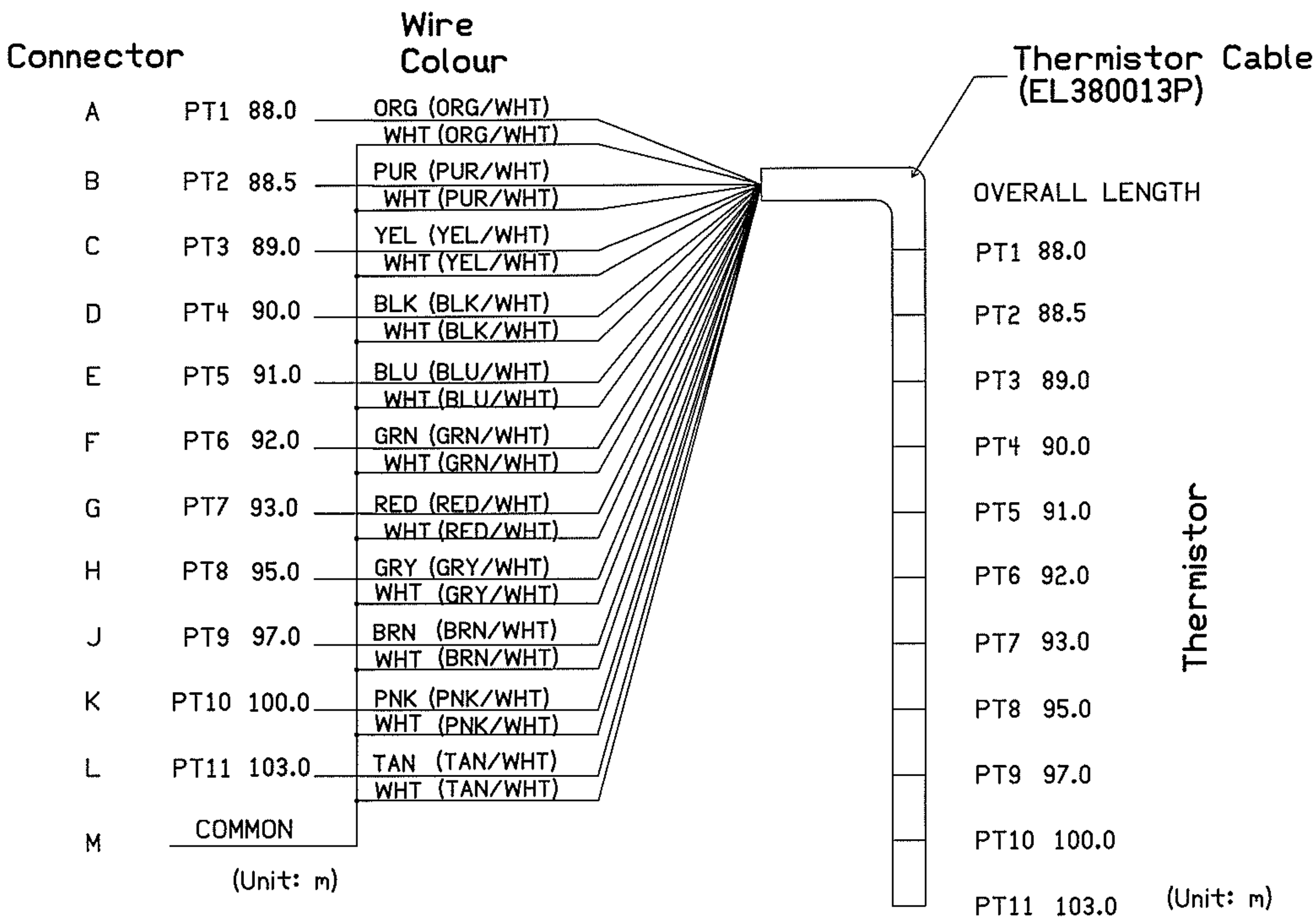
Appendix B3 - Thermistor Cable Diagrams



S/N: TS3080

ID: ND-VTS-040-KT

Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-1	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1

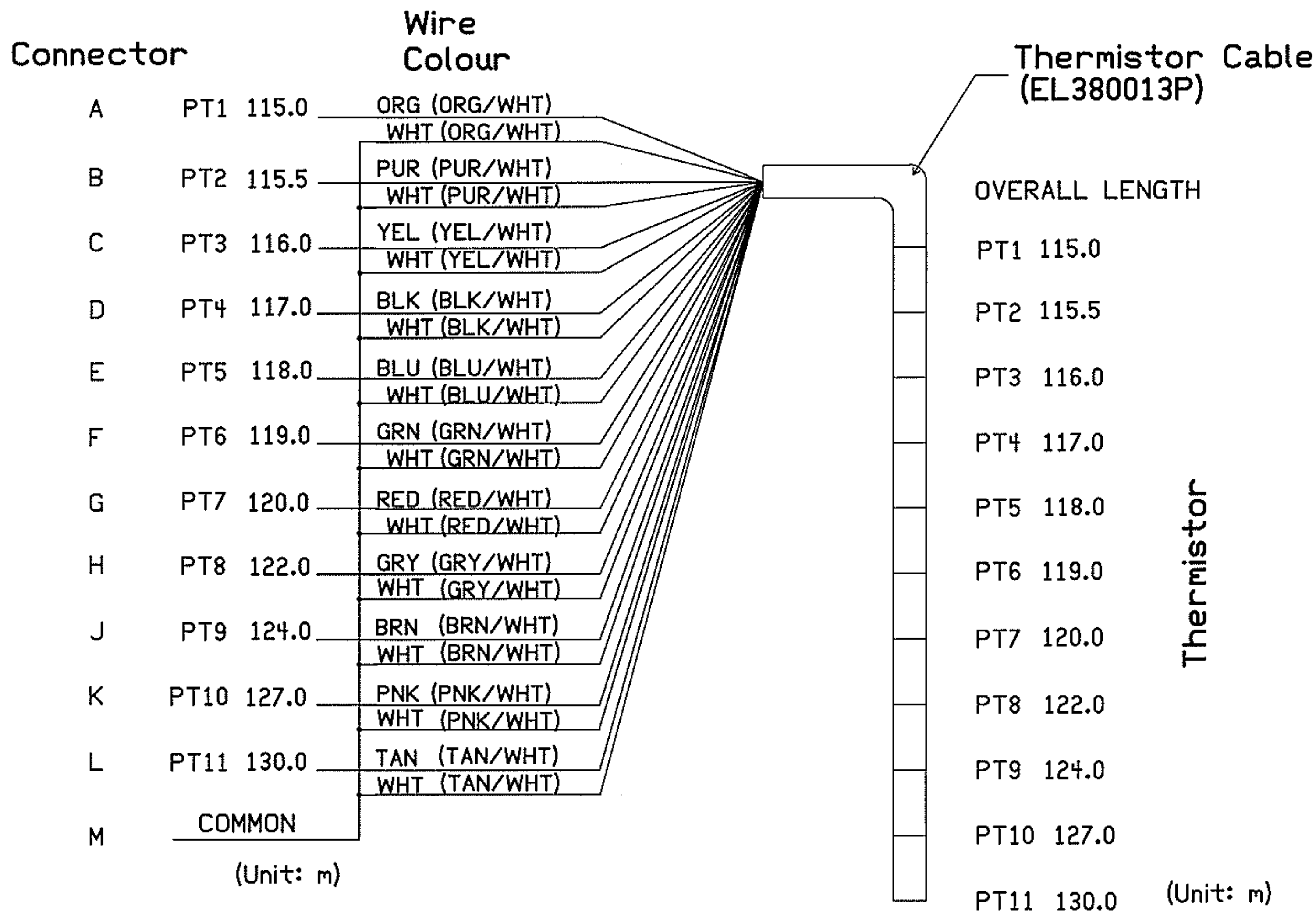


S/N: TS3081

ID: ND-VTS-060-KT

rst INSTRUMENTS

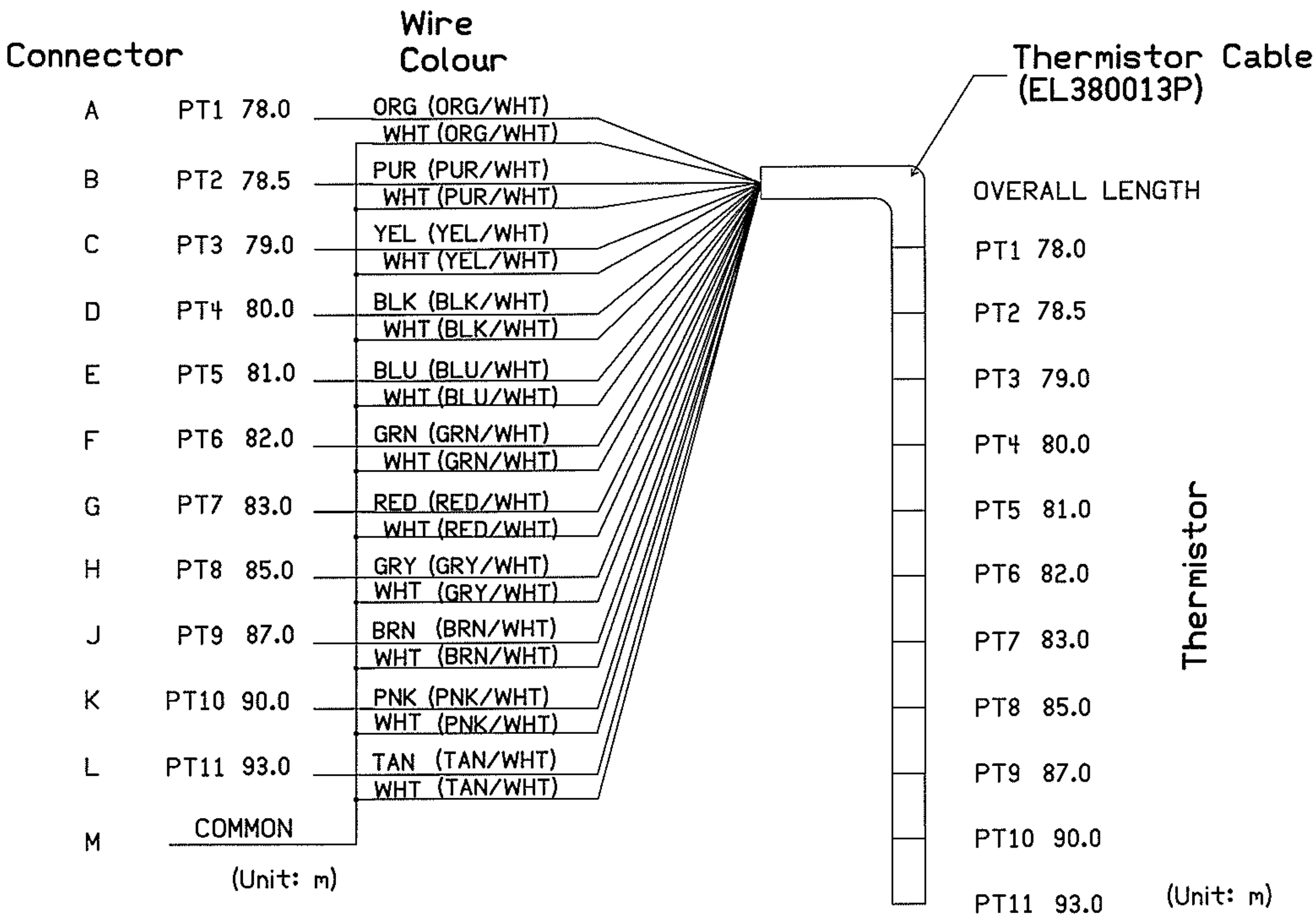
Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-2	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet 1 of 1	



S/N: TS3082

ID: ND-VTS-085-KT

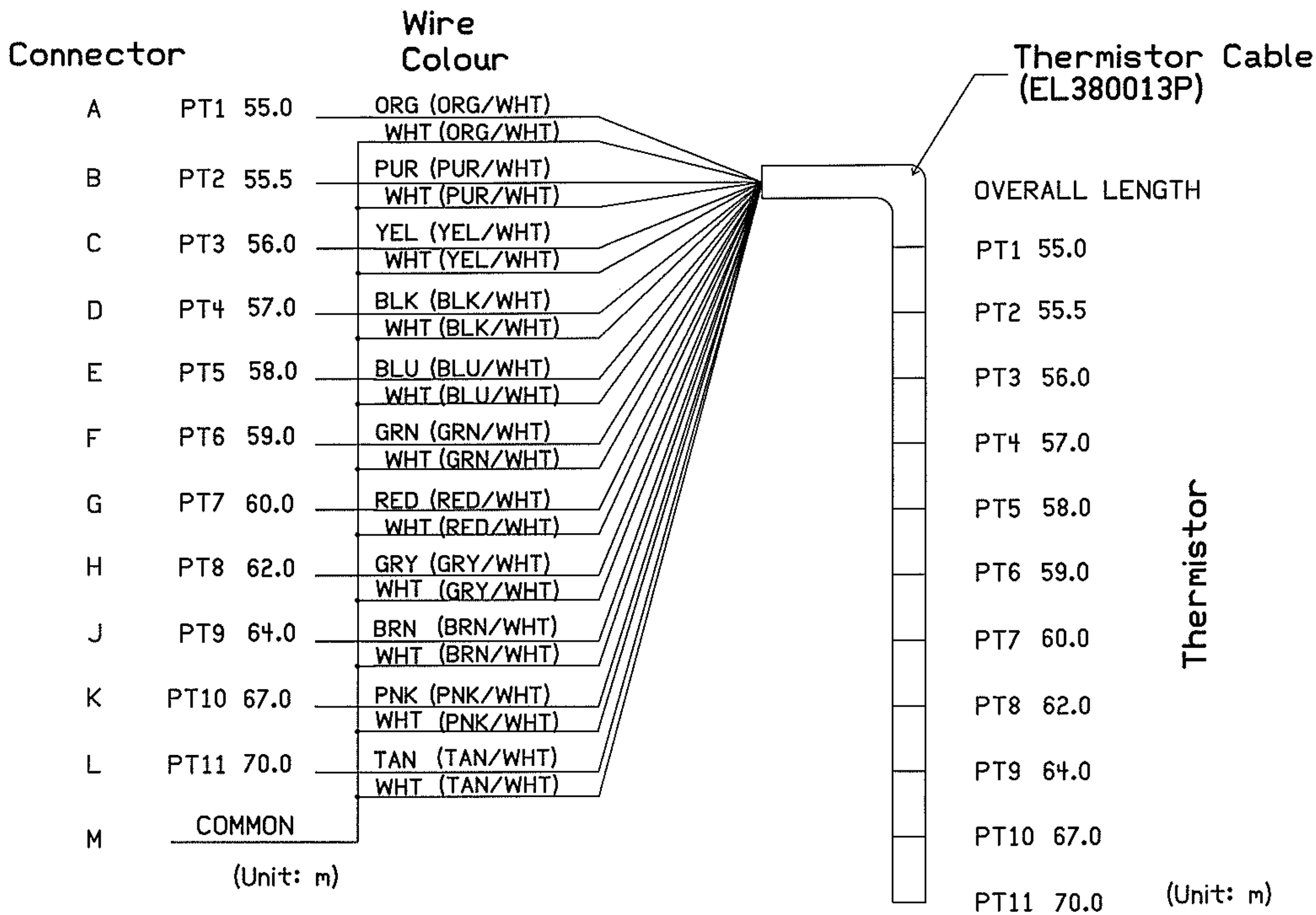
Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-3	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



S/N: TS3083

ID: ND-VTS-130-KT

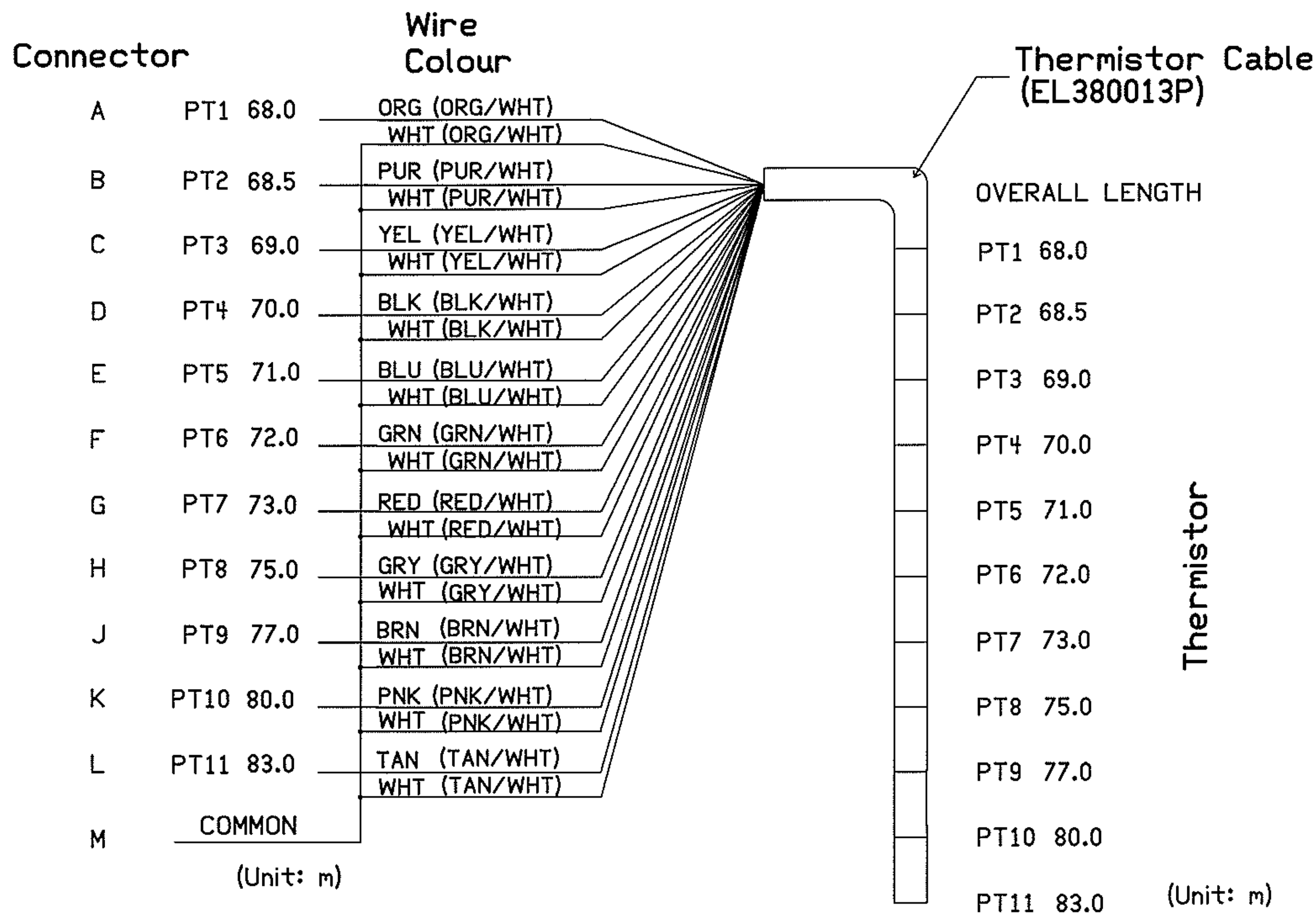
Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-4	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-5	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1

S/N: TS3084

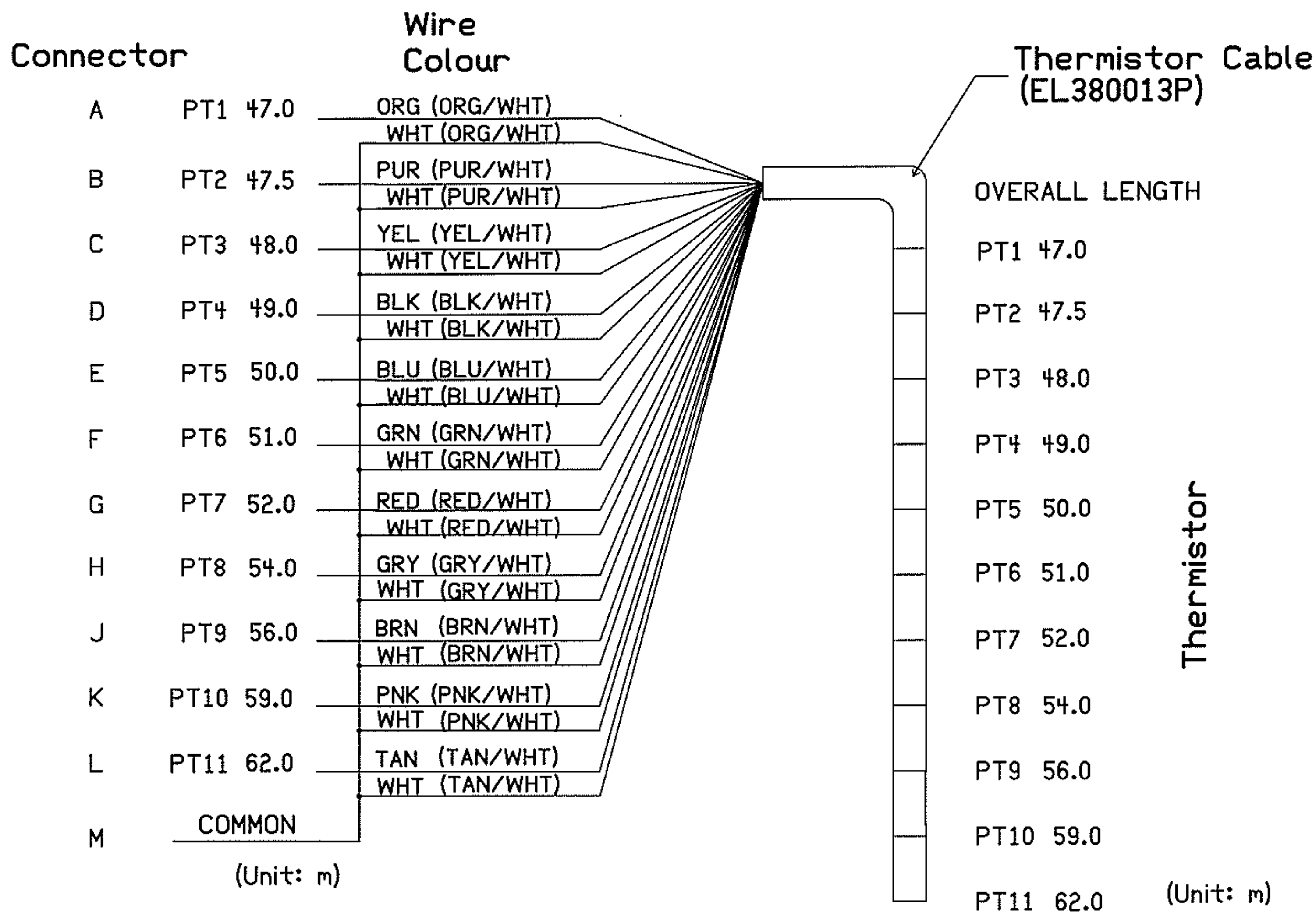
ID: ND-VTS-175-KT



S/N: TS3085

ID: ND-VTS-060-US

Co:	RST INSTRUMENTS LTD
Title:	THERMISTOR CABLE
J/N:	WOQ018560-6 Revision: A
Author:	CB Size: A
Date:	2010/10/12 Sheet 1 of 1



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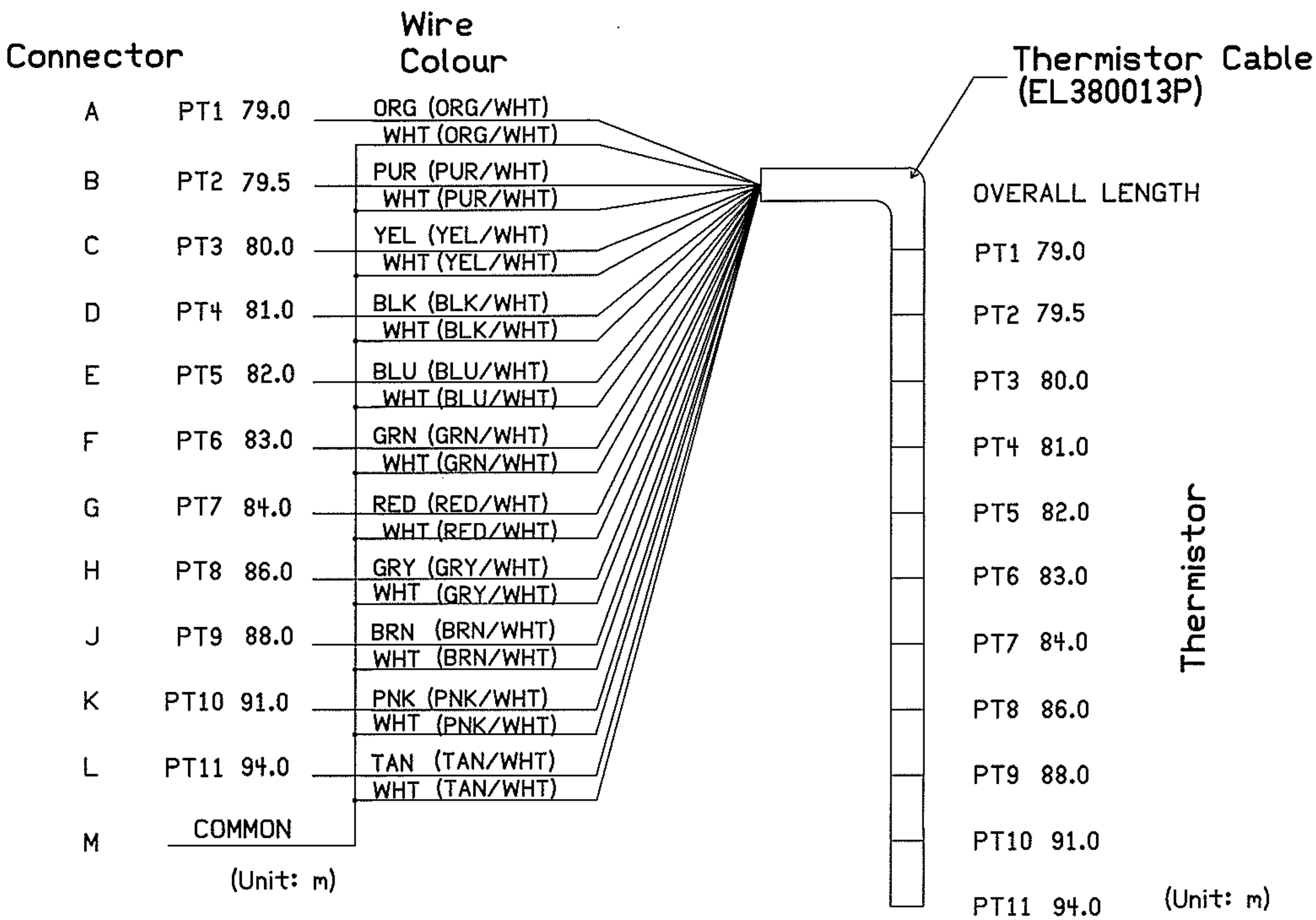
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-7	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet 1 of 1	

S/N: TS3086

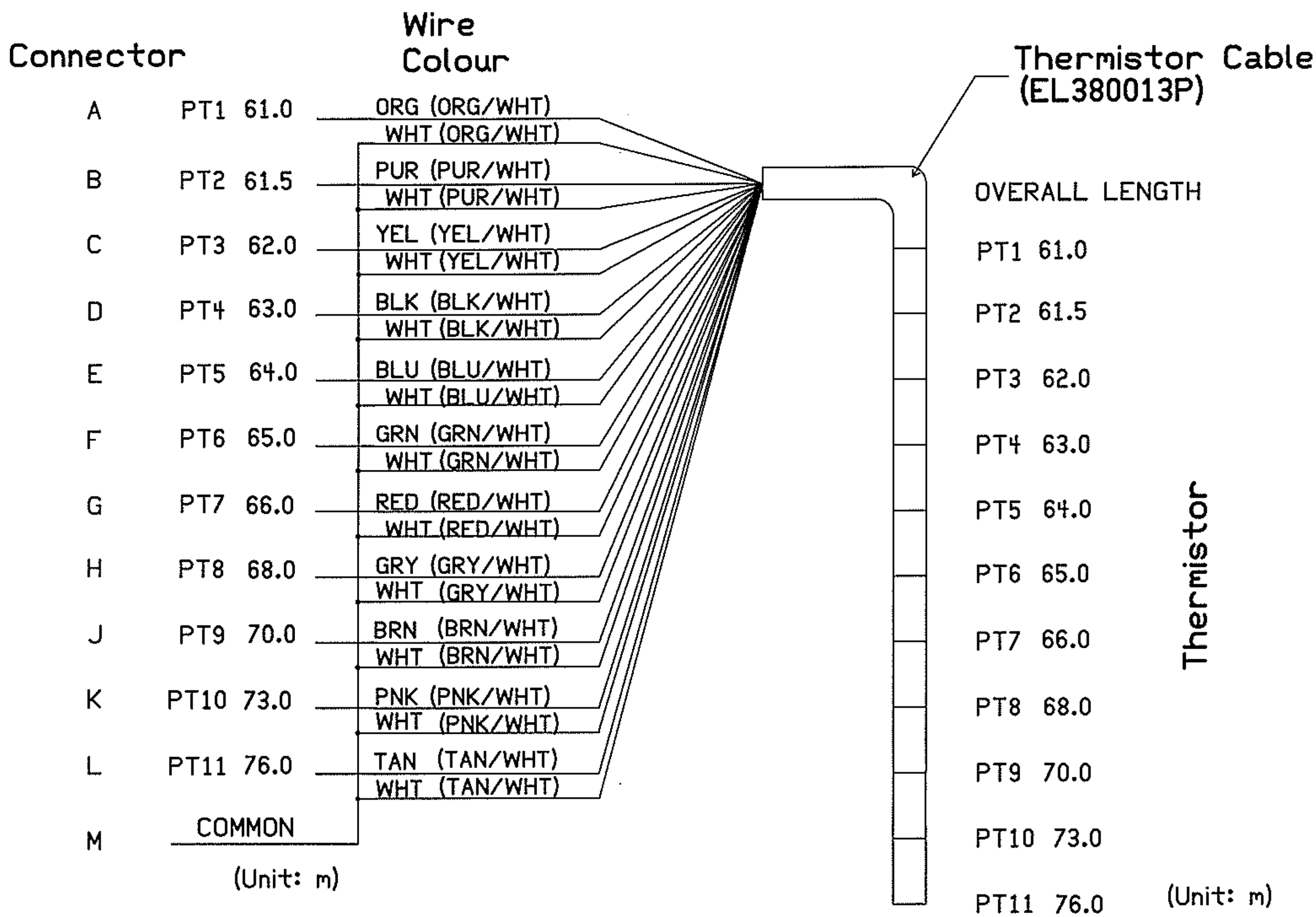
ID: ND-VTS-060-DS



S/N: TS3087

ID: ND-VTS-085-US

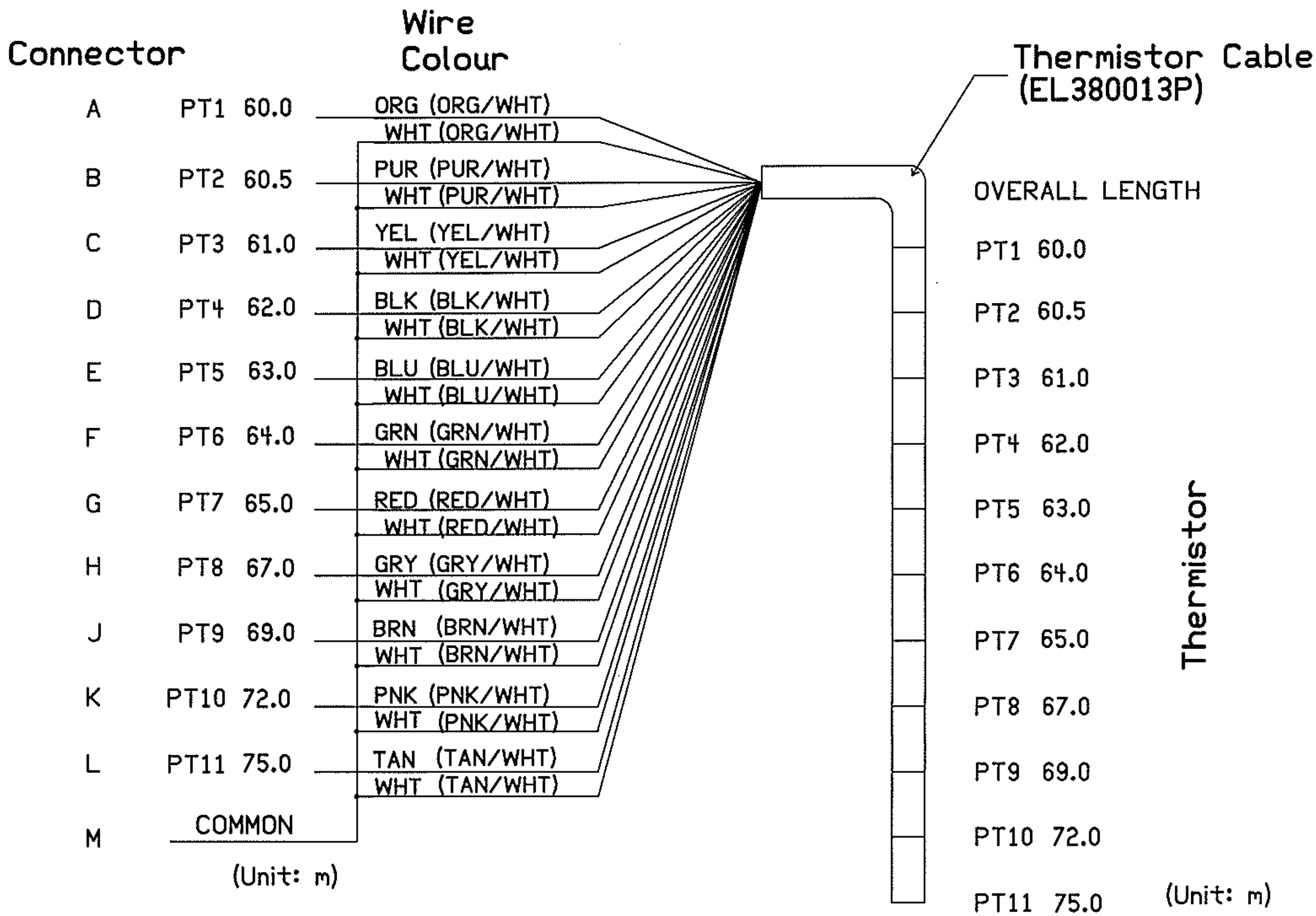
Co:	RST INSTRUMENTS LTD
Title:	THERMISTOR CABLE
J/N:	WOQ018560-8 — Revision: A
Author:	CB — Size: A
Date:	2010/10/12 — Sheet 1 of 1



S/N: TS3088

ID: ND-VTS-085-DS

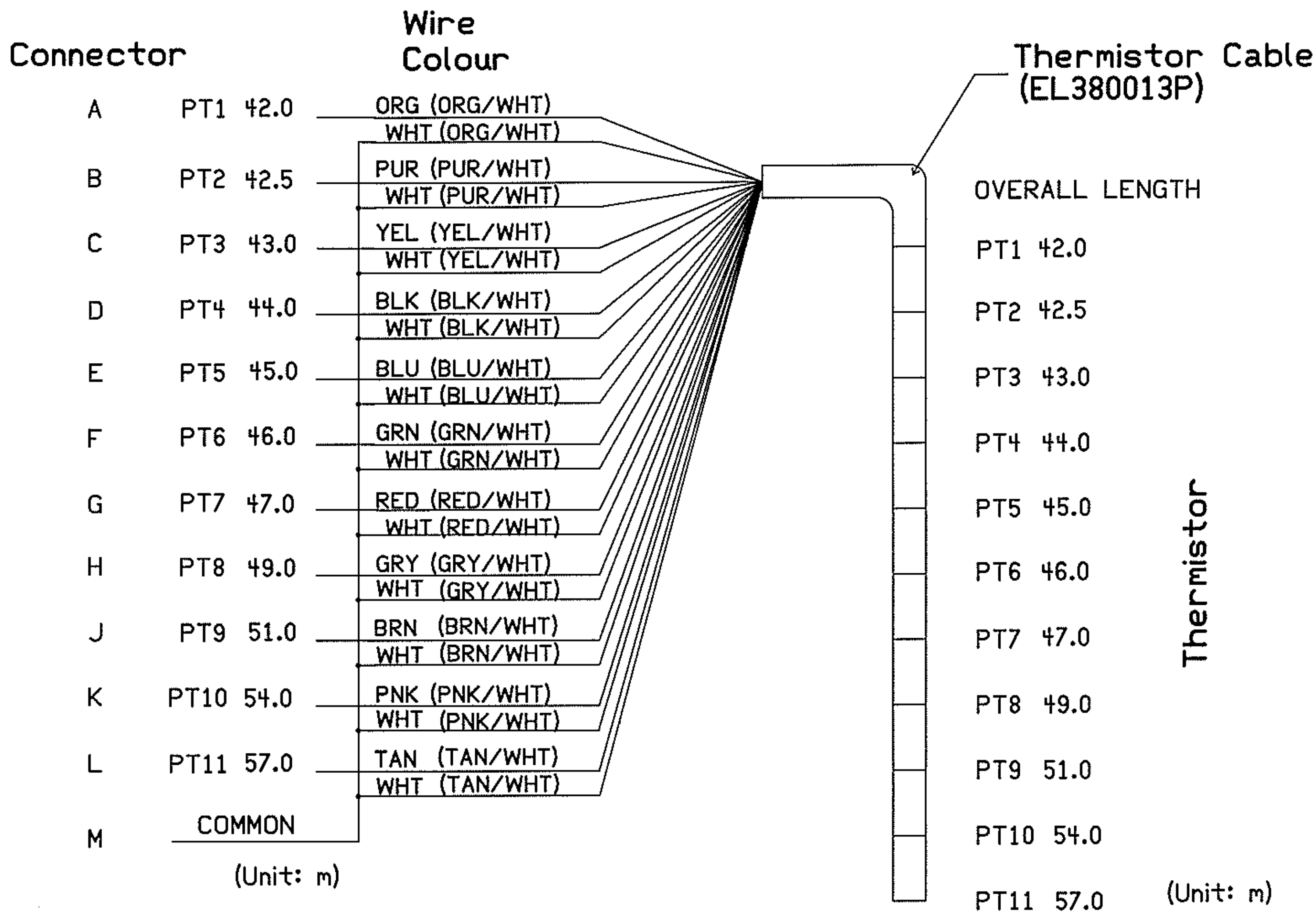
Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-9	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



S/N: TS3089

ID: ND-VTS-130-US

Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-10	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



S/N: TS3090

ID: ND-VTS-130-DS

Co:	RST INSTRUMENTS LTD		
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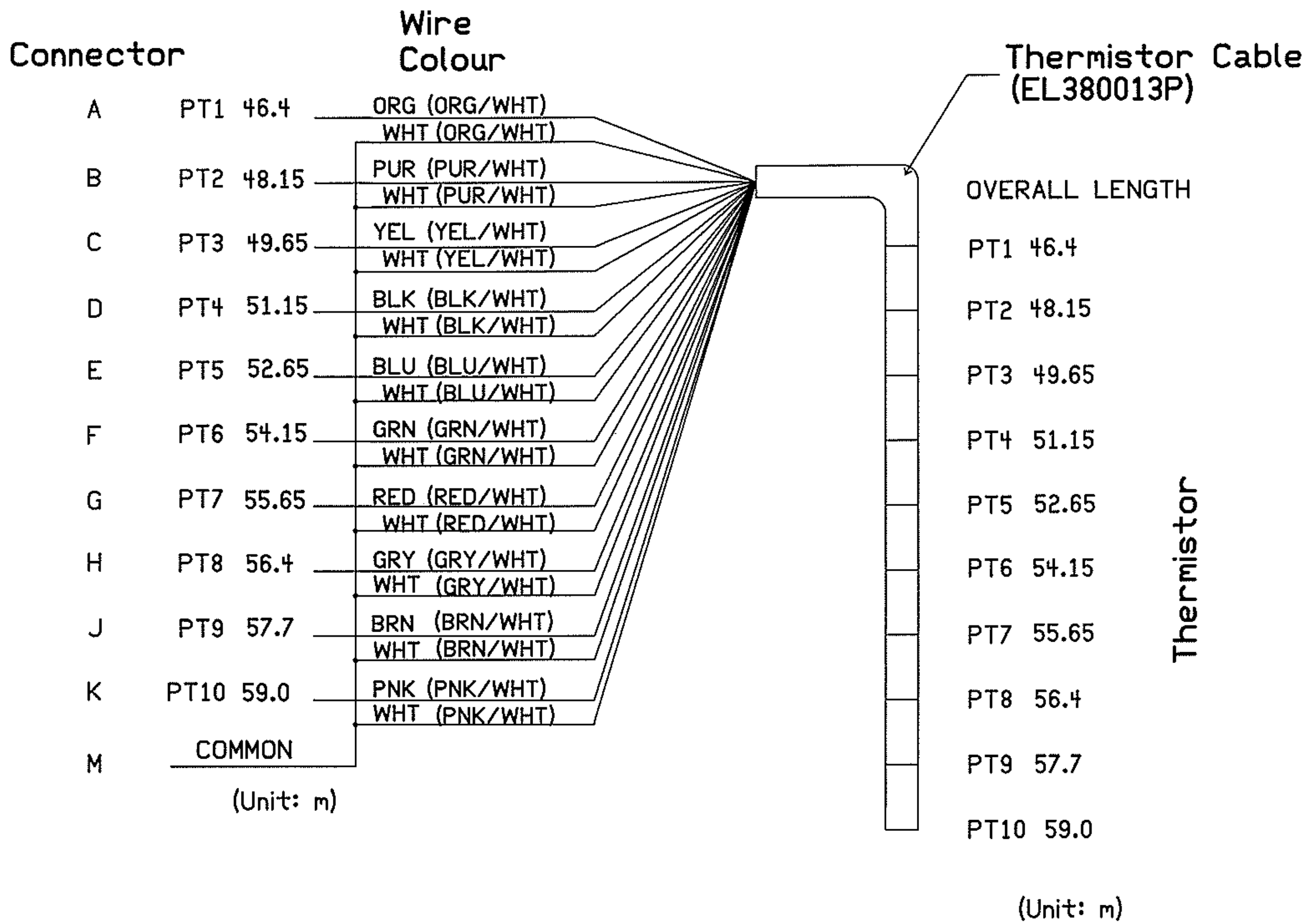
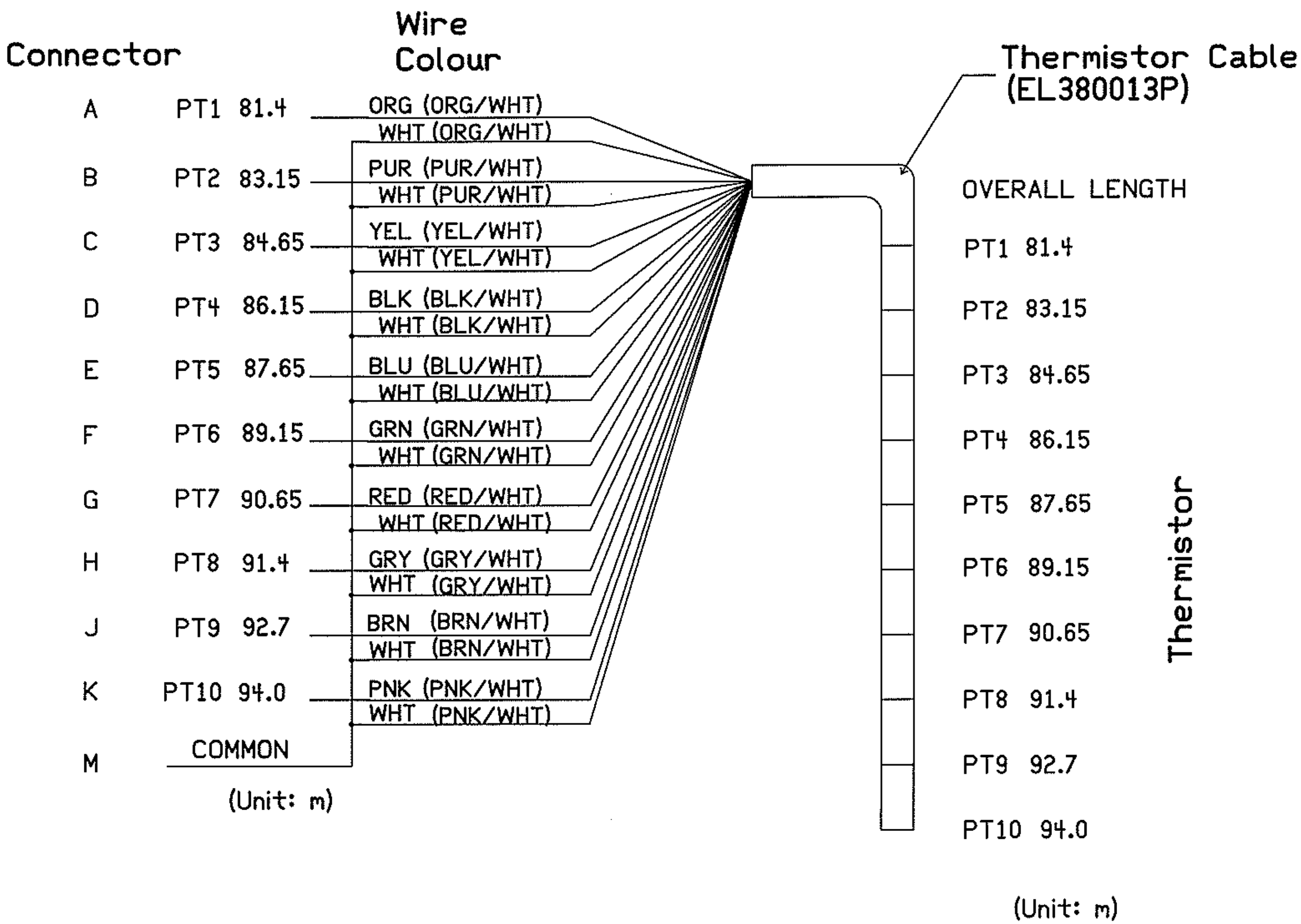
J/N:	WOQ018560-11	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



S/N: TS3091

ID: ND-HTS-040-31.5

Co: RST INSTRUMENTS LTD		
Title: THERMISTOR CABLE		
J/N: WOQ018560-12	Revision: A	
Author: CB	Size: A	
Date: 2010/10/12	Sheet 1 of 1	



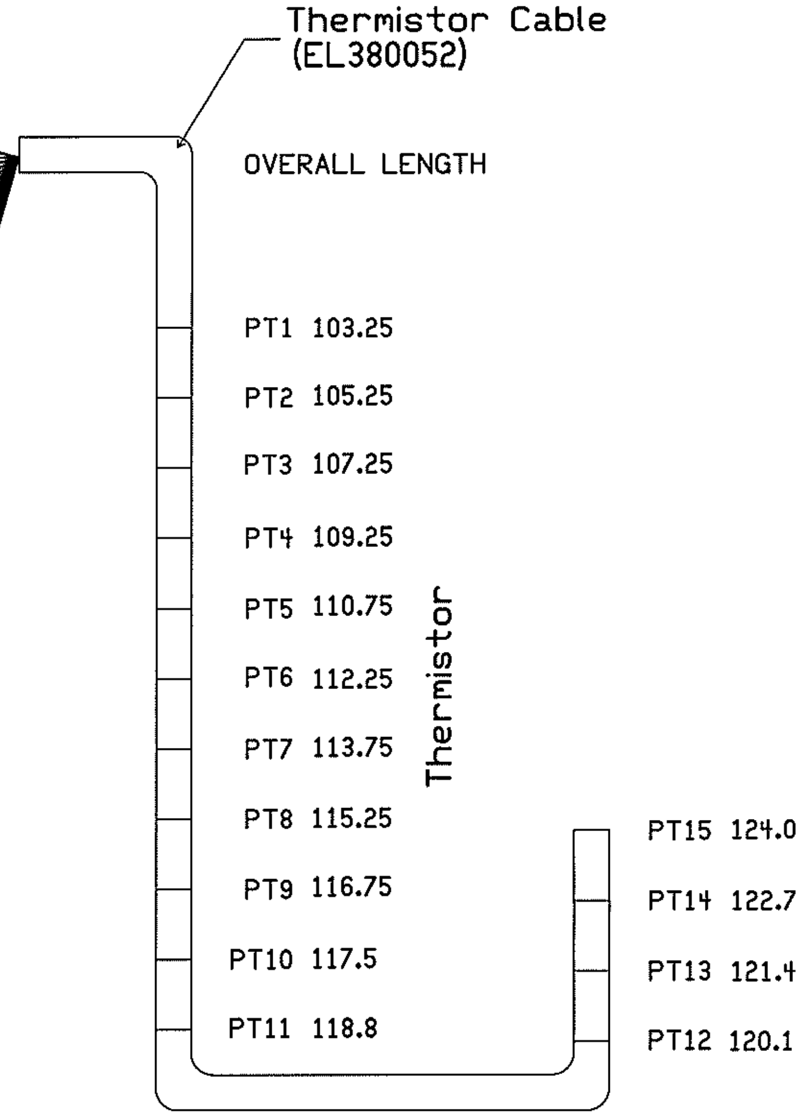
S/N: TS3092

ID: ND-HTS-060-28.8

Co:	RST INSTRUMENTS LTD	
Title:	THERMISTOR CABLE	
J/N:	WOQ018560-13	Revision: A
Author:	CB	Size: A
Date:	2010/10/12	Sheet 1 of 1

Connector			Wire Colour
A	PT1	103.25	ORG (ORG/WHT) WHT (ORG/WHT)
B	PT2	105.25	PUR (PUR/WHT) WHT (PUR/WHT)
C	PT3	107.25	YEL (YEL/WHT) WHT (YEL/WHT)
D	PT4	109.25	BLK (BLK/WHT) WHT (BLK/WHT)
E	PT5	110.75	BLU (BLU/WHT) WHT (BLU/WHT)
F	PT6	112.25	GRN (GRN/WHT) WHT (GRN/WHT)
G	PT7	113.75	RED (RED/WHT) WHT (RED/WHT)
H	PT8	115.25	GRY (GRY/WHT) WHT (GRY/WHT)
J	PT9	116.75	BRN (BRN/WHT) WHT (BRN/WHT)
K	PT10	117.5	PNK (PNK/WHT) WHT (PNK/WHT)
L	PT11	118.8	TAN (TAN/WHT) WHT (TAN/WHT)
N	PT12	120.1	PUR (PUR/ORG) ORG (PUR/ORG)
P	PT13	121.4	YEL (YEL/ORG) ORG (YEL/ORG)
R	PT14	122.7	BLK (BLK/ORG) ORG (BLK/ORG)
S	PT15	124.0	BLU (BLU/ORG) ORG (BLU/ORG)
M	COMMON		

(Unit: m)

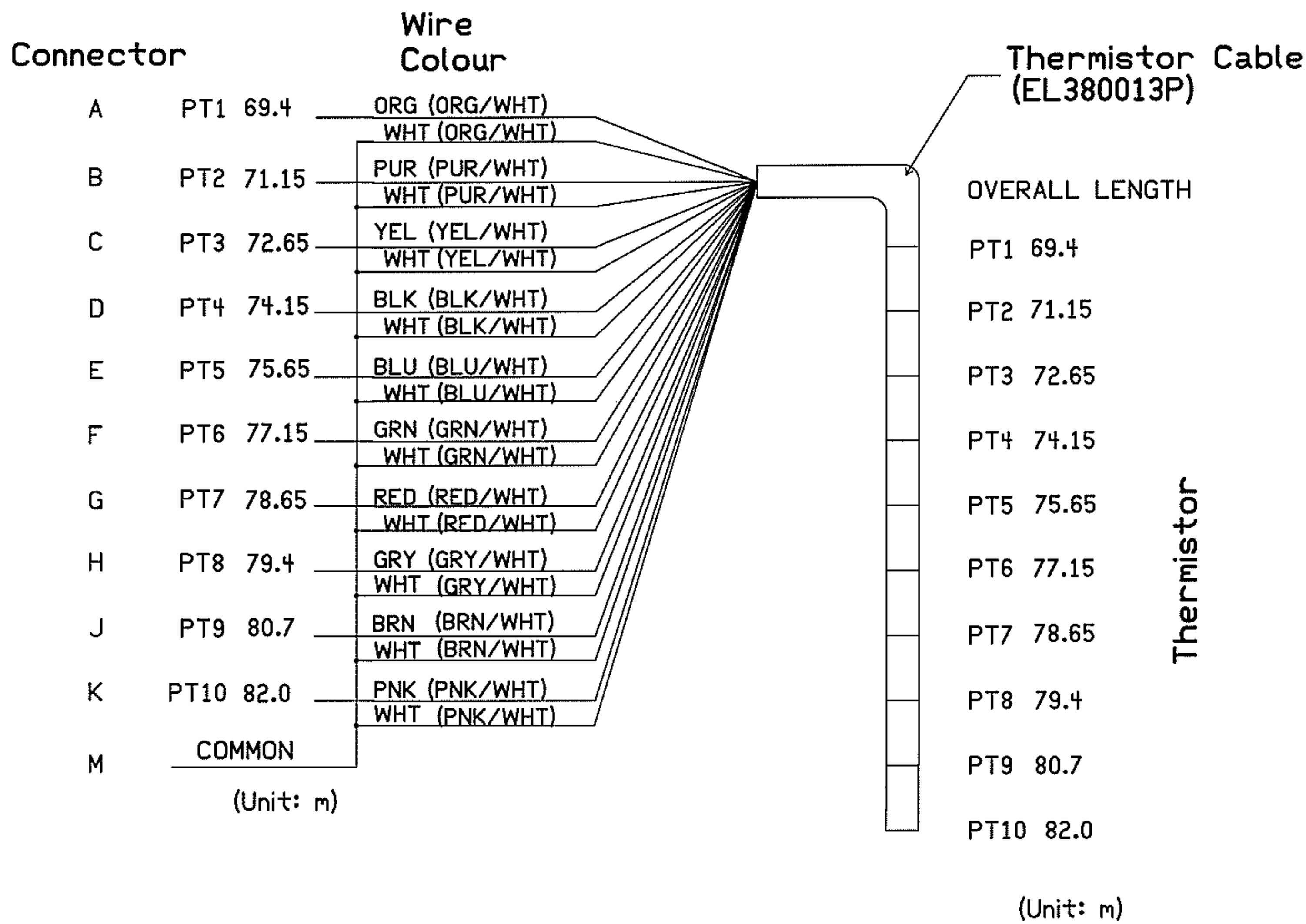


(Unit: m)

S/N: TS3093

ID: ND-HTS-085-25.3

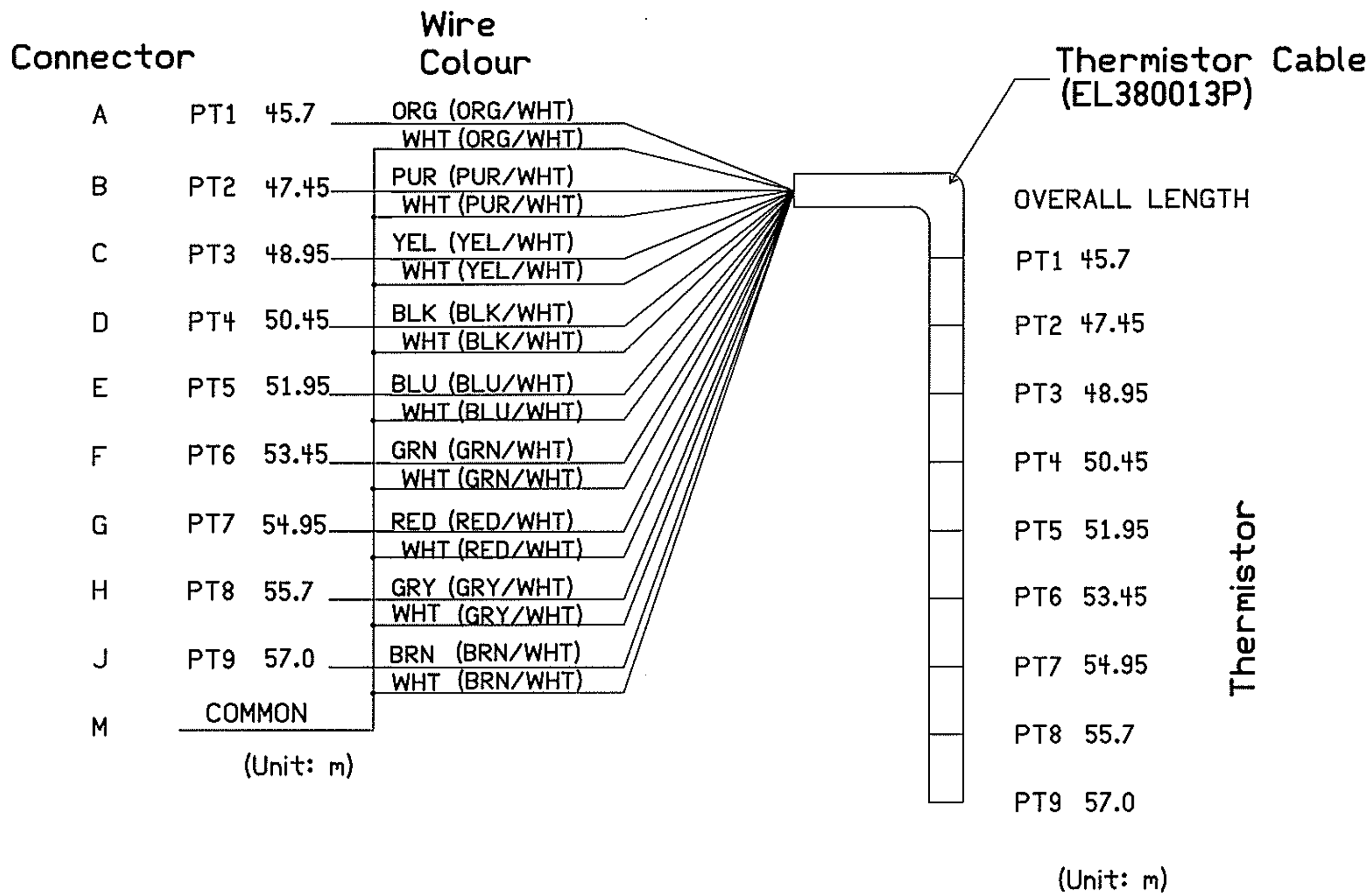
Co:	RST INSTRUMENTS LTD	
Title:	THERMISTOR CABLE	
J/N:	WOQ018560-14	Revision: A
Author:	CB	Size: A
Date:	2010/10/12	Sheet 1 of 1



S/N: TS3094

ID: ND-HTS-130-28.8

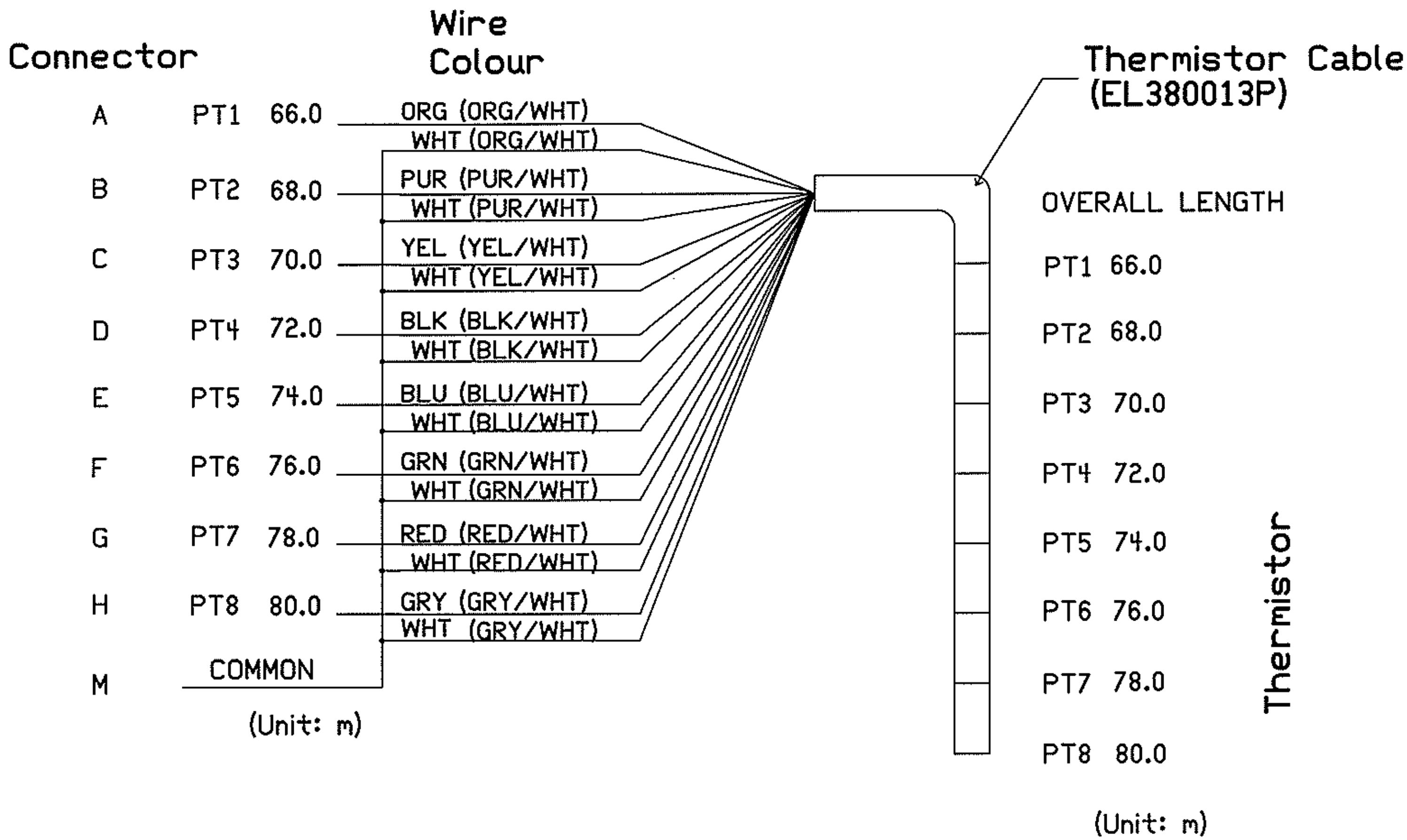
Co: RST INSTRUMENTS LTD		
Title: THERMISTOR CABLE		
J/N: WOQ018560-15		Revision: A
Author: CB		Size: A
Date: 2010/10/12		Sheet 1 of 1



S/N: TS3095

ID: ND-HTS-175-32.5

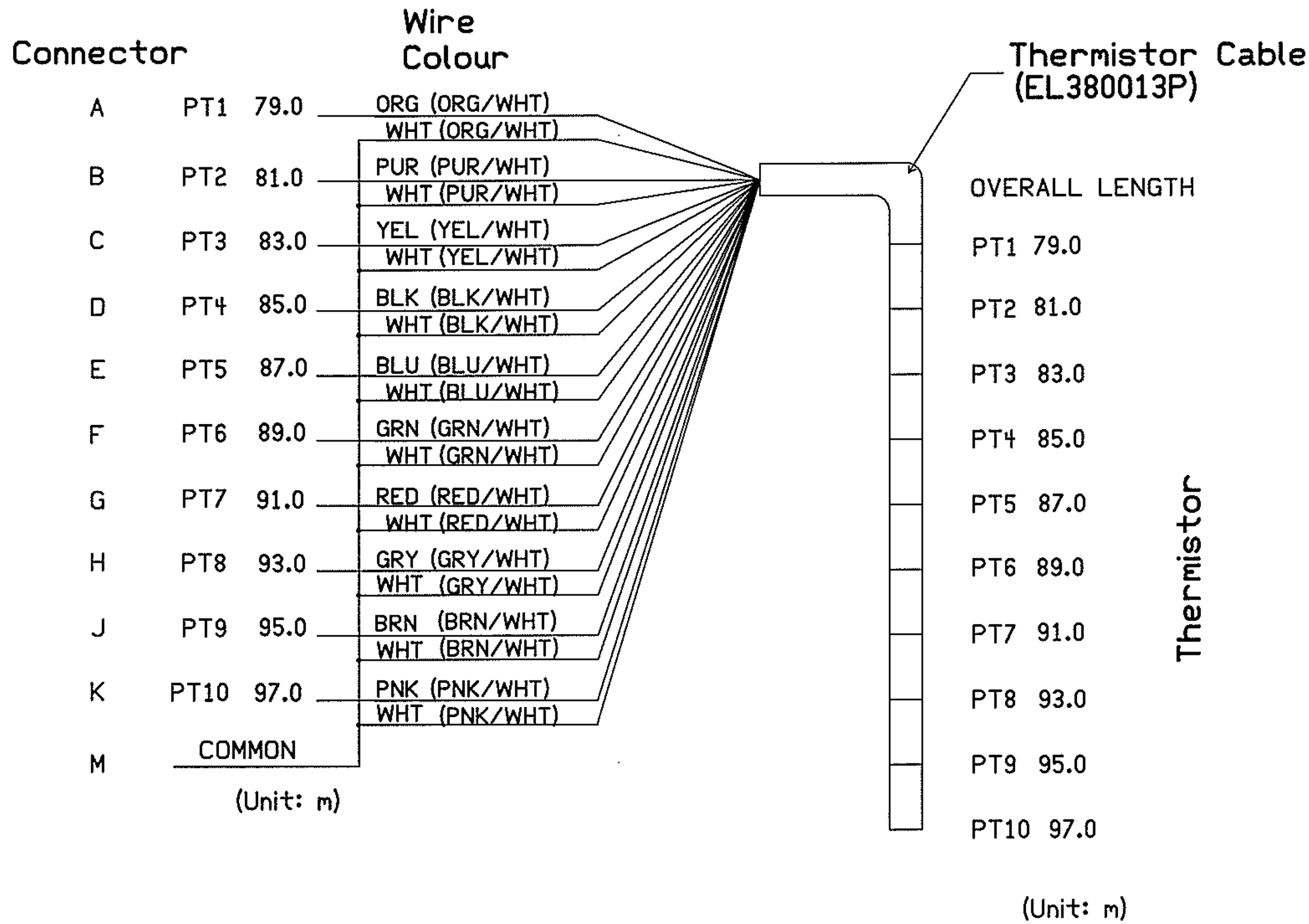
Co:	RST INSTRUMENTS LTD
Title:	THERMISTOR CABLE
J/N:	WOQ018560-16 Revision: A
Author:	CB Size: A
Date:	2010/10/12 Sheet 1 of 1



S/N: TS3096

ID: ND-HTS-060-31.0

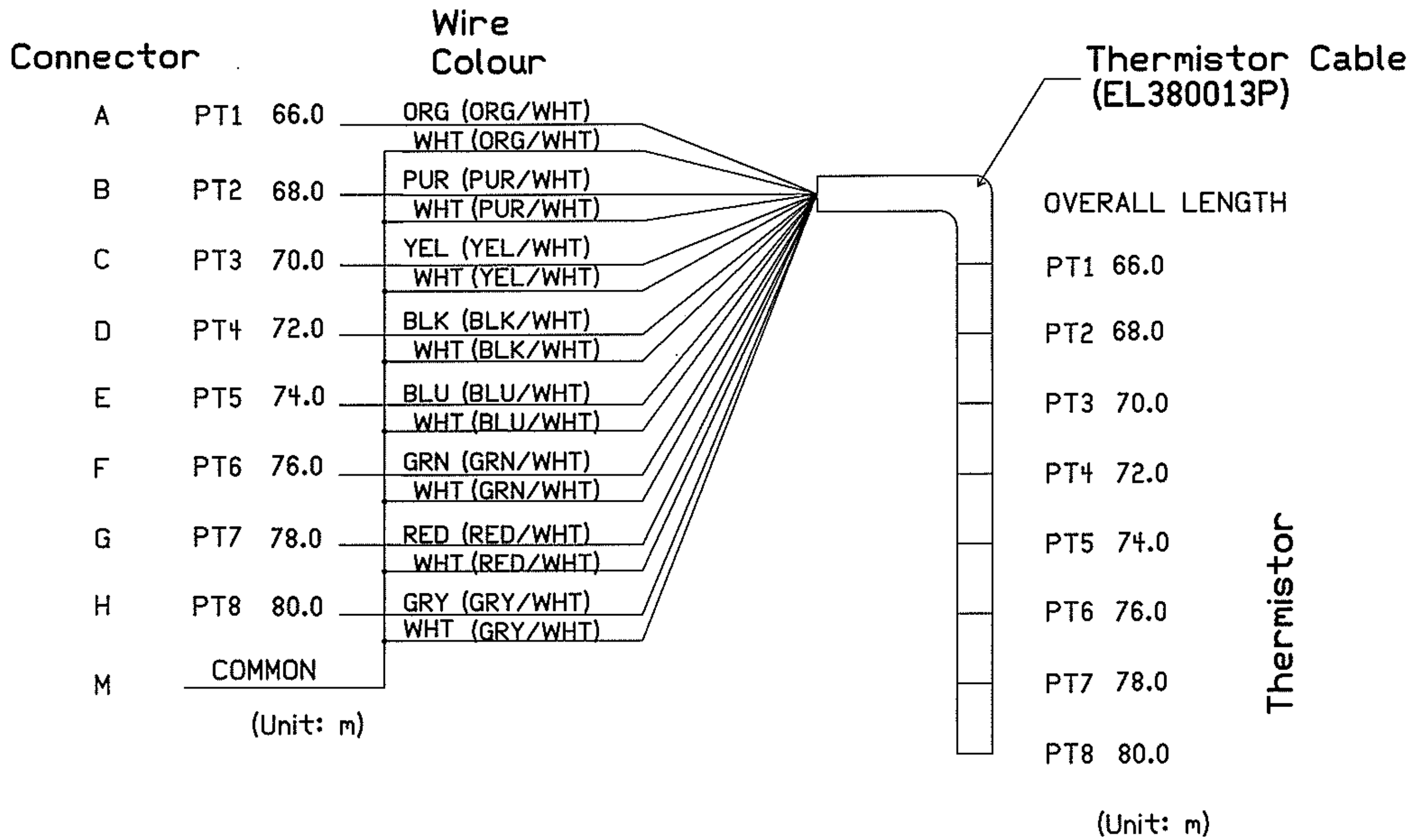
Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-17	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



S/N: TS3097

ID: ND-HTS-085-29.4

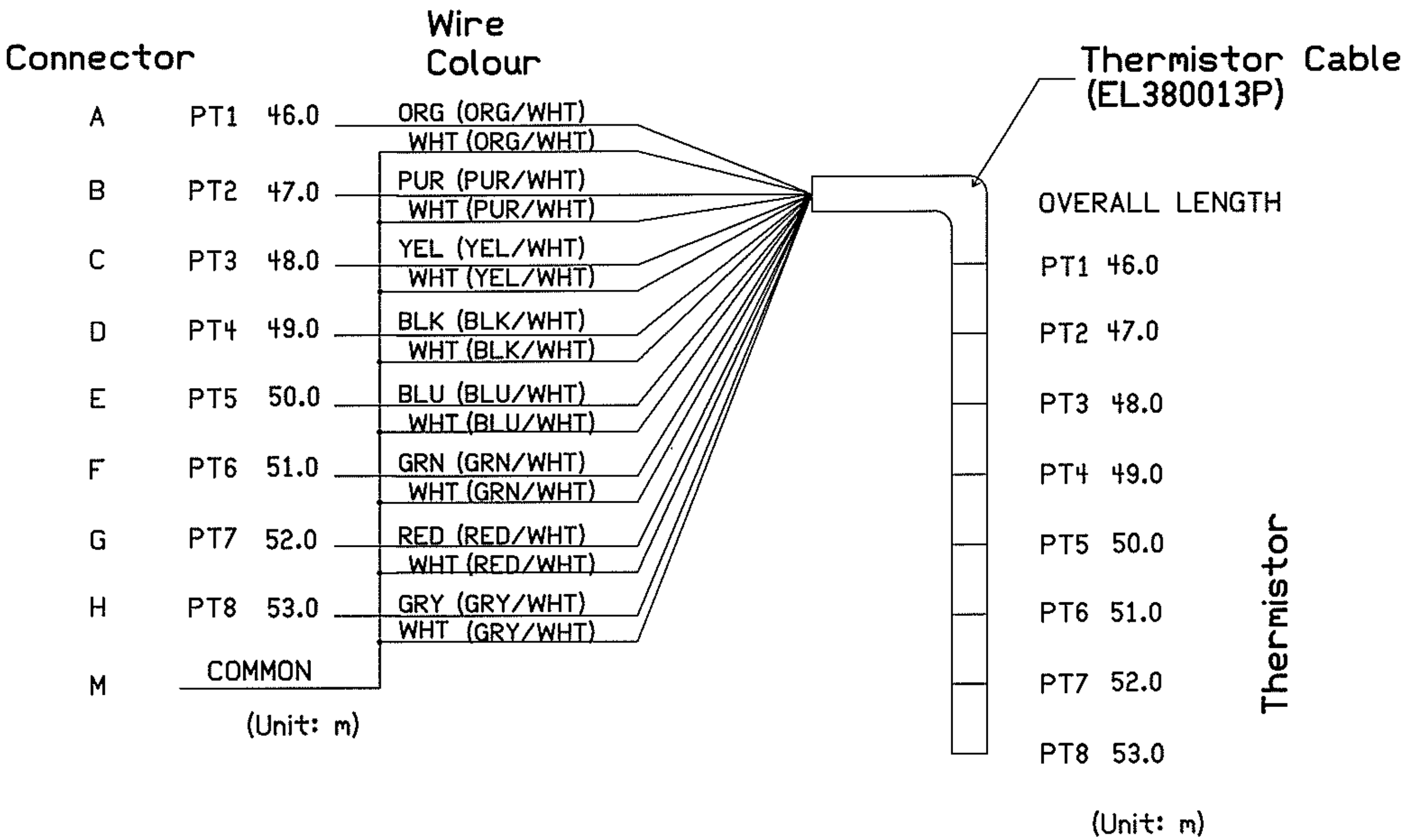
Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-18	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet 1 of 1	



S/N: TS3098

ID: ND-HTS-130-31.0

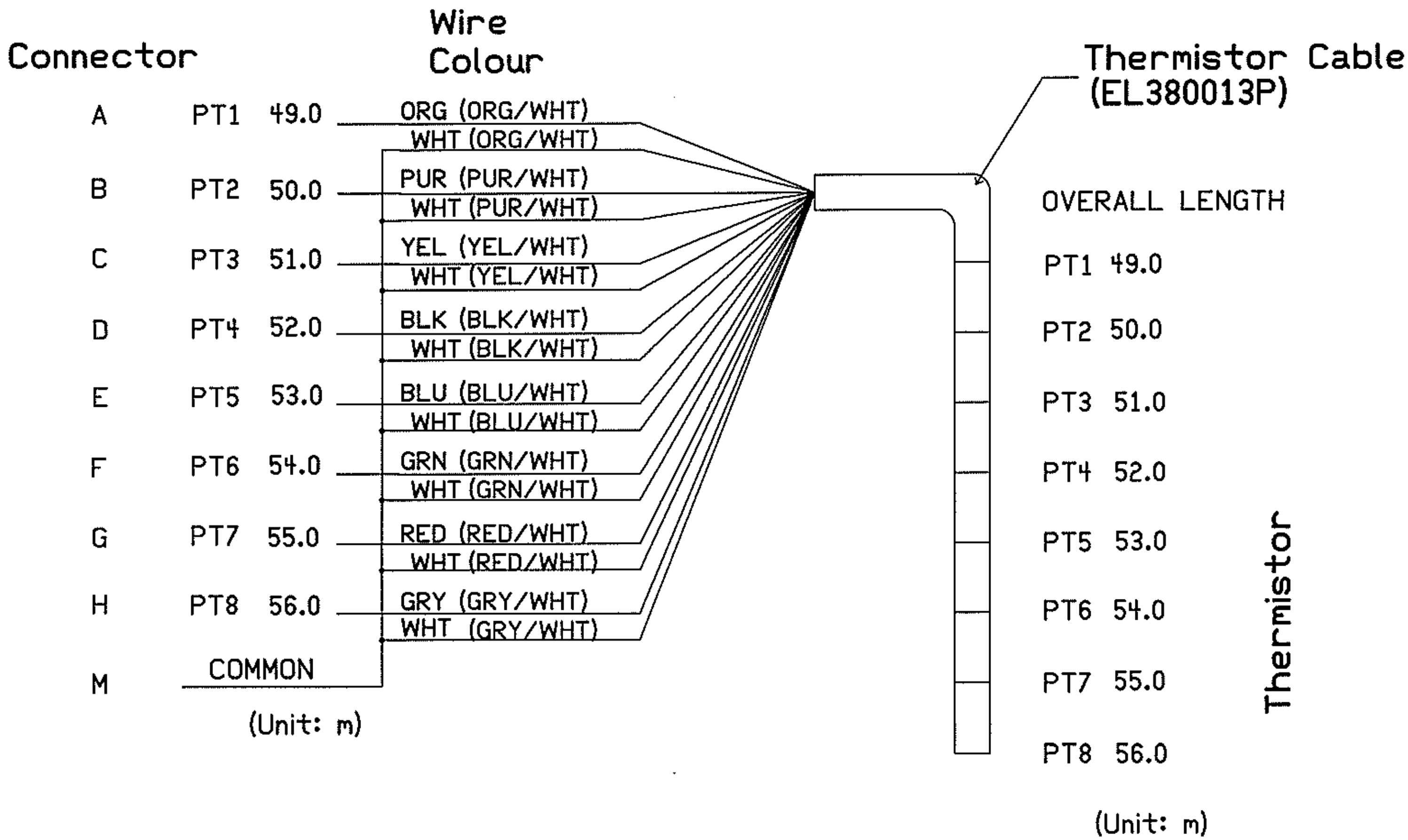
Co:	RST INSTRUMENTS LTD
Title:	THERMISTOR CABLE
J/N:	WOQ018560-19 — Revision: A
Author:	CB — Size: A
Date:	2010/10/12 — Sheet 1 of 1



S/N: TS3099

ID: ND-HTS-060-33.5

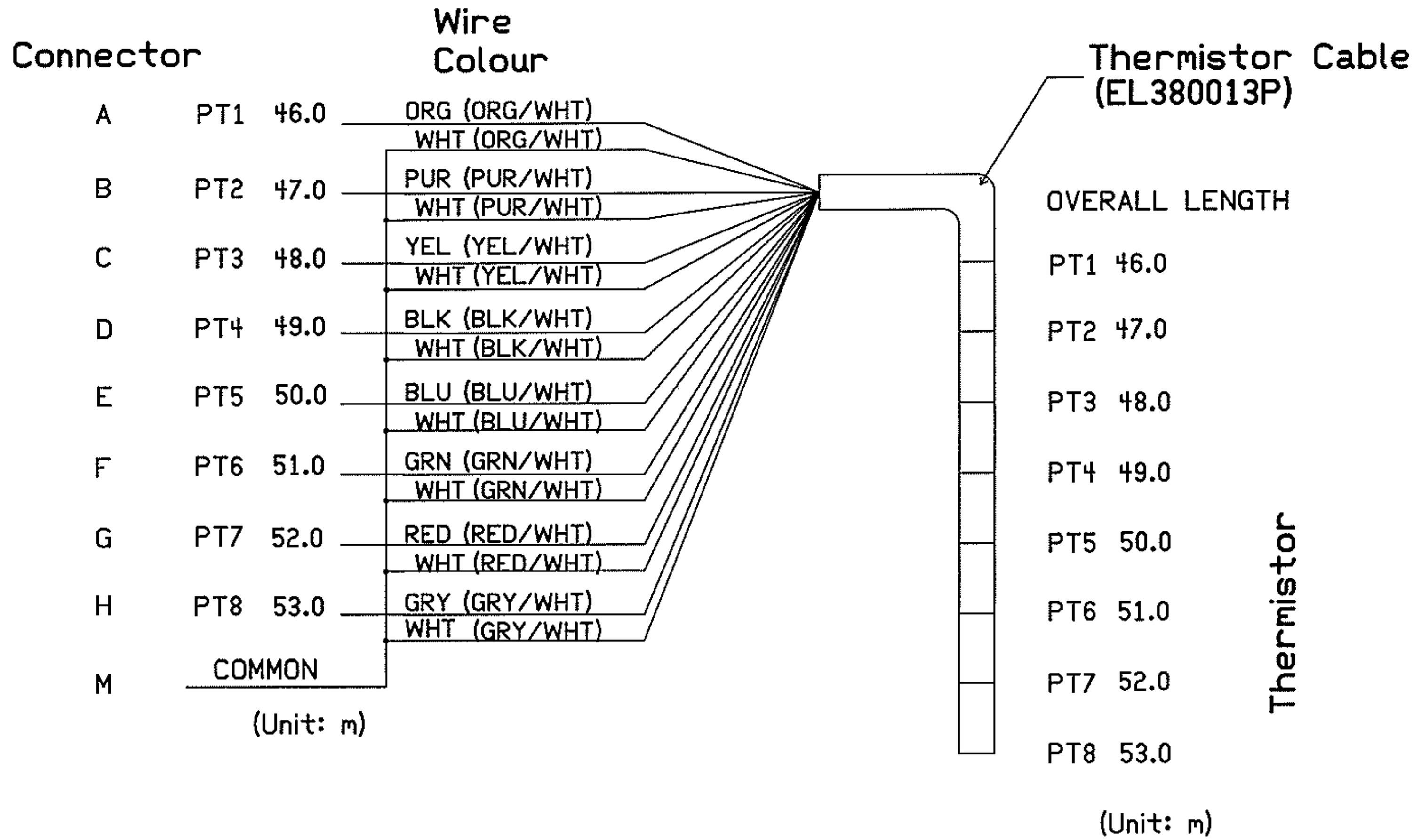
Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-20	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



S/N: TS3102

ID: ND-HTS-040-33.5

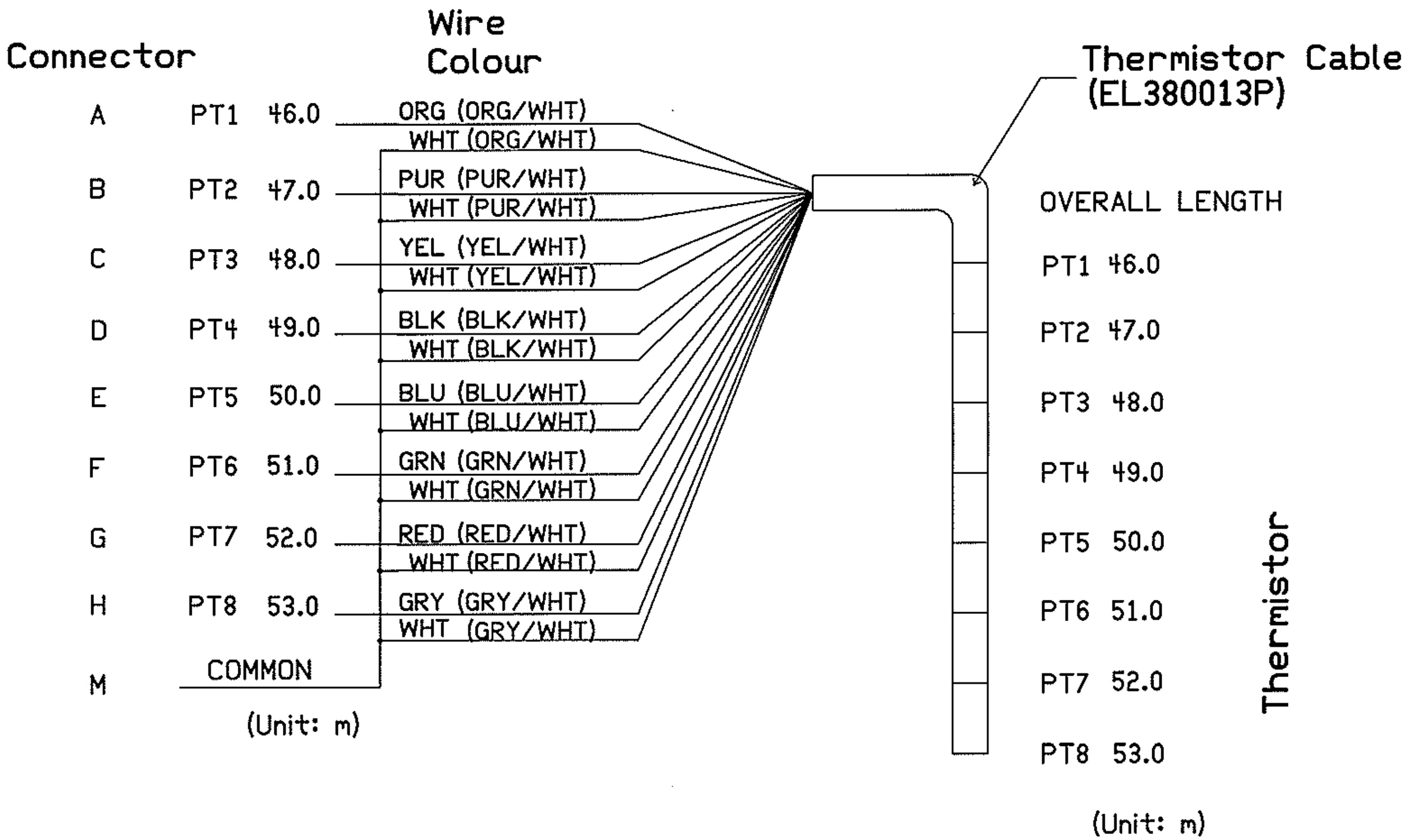
Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-21	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



S/N: TS3100

ID: ND-HTS-085-33.5

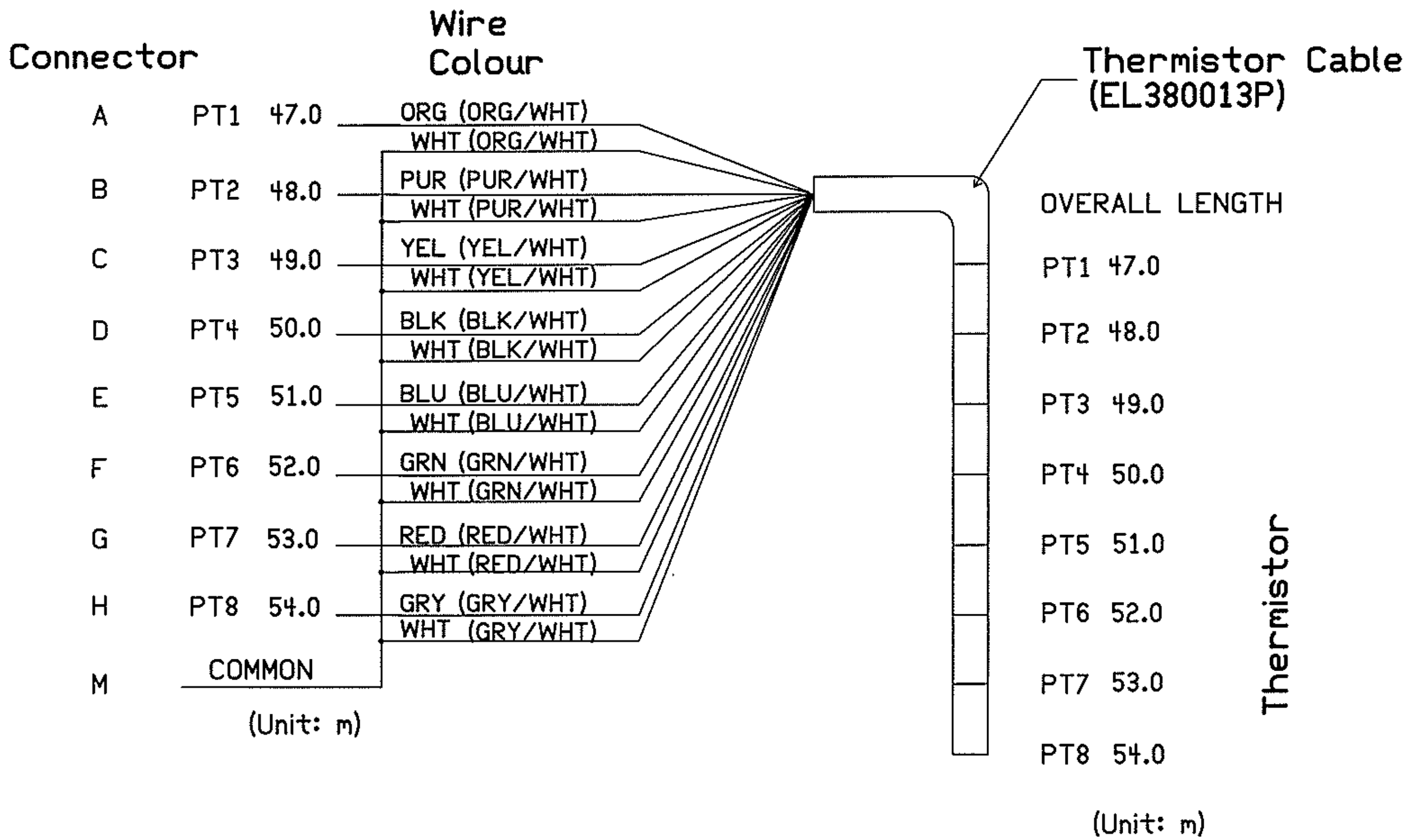
Co:	RST INSTRUMENTS LTD
Title:	THERMISTOR CABLE
J/N:	WOQ018560-22 — Revision: A
Author:	CB — Size: A
Date:	2010/10/12 — Sheet 1 of 1



S/N: TS3101

ID: ND-HTS-130-33.5

Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-23	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



S/N: TS3103

ID: ND-HTS-175-33.5

Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-24	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1

Appendix C - CR1000 Program Listing Overview

```
'CR1000 Series Datalogger


'Contact: Iozsef Miskolczi
'SRK Consulting
'2200-1066 West Hastings Street
'Vancouver, BC, V6E 3X2
'Canada

'Phone: 604-681-4196
'Direct Number: 778-785-8460
'email: IMiskolczi@srk.com



'Program overview: CR1000 #1 Station Program
'This program will take themperature measurements on a dam located
'on Hope bay, Nunavut.
' Data will be stored on a compact flash card once every 6 hours

'******************************************************
'Program author: Mike Ryder - Sales & Technical Support
' modified by Iozsef Miskolczi on August 11, 2012

'Campbell Scientific (Canada) Corp.
'11564 - 149 Street NW
'Edmonton, AB T5M 1W7
'Canada

'Main Phone: 780-454-2505
'Direct Number: 780-733-8214
'Fax: 780-454-2655
'Email: Mike.Ryder@campbellsci.ca
'General Email: dataloggers@campbellsci.ca
'Web Site: www.campbellsci.ca
'******************************************************
'============================================================================
'- - - - - - - - - - - - - - - - CR1000 Wiring - - - - - - - - - - - - - - - -
'============================================================================

'============================================================================
'- - - - - - - - - - - - - - - - Variables - - - - - - - - - - - - - - - - - -
'============================================================================

Public PTemp
Public batt_volt

Public Therm_ResA_1 (34)
Public Therm_mV_A_1 (34)
Public Therm_TempA_1 (34)

Public Therm_ResB_2 (36)
Public Therm_mV_B_2 (36)
Public Therm_TempB_2 (36)

Public Therm_ResB_3 (30)
```

```
Public Therm_mV_B_3 (30)
Public Therm_TempB_3 (30)

Public Therm_ResC_4 (36)
Public Therm_mV_C_4 (36)
Public Therm_TempC_4 (36)

Public Therm_ResC_5 (36)
Public Therm_mV_C_5 (36)
Public Therm_TempC_5 (36)

Dim Index
Dim Index2
Dim Index3
Dim Index4
Dim Index5

StationName (HB_NorthDam_CR1000_#1)

'================================================================================
'- - - - - - - - - - - - - - - Variable aliases - - - - - - - - - - - - - -
'================================================================================

Alias Therm_TempA_1 (1) = ND_VTS_040_KT_PT1
Alias Therm_TempA_1 (2) = ND_VTS_040_KT_PT2
Alias Therm_TempA_1 (3) = ND_VTS_040_KT_PT3
Alias Therm_TempA_1 (4) = ND_VTS_040_KT_PT4
Alias Therm_TempA_1 (5) = ND_VTS_040_KT_PT5
Alias Therm_TempA_1 (6) = ND_VTS_040_KT_PT6
Alias Therm_TempA_1 (7) = ND_VTS_040_KT_PT7
Alias Therm_TempA_1 (8) = ND_VTS_040_KT_PT8
Alias Therm_TempA_1 (9) = ND_VTS_040_KT_PT9
Alias Therm_TempA_1 (10) = ND_VTS_040_KT_PT10
Alias Therm_TempA_1 (11) = ND_VTS_040_KT_PT11

Alias Therm_TempA_1 (13) = ND_HTS_040_315_PT1
Alias Therm_TempA_1 (14) = ND_HTS_040_315_PT2
Alias Therm_TempA_1 (15) = ND_HTS_040_315_PT3
Alias Therm_TempA_1 (16) = ND_HTS_040_315_PT4
Alias Therm_TempA_1 (17) = ND_HTS_040_315_PT5
Alias Therm_TempA_1 (18) = ND_HTS_040_315_PT6
Alias Therm_TempA_1 (19) = ND_HTS_040_315_PT7
Alias Therm_TempA_1 (20) = ND_HTS_040_315_PT8
Alias Therm_TempA_1 (21) = ND_HTS_040_315_PT9
Alias Therm_TempA_1 (22) = ND_HTS_040_315_PT10

Alias Therm_TempA_1 (25) = ND_HTS_040_335_PT1
Alias Therm_TempA_1 (26) = ND_HTS_040_335_PT2
Alias Therm_TempA_1 (27) = ND_HTS_040_335_PT3
Alias Therm_TempA_1 (28) = ND_HTS_040_335_PT4
Alias Therm_TempA_1 (29) = ND_HTS_040_335_PT5
Alias Therm_TempA_1 (30) = ND_HTS_040_335_PT6
Alias Therm_TempA_1 (31) = ND_HTS_040_335_PT7
Alias Therm_TempA_1 (32) = ND_HTS_040_335_PT8

Alias Therm_TempB_2 (1) = ND_VTS_060_KT_PT1
```

Alias Therm_TempB_2 (2) = ND_VTS_060_KT_PT2
Alias Therm_TempB_2 (3) = ND_VTS_060_KT_PT3
Alias Therm_TempB_2 (4) = ND_VTS_060_KT_PT4
Alias Therm_TempB_2 (5) = ND_VTS_060_KT_PT5
Alias Therm_TempB_2 (6) = ND_VTS_060_KT_PT6
Alias Therm_TempB_2 (7) = ND_VTS_060_KT_PT7
Alias Therm_TempB_2 (8) = ND_VTS_060_KT_PT8
Alias Therm_TempB_2 (9) = ND_VTS_060_KT_PT9
Alias Therm_TempB_2 (10) = ND_VTS_060_KT_PT10
Alias Therm_TempB_2 (11) = ND_VTS_060_KT_PT11

Alias Therm_TempB_2 (13) = ND_VTS_060_DS_PT1
Alias Therm_TempB_2 (14) = ND_VTS_060_DS_PT2
Alias Therm_TempB_2 (15) = ND_VTS_060_DS_PT3
Alias Therm_TempB_2 (16) = ND_VTS_060_DS_PT4
Alias Therm_TempB_2 (17) = ND_VTS_060_DS_PT5
Alias Therm_TempB_2 (18) = ND_VTS_060_DS_PT6
Alias Therm_TempB_2 (19) = ND_VTS_060_DS_PT7
Alias Therm_TempB_2 (20) = ND_VTS_060_DS_PT8
Alias Therm_TempB_2 (21) = ND_VTS_060_DS_PT9
Alias Therm_TempB_2 (22) = ND_VTS_060_DS_PT10
Alias Therm_TempB_2 (23) = ND_VTS_060_DS_PT11

Alias Therm_TempB_2 (25) = ND_HTS_060_288_PT1
Alias Therm_TempB_2 (26) = ND_HTS_060_288_PT2
Alias Therm_TempB_2 (27) = ND_HTS_060_288_PT3
Alias Therm_TempB_2 (28) = ND_HTS_060_288_PT4
Alias Therm_TempB_2 (29) = ND_HTS_060_288_PT5
Alias Therm_TempB_2 (30) = ND_HTS_060_288_PT6
Alias Therm_TempB_2 (31) = ND_HTS_060_288_PT7
Alias Therm_TempB_2 (32) = ND_HTS_060_288_PT8
Alias Therm_TempB_2 (33) = ND_HTS_060_288_PT9
Alias Therm_TempB_2 (34) = ND_HTS_060_288_PT10

Alias Therm_TempB_3 (1) = ND_VTS_060_US_PT1
Alias Therm_TempB_3 (2) = ND_VTS_060_US_PT2
Alias Therm_TempB_3 (3) = ND_VTS_060_US_PT3
Alias Therm_TempB_3 (4) = ND_VTS_060_US_PT4
Alias Therm_TempB_3 (5) = ND_VTS_060_US_PT5
Alias Therm_TempB_3 (6) = ND_VTS_060_US_PT6
Alias Therm_TempB_3 (7) = ND_VTS_060_US_PT7
Alias Therm_TempB_3 (8) = ND_VTS_060_US_PT8
Alias Therm_TempB_3 (9) = ND_VTS_060_US_PT9
Alias Therm_TempB_3 (10) = ND_VTS_060_US_PT10
Alias Therm_TempB_3 (11) = ND_VTS_060_US_PT11

Alias Therm_TempB_3 (13) = ND_HTS_060_310_PT1
Alias Therm_TempB_3 (14) = ND_HTS_060_310_PT2
Alias Therm_TempB_3 (15) = ND_HTS_060_310_PT3
Alias Therm_TempB_3 (16) = ND_HTS_060_310_PT4
Alias Therm_TempB_3 (17) = ND_HTS_060_310_PT5
Alias Therm_TempB_3 (18) = ND_HTS_060_310_PT6
Alias Therm_TempB_3 (19) = ND_HTS_060_310_PT7
Alias Therm_TempB_3 (20) = ND_HTS_060_310_PT8

Alias Therm_TempB_3 (22) = ND_HTS_060_335_PT1

Alias Therm_TempB_3 (23) = ND_HTS_060_335_PT2
Alias Therm_TempB_3 (24) = ND_HTS_060_335_PT3
Alias Therm_TempB_3 (25) = ND_HTS_060_335_PT4
Alias Therm_TempB_3 (26) = ND_HTS_060_335_PT5
Alias Therm_TempB_3 (27) = ND_HTS_060_335_PT6
Alias Therm_TempB_3 (28) = ND_HTS_060_335_PT7
Alias Therm_TempB_3 (29) = ND_HTS_060_335_PT8

Alias Therm_TempC_4 (1) = ND_VTS_085_KT_PT1
Alias Therm_TempC_4 (2) = ND_VTS_085_KT_PT2
Alias Therm_TempC_4 (3) = ND_VTS_085_KT_PT3
Alias Therm_TempC_4 (4) = ND_VTS_085_KT_PT4
Alias Therm_TempC_4 (5) = ND_VTS_085_KT_PT5
Alias Therm_TempC_4 (6) = ND_VTS_085_KT_PT6
Alias Therm_TempC_4 (7) = ND_VTS_085_KT_PT7
Alias Therm_TempC_4 (8) = ND_VTS_085_KT_PT8
Alias Therm_TempC_4 (9) = ND_VTS_085_KT_PT9
Alias Therm_TempC_4 (10) = ND_VTS_085_KT_PT10
Alias Therm_TempC_4 (11) = ND_VTS_085_KT_PT11

Alias Therm_TempC_4 (13) = ND_VTS_085_US_PT1
Alias Therm_TempC_4 (14) = ND_VTS_085_US_PT2
Alias Therm_TempC_4 (15) = ND_VTS_085_US_PT3
Alias Therm_TempC_4 (16) = ND_VTS_085_US_PT4
Alias Therm_TempC_4 (17) = ND_VTS_085_US_PT5
Alias Therm_TempC_4 (18) = ND_VTS_085_US_PT6
Alias Therm_TempC_4 (19) = ND_VTS_085_US_PT7
Alias Therm_TempC_4 (20) = ND_VTS_085_US_PT8
Alias Therm_TempC_4 (21) = ND_VTS_085_US_PT9
Alias Therm_TempC_4 (22) = ND_VTS_085_US_PT10
Alias Therm_TempC_4 (23) = ND_VTS_085_US_PT11

Alias Therm_TempC_4 (25) = ND_VTS_085_DS_PT1
Alias Therm_TempC_4 (26) = ND_VTS_085_DS_PT2
Alias Therm_TempC_4 (27) = ND_VTS_085_DS_PT3
Alias Therm_TempC_4 (28) = ND_VTS_085_DS_PT4
Alias Therm_TempC_4 (29) = ND_VTS_085_DS_PT5
Alias Therm_TempC_4 (30) = ND_VTS_085_DS_PT6
Alias Therm_TempC_4 (31) = ND_VTS_085_DS_PT7
Alias Therm_TempC_4 (32) = ND_VTS_085_DS_PT8
Alias Therm_TempC_4 (33) = ND_VTS_085_DS_PT9
Alias Therm_TempC_4 (34) = ND_VTS_085_DS_PT10
Alias Therm_TempC_4 (35) = ND_VTS_085_DS_PT11

Alias Therm_TempC_5 (1) = ND_HTS_085_253_PT1
Alias Therm_TempC_5 (2) = ND_HTS_085_253_PT2
Alias Therm_TempC_5 (3) = ND_HTS_085_253_PT3
Alias Therm_TempC_5 (4) = ND_HTS_085_253_PT4
Alias Therm_TempC_5 (5) = ND_HTS_085_253_PT5
Alias Therm_TempC_5 (6) = ND_HTS_085_253_PT6
Alias Therm_TempC_5 (7) = ND_HTS_085_253_PT7
Alias Therm_TempC_5 (8) = ND_HTS_085_253_PT8
Alias Therm_TempC_5 (9) = ND_HTS_085_253_PT9
Alias Therm_TempC_5 (10) = ND_HTS_085_253_PT10
Alias Therm_TempC_5 (11) = ND_HTS_085_253_PT11
Alias Therm_TempC_5 (12) = ND_HTS_085_253_PT12

```
Alias Therm_TempC_5 (13) = ND_HTS_085_253_PT13
Alias Therm_TempC_5 (14) = ND_HTS_085_253_PT14
Alias Therm_TempC_5 (15) = ND_HTS_085_253_PT15

Alias Therm_TempC_5 (16) = ND_HTS_085_294_PT1
Alias Therm_TempC_5 (17) = ND_HTS_085_294_PT2
Alias Therm_TempC_5 (18) = ND_HTS_085_294_PT3
Alias Therm_TempC_5 (19) = ND_HTS_085_294_PT4
Alias Therm_TempC_5 (20) = ND_HTS_085_294_PT5
Alias Therm_TempC_5 (21) = ND_HTS_085_294_PT6
Alias Therm_TempC_5 (22) = ND_HTS_085_294_PT7
Alias Therm_TempC_5 (23) = ND_HTS_085_294_PT8
Alias Therm_TempC_5 (24) = ND_HTS_085_294_PT9
Alias Therm_TempC_5 (25) = ND_HTS_085_294_PT10

Alias Therm_TempC_5 (28) = ND_HTS_085_335_PT1
Alias Therm_TempC_5 (29) = ND_HTS_085_335_PT2
Alias Therm_TempC_5 (30) = ND_HTS_085_335_PT3
Alias Therm_TempC_5 (31) = ND_HTS_085_335_PT4
Alias Therm_TempC_5 (32) = ND_HTS_085_335_PT5
Alias Therm_TempC_5 (33) = ND_HTS_085_335_PT6
Alias Therm_TempC_5 (34) = ND_HTS_085_335_PT7
Alias Therm_TempC_5 (35) = ND_HTS_085_335_PT8

'=========================================================================
'- - - - - - - - - - - - - - - Declare Constants - - - - - - - - - - - - - -
'=========================================================================

' Thermistor constants 3000Ohm @ 25C thermistor
Const ConstC0 = 0.0014051
Const ConstC1 = 0.0002369
Const ConstC2 = 0.0000001019

'=========================================================================
'- - - - - - - - - - - - - - - Data Tables - - - - - - - - - - - - - - - - -
'=========================================================================
'Define Data Tables

DataTable (StationStatus,1,-1)
  DataInterval (0,6,hr,10)
  CardOut (0, -1000)
  Minimum (1,batt_volt,FP2,0,False)
  Sample (1,PTemp,FP2)
EndTable

DataTable (Daily_Samples,1,-1)
  DataInterval (0,6,hr,10)
  CardOut (0,-1000)

  Sample (11,ND_VTS_040_KT_PT1,FP2)
  Sample (10,ND_HTS_040_315_PT1,FP2)
  Sample (8,ND_HTS_040_335_PT1,FP2)

  Sample (11,ND_VTS_060_KT_PT1,FP2)
  Sample (11,ND_VTS_060_DS_PT1,FP2)
  Sample (10,ND_HTS_060_288_PT1,FP2)
```

```
  Sample (11,ND_VTS_060_US_PT1,FP2)
  Sample (8,ND_HTS_060_310_PT1,FP2)
  Sample (8,ND_HTS_060_335_PT1,FP2)

  Sample (11,ND_VTS_085_KT_PT1,FP2)
  Sample (11,ND_VTS_085_US_PT1,FP2)
  Sample (11,ND_VTS_085_DS_PT1,FP2)

  Sample (15,ND_HTS_085_253_PT1,FP2)
  Sample (10,ND_HTS_085_294_PT1,FP2)
  Sample (8,ND_HTS_085_335_PT1,FP2)

EndTable


'===============================================================================
'- - - - - - - - - - - - - - - Main Program - - - - - - - - - - - - - - - -
'===============================================================================
BeginProg
  Scan (6,hr,0,0)' 4 times daily, at midnight, 6AM, noon, 6PM
    PanelTemp (PTemp,_60Hz)
    Battery (batt_volt)
    If TimeIntoInterval (0,6,hr)
      '---------------------
      PortSet (1,1)'Turn On Node A_1 Multiplexer
      Delay (0,150,msec)
      PulsePort (2,10000)
      'Multiplexer A_1
      'Measurement conversions for Multiplexer A_1
      'Calculate resistance for 32 thermistors
      For Index = 1 To 36
        BrHalf (Therm_mV_A_1(Index),3,mv2500C,1,Vx1,3,2500,True ,20000,_60Hz,1.0,0)
        Index=Index+2
        PulsePort (2,10000)
      Next
      PortSet (1,0)
      'Multiplexer C_5
      'Measurement conversions for Multiplexer C_5
      'Calculate resistance for 35 thermistors
      PortSet (1,1)'Turn On Node Node C_5 Multiplexer
      Delay (0,150,msec)
      PulsePort (2,10000)
      For Index5 = 1 To 36
        BrHalf (Therm_mV_C_5(Index5),3,mv2500C,13,Vx3,3,2500,True ,20000,_60Hz,1.0,0)
        Index5=Index5+2
        PulsePort (2,10000)
      Next
      PortSet (1,0)
      'Turn Off Node A_1 and Node C_5 Multiplexer
      '---------------------
      PortSet (3,1)'Turn On Node B_2 Multiplexer
      Delay (0,150,msec)
      PulsePort (4,10000)
      'Multiplexer B_2
      'Measurement conversions for Multiplexer B_2
```

```
    'Calculate resistance for 33 thermistors
    For Index2 = 1 To 36
      BrHalf (Therm_mV_B_2(Index2),3,mv2500C,4,Vx1,3,2500,True ,20000,_60Hz,1.0,0)
      Index2=Index2+2
      PulsePort (4,10000)
    Next
    PortSet (3,0)'Turn Off Node B_2 Multiplexer
    '---------------------
    PortSet (5,1)'Turn On Node B_3 Multiplexer
    Delay (0,150,msec)
    PulsePort (6,10000)
    'Multiplexer B_3
    'Measurement conversions for Multiplexer B_3
    'Calculate resistance for 33 thermistors
    For Index3 = 1 To 30
      BrHalf (Therm_mV_B_3(Index3),3,mv2500C,7,Vx2,3,2500,True ,20000,_60Hz,1.0,0)
      Index3=Index3+2
      PulsePort (6,10000)
    Next
    PortSet (5,0)'Turn Off Node B_3 Multiplexer
    '---------------------
    PortSet (7,1)'Turn On Node C_4 Multiplexer
    Delay (0,150,msec)
    PulsePort (8,10000)
    'Multiplexer B_3
    'Measurement conversions for Multiplexer B_3
    'Calculate resistance for 33 thermistors
    For Index4 = 1 To 36
      BrHalf (Therm_mV_C_4(Index4),3,mv2500C,10,Vx2,3,2500,True ,20000,_60Hz,1.0,0)
      Index4=Index4+2
      PulsePort (8,10000)
    Next
    PortSet (7,0)'Turn Off Node C_4 Multiplexer

    '------------------------------------------

    'Measurement conversions for Multiplexer A_1
    For Index = 1 To 32
      ' Calculate resistance using equation : Rt = 10000*(1-Therm_mV(n))/Therm_mV(n)
      Therm_ResA_1(Index) = 10000*(1-Therm_mV_A_1(Index))/Therm_mV_A_1(Index)
      If Therm_ResA_1(Index) > 1000000 OR Therm_ResA_1(Index) <0 Then Therm_ResA_1(Index) = 0
      'Calculate temperature of 35 thermistors using the steinhart-hart equation
      Therm_TempA_1(Index) =
1/(ConstC0+ConstC1*LN(Therm_ResA_1(Index))+ConstC2*(LN(Therm_ResA_1(Index))^3))-273.15
    Next

    'Measurement conversions for Multiplexer B_2
    For Index2 = 1 To 34
      ' Calculate resistance using equation : Rt = 10000*(1-Therm_mV(n))/Therm_mV(n)
      Therm_ResB_2(Index2) = 10000*(1-Therm_mV_B_2(Index2))/Therm_mV_B_2(Index2)
      If Therm_ResB_2(Index2) > 1000000 OR Therm_ResB_2(Index2) < 0 Then Therm_ResB_2(Index2) = 0
      'Calculate temperature of 35 thermistors using the steinhart-hart equation
      Therm_TempB_2(Index2) =
1/(ConstC0+ConstC1*LN(Therm_ResB_2(Index2))+ConstC2*(LN(Therm_ResB_2(Index2))^3))-273.15
    Next
```

```
    'Measurement conversions for Multiplexer B_3
    For Index3 = 1 To 29
      ' Calculate resistance using equation : Rt = 10000*(1-Therm_mV(n))/Therm_mV(n)
      Therm_ResB_3(Index3) = 10000*(1-Therm_mV_B_3(Index3))/Therm_mV_B_3(Index3)
      If Therm_ResB_3(Index3) > 1000000 OR Therm_ResB_3(Index3) < 0 Then Therm_ResB_3(Index3) = 0

      'Calculate temperature of 35 thermistors using the steinhart-hart equation
      Therm_TempB_3(Index3) =
1/(ConstC0+ConstC1*LN(Therm_ResB_3(Index3))+ConstC2*(LN(Therm_ResB_3(Index3))^3))-273.15
    Next

    'Measurement conversions for Multiplexer C_4
    For Index4 = 1 To 35
      ' Calculate resistance using equation : Rt = 10000*(1-Therm_mV(n))/Therm_mV(n)
      Therm_ResC_4(Index4) = 10000*(1-Therm_mV_C_4(Index4))/Therm_mV_C_4(Index4)
      If Therm_ResC_4(Index4) > 1000000 OR Therm_ResC_4(Index4) < 0 Then Therm_ResC_4(Index4) = 0
      'Calculate temperature of 35 thermistors using the steinhart-hart equation
      Therm_TempC_4(Index4) =
1/(ConstC0+ConstC1*LN(Therm_ResC_4(Index4))+ConstC2*(LN(Therm_ResC_4(Index4))^3))-273.15
    Next

    'Measurement conversions for Multiplexer C_5
    For Index5 = 1 To 35
      ' Calculate resistance using equation : Rt = 10000*(1-Therm_mV(n))/Therm_mV(n)
      Therm_ResC_5(Index5) = 10000*(1-Therm_mV_C_5(Index5))/Therm_mV_C_5(Index5)
      If Therm_ResC_5(Index5) > 1000000 OR Therm_ResC_5(Index5) < 0 Then Therm_ResC_5(Index5) = 0
      'Calculate temperature of 35 thermistors using the steinhart-hart equation
      Therm_TempC_5(Index5) =
1/(ConstC0+ConstC1*LN(Therm_ResC_5(Index5))+ConstC2*(LN(Therm_ResC_5(Index5))^3))-273.15
    Next

    CallTable (Daily_Samples)
    CallTable (StationStatus)
  EndIf
 NextScan
EndProg
```

```
'CR1000 Series Datalogger

'Company: SRK Consulting / Nuna Logistics
'Contact: SRK: Iozsef Miskolczi

'Program overview: CR1000 #2 Station program
'This program will take themperature measurements on a dam located
'on Hope bay, Nunavut.
' Data will be stored on a compact flash card once every 6 hours

'********************************************************
'Program author: Mike Ryder - Sales & Technical Support

'Campbell Scientific (Canada) Corp.
'11564 - 149 Street NW
'Edmonton, AB T5M 1W7
'Canada

'Main Phone: 780-454-2505
'Direct Number: 780-733-8214
'Fax: 780-454-2655
'Email: Mike.Ryder@campbellsci.ca
'General Email: dataloggers@campbellsci.ca
'Web Site: www.campbellsci.ca
'********************************************************
'=========================================================================
'- - - - - - - - - - - - - - - CR1000 Wiring - - - - - - - - - - - - - - - -
'=========================================================================

'=========================================================================
'- - - - - - - - - - - - - - - Variables - - - - - - - - - - - - - - - - - -
'=========================================================================

Public PTemp
Public batt_volt

Public Therm_ResD_6 (36)
Public Therm_mV_D_6 (36)
Public Therm_TempD_6 (36)

Public Therm_ResD_7 (30)
Public Therm_mV_D_7 (30)
Public Therm_TempD_7 (30)

Public Therm_ResE_8 (30)
Public Therm_mV_E_8 (30)
Public Therm_TempE_8 (30)

Public Therm_109 (12)

Dim Index
Dim Index2
Dim Index3
Dim Index4

StationName (HB_NorthDam_CR1000_#2)
```

```
'=============================================================================
'- - - - - - - - - - - - - - - Variable aliases - - - - - - - - - - - - - -
'=============================================================================

Alias Therm_TempD_6 (1) = ND_VTS_130_KT_PT1
Alias Therm_TempD_6 (2) = ND_VTS_130_KT_PT2
Alias Therm_TempD_6 (3) = ND_VTS_130_KT_PT3
Alias Therm_TempD_6 (4) = ND_VTS_130_KT_PT4
Alias Therm_TempD_6 (5) = ND_VTS_130_KT_PT5
Alias Therm_TempD_6 (6) = ND_VTS_130_KT_PT6
Alias Therm_TempD_6 (7) = ND_VTS_130_KT_PT7
Alias Therm_TempD_6 (8) = ND_VTS_130_KT_PT8
Alias Therm_TempD_6 (9) = ND_VTS_130_KT_PT9
Alias Therm_TempD_6 (10) = ND_VTS_130_KT_PT10
Alias Therm_TempD_6 (11) = ND_VTS_130_KT_PT11

Alias Therm_TempD_6 (13) = ND_VTS_130_US_PT1
Alias Therm_TempD_6 (14) = ND_VTS_130_US_PT2
Alias Therm_TempD_6 (15) = ND_VTS_130_US_PT3
Alias Therm_TempD_6 (16) = ND_VTS_130_US_PT4
Alias Therm_TempD_6 (17) = ND_VTS_130_US_PT5
Alias Therm_TempD_6 (18) = ND_VTS_130_US_PT6
Alias Therm_TempD_6 (19) = ND_VTS_130_US_PT7
Alias Therm_TempD_6 (20) = ND_VTS_130_US_PT8
Alias Therm_TempD_6 (21) = ND_VTS_130_US_PT9
Alias Therm_TempD_6 (22) = ND_VTS_130_US_PT10
Alias Therm_TempD_6 (23) = ND_VTS_130_US_PT11

Alias Therm_TempD_6 (25) = ND_VTS_130_DS_PT1
Alias Therm_TempD_6 (26) = ND_VTS_130_DS_PT2
Alias Therm_TempD_6 (27) = ND_VTS_130_DS_PT3
Alias Therm_TempD_6 (28) = ND_VTS_130_DS_PT4
Alias Therm_TempD_6 (29) = ND_VTS_130_DS_PT5
Alias Therm_TempD_6 (30) = ND_VTS_130_DS_PT6
Alias Therm_TempD_6 (31) = ND_VTS_130_DS_PT7
Alias Therm_TempD_6 (32) = ND_VTS_130_DS_PT8
Alias Therm_TempD_6 (33) = ND_VTS_130_DS_PT9
Alias Therm_TempD_6 (34) = ND_VTS_130_DS_PT10
Alias Therm_TempD_6 (35) = ND_VTS_130_DS_PT11

Alias Therm_TempD_7 (1) = ND_HTS_130_288_PT1
Alias Therm_TempD_7 (2) = ND_HTS_130_288_PT2
Alias Therm_TempD_7 (3) = ND_HTS_130_288_PT3
Alias Therm_TempD_7 (4) = ND_HTS_130_288_PT4
Alias Therm_TempD_7 (5) = ND_HTS_130_288_PT5
Alias Therm_TempD_7 (6) = ND_HTS_130_288_PT6
Alias Therm_TempD_7 (7) = ND_HTS_130_288_PT7
Alias Therm_TempD_7 (8) = ND_HTS_130_288_PT8
Alias Therm_TempD_7 (9) = ND_HTS_130_288_PT9
Alias Therm_TempD_7 (10) = ND_HTS_130_288_PT10

Alias Therm_TempD_7 (13) = ND_HTS_130_310_PT1
Alias Therm_TempD_7 (14) = ND_HTS_130_310_PT2
Alias Therm_TempD_7 (15) = ND_HTS_130_310_PT3
Alias Therm_TempD_7 (16) = ND_HTS_130_310_PT4
```

Alias Therm_TempD_7 (17) = ND_HTS_130_310_PT5
Alias Therm_TempD_7 (18) = ND_HTS_130_310_PT6
Alias Therm_TempD_7 (19) = ND_HTS_130_310_PT7
Alias Therm_TempD_7 (20) = ND_HTS_130_310_PT8

Alias Therm_TempD_7 (22) = ND_HTS_130_335_PT1
Alias Therm_TempD_7 (23) = ND_HTS_130_335_PT2
Alias Therm_TempD_7 (24) = ND_HTS_130_335_PT3
Alias Therm_TempD_7 (25) = ND_HTS_130_335_PT4
Alias Therm_TempD_7 (26) = ND_HTS_130_335_PT5
Alias Therm_TempD_7 (27) = ND_HTS_130_335_PT6
Alias Therm_TempD_7 (28) = ND_HTS_130_335_PT7
Alias Therm_TempD_7 (29) = ND_HTS_130_335_PT8

Alias Therm_TempE_8 (1) = ND_VTS_175_KT_PT1
Alias Therm_TempE_8 (2) = ND_VTS_175_KT_PT2
Alias Therm_TempE_8 (3) = ND_VTS_175_KT_PT3
Alias Therm_TempE_8 (4) = ND_VTS_175_KT_PT4
Alias Therm_TempE_8 (5) = ND_VTS_175_KT_PT5
Alias Therm_TempE_8 (6) = ND_VTS_175_KT_PT6
Alias Therm_TempE_8 (7) = ND_VTS_175_KT_PT7
Alias Therm_TempE_8 (8) = ND_VTS_175_KT_PT8
Alias Therm_TempE_8 (9) = ND_VTS_175_KT_PT9
Alias Therm_TempE_8 (10) = ND_VTS_175_KT_PT10
Alias Therm_TempE_8 (11) = ND_VTS_175_KT_PT11

Alias Therm_TempE_8 (13) = ND_HTS_175_325_PT1
Alias Therm_TempE_8 (14) = ND_HTS_175_325_PT2
Alias Therm_TempE_8 (15) = ND_HTS_175_325_PT3
Alias Therm_TempE_8 (16) = ND_HTS_175_325_PT4
Alias Therm_TempE_8 (17) = ND_HTS_175_325_PT5
Alias Therm_TempE_8 (18) = ND_HTS_175_325_PT6
Alias Therm_TempE_8 (19) = ND_HTS_175_325_PT7
Alias Therm_TempE_8 (20) = ND_HTS_175_325_PT8
Alias Therm_TempE_8 (21) = ND_HTS_175_325_PT9

Alias Therm_TempE_8 (22) = ND_HTS_175_335_PT1
Alias Therm_TempE_8 (23) = ND_HTS_175_335_PT2
Alias Therm_TempE_8 (24) = ND_HTS_175_335_PT3
Alias Therm_TempE_8 (25) = ND_HTS_175_335_PT4
Alias Therm_TempE_8 (26) = ND_HTS_175_335_PT5
Alias Therm_TempE_8 (27) = ND_HTS_175_335_PT6
Alias Therm_TempE_8 (28) = ND_HTS_175_335_PT7
Alias Therm_TempE_8 (29) = ND_HTS_175_335_PT8

Alias Therm_109 (1)= South_31
Alias Therm_109 (2)= South_32
Alias Therm_109 (3)= South_33
Alias Therm_109 (4)= South_34
Alias Therm_109 (5)= South_35
Alias Therm_109 (6)= South_36
Alias Therm_109 (7)= North_1
Alias Therm_109 (8)= North_2
Alias Therm_109 (9)= North_3
Alias Therm_109 (10)= North_4
Alias Therm_109 (11)= North_5

```
Alias  Therm_109 (12)= North_6
'==============================================================================
'- - - - - - - - - - - - - - - Units - - - - - - - - - - - - - - - - - -
'==============================================================================

'==============================================================================
'- - - - - - - - - - - - - - - Declare Constants - - - - - - - - - - - - - -
'==============================================================================

' Thermistor constants 3000Ohm @ 25C thermistor
Const ConstC0 = 0.0014051
Const ConstC1 = 0.0002369
Const ConstC2 = 0.0000001019

'==============================================================================
'- - - - - - - - - - - - - - - Data Tables - - - - - - - - - - - - - - - - -
'==============================================================================
'Define Data Tables

DataTable (StationStatus,1,-1)
 DataInterval (0,6,Hr,10)
  CardOut (0 ,-1000)
  Minimum (1,batt_volt,FP2,0,False)
  Sample (1,PTemp,FP2)
EndTable

DataTable (Daily_Samples,1,-1)
  DataInterval (0,6,Hr,10)
  CardOut (0, -1000)

  Sample (11,ND_VTS_130_KT_PT1,FP2)
  Sample (11,ND_VTS_130_US_PT1,FP2)
  Sample (11,ND_VTS_130_DS_PT1,FP2)

  Sample (10,ND_HTS_130_288_PT1,FP2)
  Sample (8,ND_HTS_130_310_PT1,FP2)
  Sample (8,ND_HTS_130_335_PT1,FP2)

  Sample (11,ND_VTS_175_KT_PT1,FP2)
  Sample (9,ND_HTS_175_325_PT1,FP2)
  Sample (8,ND_HTS_175_335_PT1,FP2)

  Sample (12,Therm_109(),FP2)
EndTable


'==============================================================================
'- - - - - - - - - - - - - - - Main Program - - - - - - - - - - - - - - - -
'==============================================================================
BeginProg
  Scan (6,hr,0,0)' 4 times daily at midnight, 6AM, noon, 6 PM
    PanelTemp (PTemp,_60Hz)
    Battery (batt_volt)
   If TimeIntoInterval(0,6,hr)
      'Mutliplexer in 4x16 mode
      'Turn on all AM16/32B-XT multiplexers
```

```
PortSet (1,1)'Node D_6

Delay (0,150,msec)
PulsePort (2,10000)
'Multiplexer D_6
' measurement conversions for Multiplexer D_6
'Calculate resistance for 33 thermistors
For Index = 1 To 36
  BrHalf (Therm_mV_D_6(Index),3,mv2500C,1,Vx1,3,2500,True ,20000,_60Hz,1.0,0)
  Index=Index+2
  PulsePort (2,10000)
Next
PortSet (1,0)

'Multiplexer D_7
PortSet (3,1) 'Node D_7
Delay (0,150,msec)
PulsePort (4,10000)
For Index2 = 1 To 30
  BrHalf (Therm_mV_D_7(Index2),3,mv2500C,4,Vx1,3,2500,True ,20000,_60Hz,1.0,0)
  Index2=Index2+2
  PulsePort (4,10000)
Next
PortSet (3,0)

'Multiplexer E_8
PortSet (5,1) 'Node E_8
Delay (0,150,msec)
PulsePort (6,10000)
For Index3 = 1 To 30
  BrHalf (Therm_mV_E_8(Index3),3,mv2500C,7,Vx2,3,2500,True ,20000,_60Hz,1.0,0)
  Index3=Index3+2
  PulsePort (6,10000)
Next
PortSet (5,0)

'Multiplexer E_9 (109 thermistors)
PortSet (7,1) ' Node E_9
Delay (0,150,msec)
PulsePort (8,10000)
For Index4 = 1 To 12
  Therm109 (Therm_109 (Index4),1,10,Vx3,20000,_60Hz,1.0,0)
  PulsePort (8,10000)
Next
PortSet (7,0)


For Index = 1 To 35
  ' Calculate resistance using equation : Rt = 10000*(1-Therm_mV(n))/Therm_mV(n)
  Therm_ResD_6(Index) = 10000*(1-Therm_mV_D_6(Index))/Therm_mV_D_6(Index)
  If Therm_ResD_6(Index) > 1000000 OR Therm_ResD_6(Index) <0 Then Therm_ResD_6(Index) = 0
  Therm_TempD_6(Index) =
1/(ConstC0+ConstC1*LN(Therm_ResD_6(Index))+ConstC2*(LN(Therm_ResD_6(Index))^3))-273.15
Next

' Measurement conversions for Multiplexer D_7
```

```
    For Index2 = 1 To 29
      ' Calculate resistance using equation : Rt = 10000*(1-Therm_mV(n))/Therm_mV(n)
      Therm_ResD_7(Index2) = 10000*(1-Therm_mV_D_7(Index2))/Therm_mV_D_7(Index2)
      If Therm_ResD_7(Index2) > 1000000 OR Therm_ResD_7(Index2) < 0 Then
Therm_ResD_7(Index2) = 0
      Therm_TempD_7(Index2) =
1/(ConstC0+ConstC1*LN(Therm_ResD_7(Index2))+ConstC2*(LN(Therm_ResD_7(Index2))^3))-273.15
    Next

    ' Measurement conversions for Multiplexer E_8
    For Index3 = 1 To 29
      ' Calculate resistance using equation : Rt = 10000*(1-Therm_mV(n))/Therm_mV(n)
      Therm_ResE_8(Index3) = 10000*(1-Therm_mV_E_8(Index3))/Therm_mV_E_8(Index3)
      If Therm_ResE_8(Index3) > 1000000 OR Therm_ResE_8(Index3) < 0 Then Therm_ResE_8(Index3)
= 0
      Therm_TempE_8(Index3) =
1/(ConstC0+ConstC1*LN(Therm_ResE_8(Index3))+ConstC2*(LN(Therm_ResE_8(Index3))^3))-273.15
    Next


    CallTable (Daily_Samples)
    CallTable (StationStatus)

   EndIf
  NextScan
EndProg
```

Appendix D - Suggested Guidelines for Surveying at the North Dam

Suggested guidelines for surveying at the North Dam

Introduction

In the upcoming years, it is expected that at regular interval, monitoring surveys will take place at the North Dam. Various surveyors may be called up to do the work. Following those suggested guidelines will provide consistency in the data acquisition process.

Manpower & Time allocation

If the surveyor is flying to the mine site for the work, three days should be allocated for this work.

- Day one: Fly to site, orientation, equipment testing and calibration.
- Day two: Surveying, data processing.
- Day three: Final data preparation, packing of equipment and fly out.

Equipment and accessories

- Robotic total station and accessories, including barometer and thermometer.
- Back sight kit.
- Extensions for the mini prism for the surveying of the crest monitoring points.
- A source of light to shine into the casing for the surveying of the crest monitoring points.
- A transparent template with circles at 5mm increment to pin point exactly the center of the deep settlement points.

Metadata

There are five control points: ND1, ND2, ND3, ND4 and ND5. Each control point consists of 1 inch Hilti bolt with an approximate height of 15 centimeters (~ 6 inch) from ground. The control points at the North Dam were originally surveyed by GNSS method. Closed leveling loops were performed in 2012 (ND3-ND2) and 2013 (ND3-ND2-ND1). ND5 appears to be weak, being located on a large flat boulder, 2013 survey indicates that it could have shifted.

The data is grid. Scale factor at DN1 is 0.99965099.

Station set-up

For consistency from one survey to the next, the total station should set-up at control point ND1. From this station, all points to be surveyed are visible. Back sight point is ND4. Once the station set-up is completed, it is suggested to transfer the elevation to the total station from ND3. Most total stations have this capability (whether called elevation transfer, remote benchmark, etc). This method helps in reducing the error that could have been introduced in measuring the height of the station with a tape. Once the station is set-up is in orientation and elevation, a check shot on ND2 should be carried before commencing the monitoring surveys.

Surveying - general

As a minimum, each surveyed point should have face 1 and 2 observations. Taking measurements with both faces eliminate the following systematic errors of the total station:

- HZ collimation error
- Tilting axis error
- Compensator index error
- vertical index error

Once all points have been surveyed, if time allows, additional data should be obtained to confirm the observations. Should multiple prisms be used, it is recommended to use prisms that have the same prism constant. By doing so, the chances of introducing a prism constant error are reduced.

Conclusion

This document was simply prepared to help out the surveyor who will do the work. By following the same method in the station set-up as well as using the right coordinate system will help in providing reliable data to the engineering team.

Those guidelines were prepared for the scenario of having only one (1) surveyor allocated to the work. Should there be additional manpower, some of the work should also include traditional leveling method.

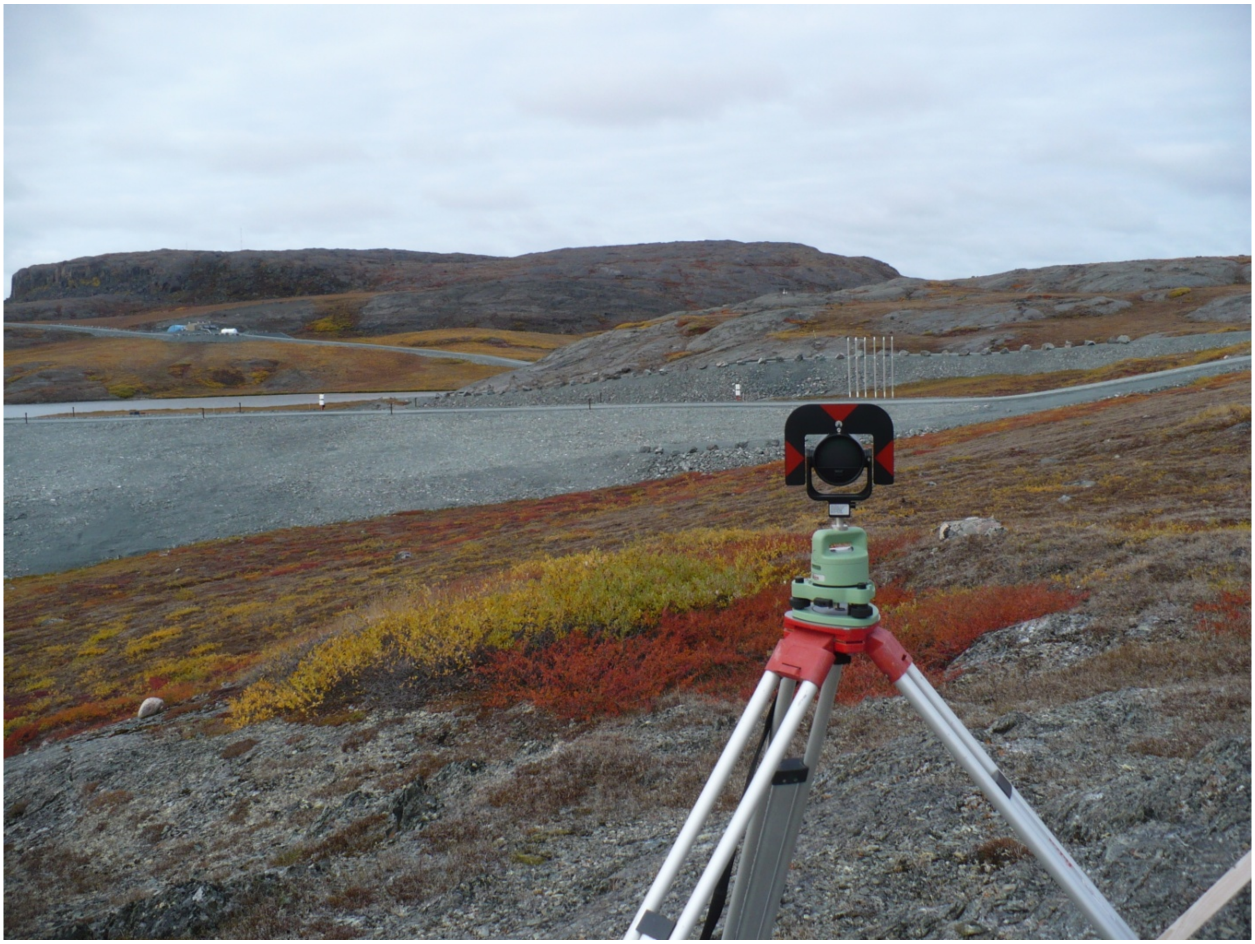
In the following pages are pictures and supplementary information for this work.

Prepared by:

Georges Cornelissen, C.E.T.
E-mail: gc@yk.com
Hopebay, Nunavut
September 10, 2013

A robotic total station kit

Station at ND1



Back sight at ND4

Control Point ND5

Note: Could be weak, not recommended to use for set-up.

Mini-prisms

Note: some points require greater than 40 cm height.

Consistent prism constants

Deep settlement point

Note: Placing a transparent template with circles at 5mm
Increment (example) would help to pin point
exactly the center of the deep settlement points.

View inside the casing of a crest monitoring point

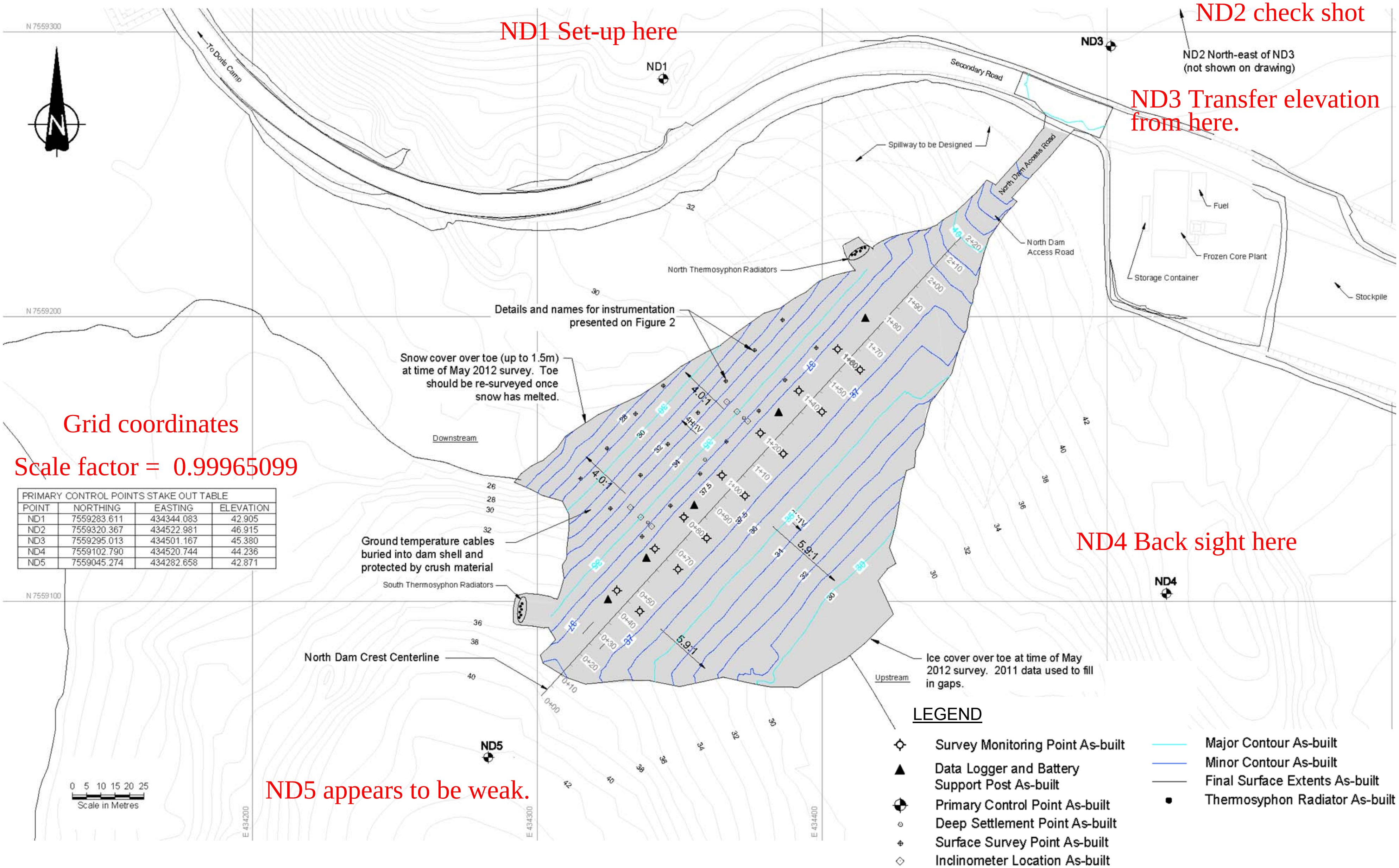
The surface survey points are constructed with same material as control points.

Please remember

The data is grid.

Scale factor at ND1 is 0.99965099.

J:\01_SITES\Hope.Bay\!ACAD\2013 Drawings\North Dam



PRIMARY CONTROL POINTS STAKE OUT TABLE			
POINT	NORTHING	EASTING	ELEVATION
ND1	7559283.611	434344.083	42.905
ND2	7559320.367	434522.981	46.915
ND3	7559295.013	434501.167	45.380
ND4	7559102.790	434520.744	44.236
ND5	7559045.274	434282.658	42.871

srk consulting

MAC RESOURCES

North Dam Monitoring SOP

North Dam General Arrangement and Primary Control Points

Job No:	1CT022.000	Hope Bay	Date: July 2013
Filename:	HopeBay_NorthDamMonitoringSOP_NodeFIGS_1CT022.000_im_jbk_20130709.pptx		Approved: IM / JBK
			Figure: 1

Appendix E - North Dam Visual Inspection / Checklist Form

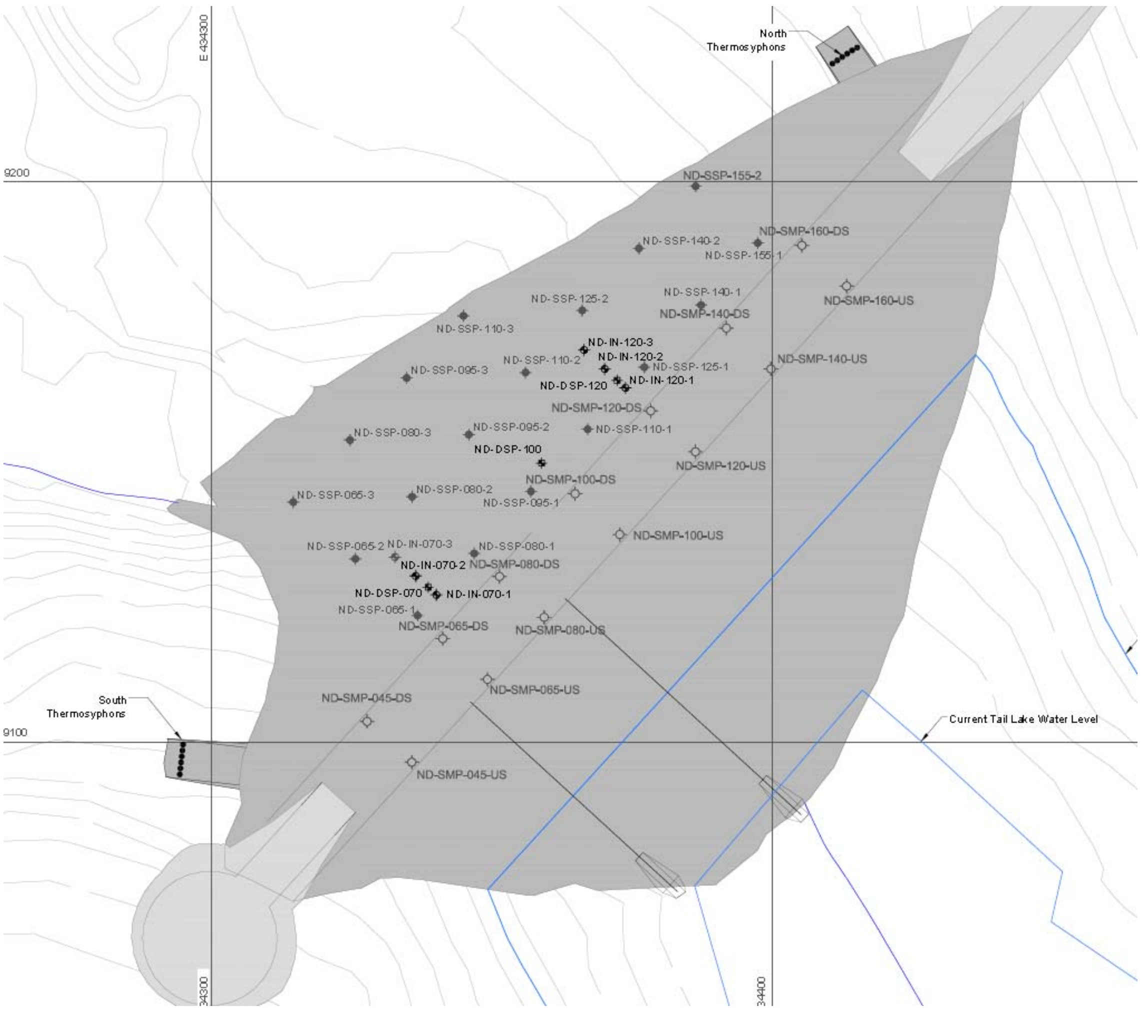
North Dam Weekly Walkover Survey Report

Date:	
Inspected By:	
Conditions:	(ie. snow on ground, clear)

Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	No
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	No
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	No
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	No
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	No
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	No
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	No
Suspended Sediment in the TIA (When not frozen)		
Any suspended sediment visible in the reclaim pond?	Yes	No
Water at the Toe of the Downstream Side of the Dam		
Is water visible on the downstream side of the dam?	Yes	No
If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.		

Please provide any other observations you have made


Photos:

Please collect the following photos:	
Photo from north end looking south along the dam	☐
Photo from south end looking north along the dam	☐
Other photos, please describe.	

Appendix F - TIA-2 Station Description

Memorandum

Refer to File: ERM Memo template.dotx

Date: October 30, 2017

To: John Roberts, Vice President, Environmental Affairs, TMAC Resources Inc. (TMAC); Oliver Curran, Director, Environmental Affairs (TMAC); Shelley Potter, Manager, Environment (TMAC)

From: Cameron Evans, E.I.T; Ali Naghibi, Ph.D, P.Eng., Erin Forster, B.Sc., R.P.Bio.

Cc: Peter Luedke (SRK)

Subject: **Hope Bay Project: TIA-2 Station Description**

1. INTRODUCTION

A permanent, year round, water level monitoring station was installed in the Hope Bay Project Tailings Impoundment Area (TIA) at location TIA-2 on September 28, 2017. The new monitoring station has become the primary level monitoring station for the TIA, with the existing levelogger station at the same location becoming the backup station. The existing station was also reinforced during September 2017 to further protect it during the under-ice season. Redundant stations are in place due to the importance of data collected in the TIA and the potential for damage, particularly during the winter season. The purpose of this memorandum is to describe the station location, equipment, and setup as well as management of data collected at the station.

2. STATION DESCRIPTIONS

2.1 Location

The water level monitoring station, TIA-2, is located at UTM 13W 434905 E, 7558709 N. The pressure transducers extend south from the end of the bedrock outcrop. The telemetry tripod and levelogger station box are located on the top of the ridge approximately 25 m from the water edge, at an approximate elevation of 37 meters above sea level (masl).

The station can be accessed by parking at the pullout on the TIA road at the bedrock outcrop just south of the pump house jetty, then walking south approximately 250 m.

2.2 Equipment

Two separate pressure transducers are set up at the TIA-2 location. A telemetry station was newly installed next to the existing levelogger station (Plates 1 to 3). The telemetry station is considered the primary station, with the levelogger acting as a backup in the event the telemetry station stops functioning.

2.2.1 TIA-2 Telemetry (Primary)

The telemetry station uses a 0-15 pounds per square inch (psi) vented PS9800 pressure transducer (Instrumentation Northwest Inc.) with a 125 m long cable, paired with a HOBO Energy Pro Datalogger (Onset Computer Corp). Data is transmitted using a Solarstream solar-powered Iridium satellite transceiver (Upward Innovations Inc.) and accessible on the Data Garrison website (see Section 3). The station is powered by a 12 volt battery connected to a solar panel. Water levels are logged every 15 minutes in the summer, and every 60 minutes in the winter (to save power). Data are uploaded to the Data Garrison website via satellite once every 24 hours.

2.2.2 TIA-2 Levelogger (Backup)

The levelogger station uses a 0-5 m unvented Levelogger Edge, coupled with a barologger located at Doris Camp. The levelogger is connected to a 250 ft direct read cable. The cable connector is protected in a metal electrical junction box located approximately 10 m east of the telemetry station. The levelogger logs every 15 minutes and is set to continuous logging, meaning it will overwrite the oldest data when it becomes full. The logger can store 40,000 readings and is downloaded at minimum once per year to prevent data loss.

2.3 Station Setup

2.3.1 TIA-2 Telemetry (Primary)

The pressure transducer and cable for the telemetry station is protected inside a 2 (inch) diameter high density polyethylene (HDPE) pipe. The 2″ pipe is made up of three 40 ft (foot) sections clamped together to create a 120 ft long pipe. The lowest 40 ft section has holes drilled along the length of the pipe to allow water to pass unimpeded into the pipe so that water level measurement will not be impeded if the end of the pipe becomes buried by sediment in the future. This 120 ft long pipe is protected inside sections of 3″ aluminum pipe to protect the 2″ HDPE pipe from ice damage during the winter. The lowest section of 3″ aluminum pipe consists of two 20 ft lengths clamped together, and extended approximately 30 feet from shore at the time of installation. The lowest 20 feet of aluminum pipe has holes drilled along its length to allow water to pass unimpeded into the pipe in the event that the end becomes buried by sediment in the future. An additional 30 feet of aluminum pipe protects the 2″ HDPE pipe up to the top of the ridge to protect the pipe as water levels in the TIA continue to rise. There are short sections where the 2″ HDPE pipe is exposed to allow the 3″ aluminum pipes to be fit to the bedrock topography. A 1″ aluminum conduit protects the pressure transducer cable from the top of the 2″ HDPE pipe to the telemetry station.

The pressure transducer cable is secured in the pipe with a hose clamp at the top of the 2″ HDPE pipe. This allows for the adjustment, removal and/or replacement of the pressure transducer in the future when water levels are higher.

At the time of installation, the pressure transducer was approximately 30 feet from shore and at a depth of approximately 2.15 m.

2.3.2 TIA-2 Levelogger (Backup)

The existing levelogger station was improved in September 2017 to accommodate rising water levels in the TIA. The pressure transducer and cable for the levelogger station is protected by a combination of 2″ steel drill casing and 2″ HDPE pipe. The 2″ HDPE pipe is further protected from future ice damage by 3″ aluminum pipe.

The previous station consisted of 40 feet of 2″ drill casing that extended into the TIA approximately 35 feet. The pressure transducer and cable are housed in 1″ aluminum conduit that runs down the length of the drill casing, however the connection point to the pressure transducer cable was only 1 m above the current TIA water level and would have been submerged in the spring. The drill casing is now connected to 2″ HDPE pipe that runs 80 feet (two 40 ft sections that are clamped together) up the bank. The 3″ aluminum pipe protects the connection between the steel drill casing and HDPE pipe, as well as a further 30 feet of aluminum pipe up to the top of the ridge to protect the pipe as water levels in the TIA continue to rise to the maximum design elevation. There are short sections where the 2″ HDPE pipe is exposed to allow the 3″ aluminum pipes to be fit to the bedrock topography. A 1″ aluminum conduit protects the pressure transducer cable from the top of the 2″ HDPE pipe to the telemetry station (Plates 1 to 3).

The 1″ aluminum conduit housing the levelogger pressure transducer is clamped to the inside of the steel drill casing to prevent movement of the pressure transducer. This prevents the levelogger from being adjusted, recovered or replaced once the water level exceeds the top of the drill casing. The levelogger will remain in place and continue to gather data for the life of the pressure transducer, approximately 7 to 10 years.

At the time of installation, the pressure transducer was approximately 35 feet from shore and at a depth of approximately 2.3 m.

2.4 Station Bench Marks

Three rock bolts serve as bench marks for water level surveys of the TIA. They are located on the north side of the bedrock outcrop, just south of the reclaim jetty, at UTM coordinates 13W 434790 E, 75558934 N. Geodetic elevations for the bench marks, determined by TMAC surveyors, are presented in Table 1 below.

Table 1: TIA-2 Bench Mark Elevations

Bench Mark Tag Number	Geodetic Elevation
41	32.365
42	32.392
43	32.559

3. STATION DATA

3.1 TIA-2 Telemetry (Primary)

Data collected by the TIA-2 telemetry station are uploaded to the Data Garrison website once every 24 hours. The website displays the most recent water level and battery readings, as well as a graph of historical data. Data can be downloaded from the website in either Hoboware format or tab delimited format. The satellite data subscription must be renewed annually – this is currently performed by ERM.

Website: www.datagarrison.com
Username: 300234010417660
Password: hobo

The value reported by the telemetry station is m (meters) of water above the pressure transducer. To convert to masl, a constant of 27.761 m should be added to the telemetry pressure transducer reading. This constant may change over time due to sensor drift or movement. ERM currently performs bench mark and water level surveys at least twice annually to confirm or modify this constant. Any changes are communicated to TMAC. This procedure should be continued in future years.

3.2 TIA-2 Levelogger (Backup)

Data collected by the TIA-2 Levelogger must be manually downloaded from the connection at the end of the direct read cable, and compensated using the barologger located in Doris Camp. The levelogger data are currently collected and stored by ERM but will only be used in the event the telemetry station is not functioning properly.

The value reported by the levelogger is in m of water above the pressure transducer. To convert to masl, a constant of 27.586 m should be added to the compensated levelogger reading. This constant may change over time due to sensor drift or movement. ERM currently performs bench mark and water level surveys at least twice annually to confirm or modify this constant. Any changes are communicated to TMAC. This procedure should be continued in future years.

Prepared by:

Cam Evans, EIT
Water Resources Engineer
ERM

PHOTOGRAPHIC PLATES

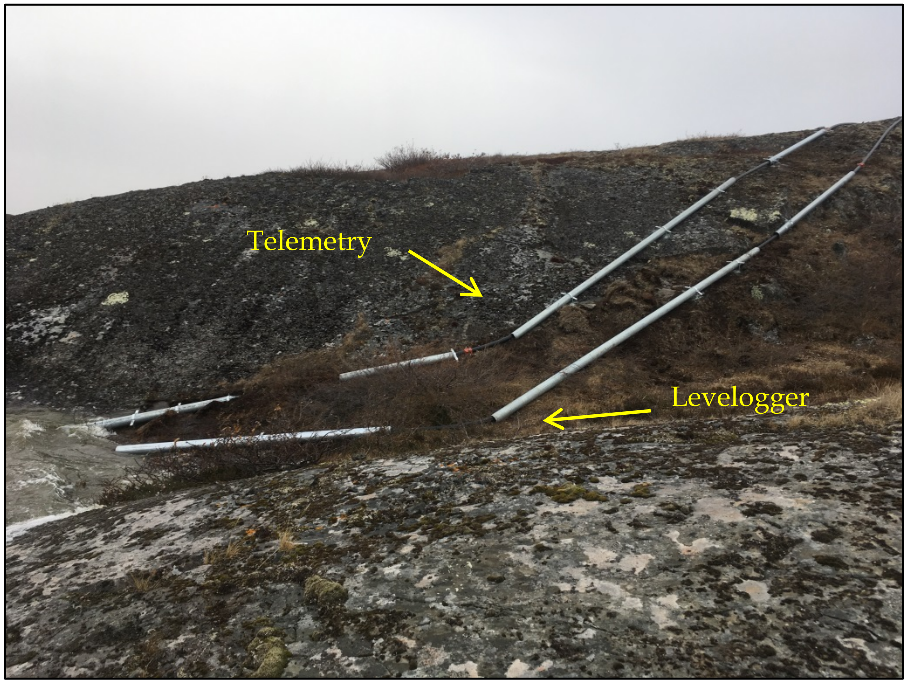


Plate 1: View of 3" aluminum pipes, protecting the 2" HDPE pipes that house the pressure transducer cable, extending from the TIA up to the top of the ridge. September 28, 2017.

Plate 2: View from the top of the ridge looking down at the TIA. September 28, 2017.

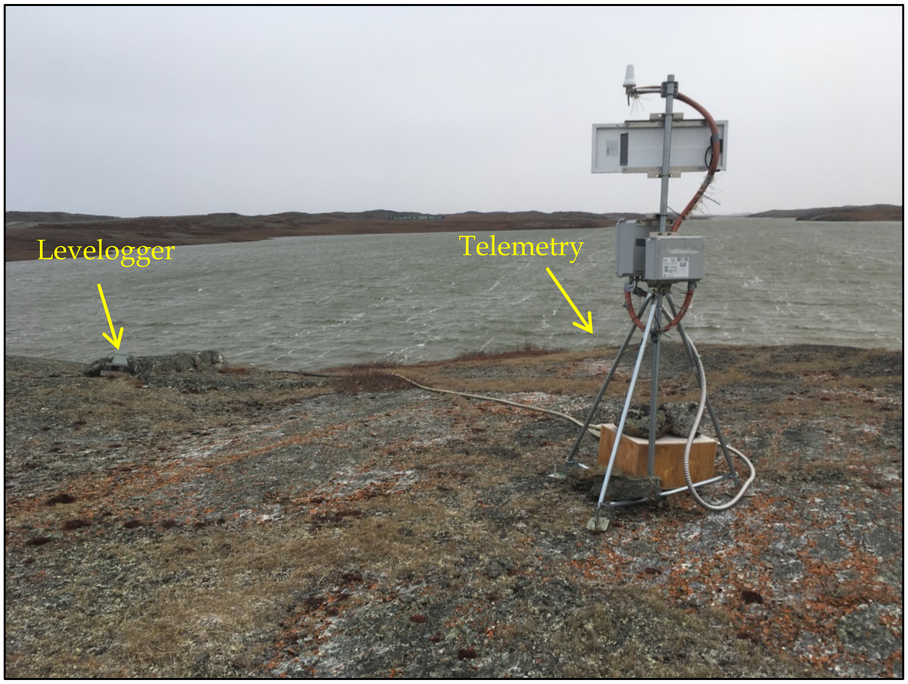


Plate 3: Southerly view of the telemetry station with the junction box housing the levelogger direct read cable in the background. September 28, 2017.

Hope Bay Project, South Dam Monitoring: Standard Operating Procedures – Revision 1

Prepared for

TMAC Resources Inc.

Prepared by

SRK Consulting (Canada) Inc.
1CT022.064
August 2020

Hope Bay Project, South Dam Monitoring: Standard Operating Procedures – Revision 1

August 2020

Prepared for

TMAC Resources Inc.
181 University Avenue, Suite 300,
P.O. Box 33,
Toronto, ON,
M5H 3M7

Tel: +1 416 628 0216
Web: www.tmacresources.com

Prepared by

SRK Consulting (Canada) Inc.
2200–1066 West Hastings Street
Vancouver, BC
V6E 3X2

Tel: +1 604 681 4196
Web: www.srk.com

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1 Introduction

1.1 Revision Summary

Table 1 provides a summary of the revision history for the South Dam Monitoring Standard Operating Procedures (SOP).

Table 1: Revision History for the South Dam Monitoring SOP

Revision	Status	Date	Major Changes
0	DRAFT - Issued for Review	June 2020	-
1	Issued for Use	August 2020	-

1.2 Background

The South Dam is one of three dams that will be constructed as part of the ultimate Doris tailings impoundment area (TIA). Phase 1 tailings deposition requires the use of two out of the three structures; namely the North Dam and Phase 1 of the South Dam. Future Phase 2 tailings deposition will require the South Dam to be raised with downstream methods to its ultimate crest elevation (46.0m). During Phase 2, as the tailings elevation continues above the containment provided by natural topography around Phase 1 TIA, a third containment structure, the West Dam, will be required.

The South Dam was designed to have tailings deposited off the upstream face to create a beach. Its successful performance is dependent on maintaining the integrity of the frozen foundation through preservation of permafrost underlying the dam. Because of complex foundation conditions, differential settlement longitudinally and transversely across the dam is expected. To track whether foundation conditions and deformations are within the design limits for the dam, a rigorous monitoring program has been established.

Table 2 lists the South Dam monitoring components.

Table 2: South Dam Monitoring Components

Component	Instrument	Quantity
Thermal	Horizontal ground temperature cables	9
	Vertical ground temperature cables	12
	Key trench toe alignment temperature cables	1
	D505 Dataloggers	8
Deformation	Deep Settlement Points (DSP)	3
	Surficial Survey Points (SSP), located on the crest and downstream face	19
	Crest Survey Monitoring Points (SMP), located along the upstream crest	6
	Crest survey monitoring points, located along the downstream crest	6
Water level	Pressure transducer installed in Reclaim pond	1
Seepage	No defined instrumentation	n/a
Visual	No defined instrumentation	n/a

1.3 Objectives

Responsibility for implementing the South Dam monitoring program rests with TMAC, and the data must be reviewed annually by the Engineer of Record (EOR) as part of an annual geotechnical inspection. This document provides Standard Operating Procedures (SOP) for carrying out the required monitoring.

2 Monitoring Overview

2.1 Thermal Monitoring

2.1.1 Ground Temperature Cables

The foundation of the Phase 1 South Dam has been designed to remain frozen for the life of the structure. The upstream edge of the key trench base is expected to remain at a temperature of at least -2°C, while the underlying foundation soils remain colder. Twelve functioning vertical GTCs are installed to monitor the foundation temperature, to an approximate depth of 15 m below the base of the key trench or original ground dependent on the cables installed location. Four functioning horizontal GTCs are installed directly above the lower GCL liner to monitor foundation temperatures within the key trench and five functioning horizontal GTCs are installed along the upper GCL liner to monitor temperatures within the above ground dam fill. A single longer horizontal GTC is installed directly above the liner overlap flap, between approximately stations 2+45 and 4+25 to monitor temperature near the interface with the original ground. At the time of writing, six of the installed GTCs are inactive due to irreparable damage or malfunction.

Eight dataloggers were installed at the South Dam. These D505 data loggers are manufactured by BeadedStream and are powered by an internal battery that is charged from solar panels on each unit. Appendix A1, A4 and A5 provides additional details on the D505 data loggers, and Appendix B1 provides additional data logger specifications. Data is stored internally and currently transmitting every 12hrs via satellite telemetry through a two-way satellite transceiver and Iridium antenna. These dataloggers have an operating range of -40°C to +85°C. The SOP for monitoring downloading data from this instrumentation is presented in Section 4.

2.2 Deformation Monitoring

2.2.1 Survey Point Monitoring

The Phase 1 South Dam is expected to undergo deformation because of creep over its design life, which includes differential longitudinal and transverse settlement. A total of 34 survey monitoring points were installed within the structure to track these deformations such that it can be confirmed that they are within the specified design limits.

The installed monitoring points are illustrated on Figures 1 and 2, and include the following:

- **Deep Settlement Points (DSP):** Three deep settlement points are located on the downstream slope of the dam. The deep settlement points are intended to track deformation of the foundation soils directly below the dam. The Deep Settlement Points are constructed of rods attached to plates buried at the foundation of the dam. The rods are contained within a casing that allows free movement of the rod, independent of the dam fill
- **Crest (Fixed) Survey Monitoring Points (SMP):** Twelve crest survey monitoring points are located along the crest of the dam, six of which are intended to monitor deformation below the upstream crest near the upper GCL liner contact and six intended to monitor deformation below the downstream crest under 2 meters of transition material.

- **Surficial Survey Points (SSP):** Nineteen surficial survey points are located at select locations on the crests and downstream shell of the dam. The surficial survey points are intended to track deformation of the dam shell or the foundation soils dependent on their installation location.

The SOP for completing these manual surveys, are included in Section 5.

2.3 Water Balance Monitoring

The Phase 1 South Dam is not designed to retain water. Water level measurements in the Reclaim Pond are monitored with a pressure transducer and data logger. An elevation constant is used to convert the water level to an elevation. This should continue to be used as the primary source of water level data. See the SRK North Dam SOP for additional details (SRK 2020a). Ponded water should never encroach closer than 100 m from the upstream Phase 1 South Dam Crest. As communicated in a number of reports, including the Annual Geotechnical Report (SRK 2020b) and the deposition plan (SRK 2020b, Appendix N). Visual markers approximately 100 m from the Phase 1 upstream dam crest have been placed on each shoreline to assist in visual checks (Figure 1 and 2).

2.4 Visual Monitoring

Visual inspections are critical to the safe operations of the TIA as infrequent or specific instrumentation data alone does not complete the full performance picture. It is expected that the tailings deposition operations are monitored daily by qualified site staff at the dam. These inspections undocumented and are intended to be checks of dam conditions with a focus on atypical conditions or obvious geotechnical concerns at the dam or surrounding infrastructure. A weekly visual inspection must be carried out to thoroughly inspect the dam and formally document any issues observed. More details on the visual monitoring requirements are provided in Section 7.

A comprehensive visual inspection must be carried out as part of the AGI while a Dam Safety Review (DSR) must be completed in accordance with the CDA guidelines, at a frequency dependent on the dam hazard classification and the Canadian Dam Association (CDA) guidelines. It is suggested that the next South Dam DSR be completed in 2021 at the same time as the next North Dam DSR. While this is earlier than the stated CDA guideline minimum frequency requires, this will allow a more comprehensive review of the TIA as a system, rather than just the dam in isolation. A DSR is intended to re-assess the containment facility to validate the safety margin established for day-to-day operation, engineering practices, and legal and/or regulatory requirements. DSRs are completed by an independent review engineer that is not influenced by his or her prior participation in the design, construction, operation, maintenance, or inspection of the dams under review.

2.5 Seepage Monitoring

Dam seepage is not expected, however, if seepage is observed at the toe of the South Dam, monitoring is required in accordance with the SOP provided in Section 8. Ponded water was present in ice-wedge troughs prior to construction of the South Dam. Baseline water quality monitoring of ponded water on the downstream side of the dam is also required in accordance with Section 8 to establish a record of baseline water chemistry.

2.6 Tailings Deposition

Performance of the Phase 1 South Dam is directly dependent on adherence to the tailings deposition plan (SRK 2020b, Appendix N) to specifically establish an adequate tailings beaches upstream of the structure and limit ponding of supernatant water. Annual topographic surveys of the tailings beach above water and bathymetric surveys should be completed to confirm that deposition is consistent with the current plan. The deposition plan can be modified as necessary based on the annual data.

3 Monitoring Protocols

3.1 Monitoring Frequency/Responsibility

A summary of the monitoring requirements and associated responsibility is listed in Table 3. These monitoring requirements can be revised at any time under the direction of the South Dam Engineer-of-Record, or the qualified Licensed Geotechnical Engineer carrying out the AGI.

Table 3: Summary of Monitoring Requirements

Element	Item	Method	Responsibility	Minimum Frequency
Thermal	Ground Temperature Cables	Data Loggers	TMAC	Daily[1]
Deformation	Deep Settlement	Manual	TMAC	Monthly (from May to November)
	Shallow Settlement	Manual	TMAC	Monthly (from May to November)
	Surficial Settlement	Manual	TMAC	Monthly (from May to November)
Water Balance	Water Level	Data Logger	TMAC	Daily[2]
	Seepage Monitoring and Sampling	Manual	TMAC	Weekly when observed
	Downstream Ponded Water	Manual	TMAC	Monthly when observed
Tailings Deposition	Ground and Bathymetric Surveys	Manual	TMAC	Annually
Visual	Walkover Survey	Informal (not documented)	TMAC	Daily
		Formal (documented)	TMAC	Weekly
	Annual Geotechnical Inspection	Manual	Independent Qualified Licensed Geotechnical Engineer	Annually

Element	Item	Method	Responsibility	Minimum Frequency
	Dam Safety Review	Manual	Independent Qualified Licensed Geotechnical Engineer	In accordance with CDA Guidelines

Notes:

1. Currently thermal data is collected and transmitted every 12 hours.
2. Currently water level data is collected every 6 hours and transmitted every 5 days.

3.2 Monitoring Data Management Protocols

All monitoring data collected must be stored electronically. Manual notes must be scanned, and the raw data saved together with any transposed or processed data. All data must be reviewed by appropriate qualified staff immediately following collection to confirm integrity of the instrumentation, as well as to ensure that dam performance is consistent with expectations. If staff is not qualified to draw such conclusions, the EOR must be contacted to perform these duties.

Reporting requirements are specified in each section typically via email, however where appropriate, agreed upon shared drives can be used for file transfer, but a notification email should be sent once the inspection is uploaded. Currently a South Dam monitoring shared folder is stored here:

https://van.files.srk.com/nextcloud/index.php/s/EERtAo85KZLocdy?path=%2FTIA%20Monitoring

4 BeadedStream GTC and Datalogger Standard Operating Procedure

Ground Temperature Cables (GTCs) and Dataloggers at the South Dam are manufactured by BeadedStream. Each of the eight dataloggers installed are powered by an internal battery that is charged by integrated solar panels on each unit (Figure 3). Appendix A and Appendix B1 provides additional details on the D505 BeadedStream data loggers that were installed on site.

These data loggers record the data internally and are currently transmitting data (every 12hrs) to an online portal via satellite telemetry. The BeadedStream online portal can be accessed at the website below, using the login name provided or by creating an account that is created by contacting BeadedStream.

https://app.beadedstream.com

Username: enviro@tmacresources.com

Password: TmacResources1

To access the GTC data, navigate to Projects> Hope Bay South Dam> Sites > Select the GTC name. This data is treated as the ‘raw data’.

SRK has developed a centralized Hope Bay ‘Data Management System’ portal and parallel database for the TIA and more broadly the Hope Bay project overall. The ‘raw data’ from the BeadedStream portal is automatically loaded into the database daily and displayed on the DMS portal. The login details for the portal are provided below:

https://maps.srk.com/hopebay/

Username: enviro@tmacresources.com

Password: HopeBay1!

To create a new account, select “Register as a new user”.

The instrumentation layout (Figure 1 and 2) shows the location of the data logger and GTCs IDs at each monitoring node.

The Operator’s manuals and app based manual download procedures are provided in Appendix A. The cable configurations and calibration sheets for the GTCs are presented in Appendix B.

No regular data collection is currently required for the South Dam GTCs. Data transmitted to the web portal is monitored by the monitoring team at SRK and the EOR, if conditions of concern arise, the EOR will notify site and take appropriate measures. TMAC personnel responsible for the monitoring and safe operation of the TIA should familiar with the portal and review the GTC data regularly (Suggestion: Monthly).

4.1 Overall Procedure

The South Dam dataloggers transmit data automatically, and do not normally require manual downloads. The following provides monthly monitoring requirements under automated and manual conditions:

1. **Field Data Collection**

   (a) Automated data collection and transmission of data: No action required, however regular reviews of the data are conducted by SRK and may require input or review from TMAC personnel.

   (b) Manual Option 1: Downloading via “Capture by Beaded Stream (Capture app)” (iOS only app) using Bluetooth communication

   (c) Manual Option 2: Downloading via Laptop and Realterm

2. **Inspection.** Dataloggers must be inspected for damage as part of the weekly visual monitoring (Section 7)

3. **Maintenance**. This procedure defines basic maintenance necessary for the ongoing operation of the dataloggers (Section 4.3).

4.2 Field Data Collection

4.2.1 Automated Data Collection and Transmission

Currently the ground temperature is collected and transmitted automatically. No action is regularly required on site to complete the downloads. The Sections 4.2.2 are provided as reference.

4.2.2 Manual Data Download Methods

Downloading via the *Capture* by Beaded Stream app (iOS app) using Bluetooth communication

Attached is the manufacturer instruction for use of the Capture app with the D505 datalogger titled “D505 & Torpedo 2 **|** Capture App Guide” (Attachment A1). The attached document is the main reference from which a summary is provided below for quick reference:

1) Download the “Capture by BeadedStream” app from the Apple App Store and install. Prior to heading to the field ensure the App is working and that the iOS device has a full battery. https://apps.apple.com/us/app/capture-by-beadedstream/id1329058755

2) Configure the Settings, including Units (°C, Meters), Lat/Long (Degrees Decimal) and an email for data export (This must be an active email in the Apple “Mail” app).

3) A magnet is required to activate the datalogger Bluetooth in the field. Small silver magnets are provided with the datalogger, as shown in the picture below. Other small magnets

available on-site should also work.

4) Once at the datalogger is in the field, swipe the magnet over the left panel near the blinking light. Swiping the magnet will activate a Red flashing light, indicating the datalogger and Bluetooth have been activated. At this point, the datalogger should be indicated as a “Loggers In Range” in the app.

   Note: do not hold the magnet near the magnet switch for extended periods unless intending to force a reading or otherwise reboot the datalogger (See Appendix A1 for more detail)

5) In the app, click New Capture, select the logger, then download logger data on the next screen. When process completes an email draft should appear, ensure a log of the Datalogger ID is contained within the email text or csv and send this email draft to the pre-defined email address (Typically enviro@tmacresources.com).
   Note: Downloading 300-500 readings can take 5-10 minutes

6) On the opposite side of the logger there is a widow with a green and blue LED.

   a) The Blue LED will be activated during Bluetooth connection or activity.

   b) The Green LED indicates processor activity and will blink every 7 seconds if the datalogger is idle but operational, and solid during a reading or transmission.

   Note: Details on all logger states and the associated status lights are provided in Appendix A1)

7) Once all data collection is complete, access the emailed files in the office, compile these and send in one email to hopebaymonitoring@srk.com.

Data logger status via the Capture by BeadedStream App

Open the app, navigate to Settings > Terminal Emulator then select the logger. Attachment A1 details all the commands, below are the minimum necessary commands to download the data:

a) Status: This will output a number of records relevant to the status of the datalogger and a quick check for the connected GTC’s.

```
> status
status
 Real Time Clock  : 2017/05/09 22:53:00
 Firmware version : 40x-4.2a
 Serial number    : DLB00297
 Number of sensors: 0, 4, 4, 0
 Logging  period  :  0:30
 Transmit period  :  1:00
 Inbox rx period  : 24:00
 Unit temperature : 30.54 C
 Battery voltage  : 6.208 volts
 Storage used     : 48 of 14100
```

Note the GTC position in the datalogger in "number of sensors". The GTC is the non zero port. i.e. Number of sensors: 0, 0, 13, 0 would indicate that the GTC is connected to Port 3.

b) Temps: This command will read the current temperatures of the GTC, with the output values displayed on the emulator screen. These can be recorded in a field notebook or a screen capture can be saved.

Forced spot readings and other commands may be required at times. Refer to Appendix A1 for more detail.

Regardless of the method, the green LED should remain on to verify transfer has not stopped or failed.

Downloading via Laptop and Realterm

Communication with the datalogger via Realterm should be used as an alternative method for downloading data from the datalogger. The section below outlines the basic instructions and detailed instruction is provided in the Attachment A5, "D400 Series Data Logger".
Caution: This guideline should be used for Realterm instructions only, the data logger referenced (D400) is not installed on site.

Realterm software must be installed on a laptop computer.

http://sourceforge.net/projects/realterm/files/Realterm/

A MiniUSB cable will be needed to connect between the laptop computer and the datalogger. In order to connect via USB, a driver is also required that may not be automatically installed on the computer. The proper driver for the laptop operating system is available at:

http://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx

Select the correct driver that corresponds to your operating system for installation.

Follow the setup instructions in Attachment A3 page 3 and 4 to setup Realterm. The most important section is the PORT settings and Baud rate. Your computer needs information regarding the nature and location of devices to communicate with the logger. This is designated by assigning ports. At this point, using the miniUSB connector cable, connect the Data Logger to the USB interface on your computer.

To determine what port is being used, access the ‘Device Manager’, when using a Windows platform. To access the Device Manager, navigate to ‘Device Manager’ on the computer (under Windows ‘Home’, ‘My PC’ or the search bar. Locate the Universal Double-clicking on ‘Ports (COM & LPT)’ or ‘Universal Serial Bus controllers’ will reveal which USB Serial Port is being used (i.e. Port_#0005 or COM5 would mean that your computer assigned Port 5 arbitrarily to this device). Return to Realterm.

In Realterm, change the baud rate to 115200, enter the port number and click ‘Open’. Open initiates communication between the computer and the data logger, click ‘Change’ in order for communication prompts to be actualized. At this point, the data logger is synced to the computer and active communication can begin.

To test that this has been set up correctly, while connected to the datalogger via USB, type STATUS into the Realterm interface. This command will prompt the current status of the datalogger and a number of sensors connected. The number of sensors should be output as “Number of sensors: 0, 0, 13, 0”, this would indicate that the GTC is connected to Port 3. The GTC could also be connected to Port 1 through 4, if needed.

For each command, the user must hit enter after each request to send the command to the datalogger.

Read X: Read X will output the current temperature at the GTC beads connected to a specific port, where that Port number is X. The temperatures and GTC details will be output on the screen and record a reading into the datalogger. This is only used if necessary.

Temps: Temps will display the temperatures, but not record the measurements.

Data: Typing Data will output all current readings from the day the datalogger was initiated.

To complete the data download, type the following:

Status (Enter)

Data (Enter)

The output the file in a CSV format on the Realterm screen. To capture the data, the user manual states:

In Realterm select the third tab called, ‘capture’ to save logger data to your computer using the following steps:

1. Next to ‘File’, select the desired output location of the file that will hold your captured data. Name this something that reflects the data that you are capturing.

2. Uncheck the box that selects 'Direct Capture'. This will allow you to see the commands that you are typing while they are being captured.

3. If starting a new capture, select 'Start Overwrite'. If appending data to an existing capture file, select 'Start Append'. Upon selecting one of these options, the interface will turn RED. This is good and indicates that capturing is imminent.

4. Now you will type commands into the command window. Information typed into this window during a capture will be stored in the output file.

5. Type 'status', and then 'data'. When all data has been captured, simply select, 'Stop Capture'.

6. All data is now available in the capture output file designated in Step 1.

If this capture method does not work, the text can also be copied into a typical text file in Notepad.

4.3 Maintenance Procedure

The BeadedStream data loggers are designed to be reliable and require minimal recurring maintenance. Below is the key parameters for monitoring the health of the datalogger and the GTC system, and some additional notes on maintenance that may be required.

- Battery Voltage: Maintain above 6.15 Volts.
- Solar panel and housing orientation:
  - Maintain the solar panel orientation in a true south direction with the solar panel facing the horizon, and the cable ports facing down (i.e. 0° vertical tilt).
  - The panel and housing should be kept snow and ice free.
- Moisture: Inspect for condensation on the inside of the housing (inspect the clear portions of the housing, DO NOT OPEN for this purpose).
- GTC Cables: Ensure the GTCs remain securely connected to the datalogger, this can be checked by lightly tugging on the cable.
- A typical BeadedStream datalogger installation on the South Dam is shown in Figure 4.

4.3.1 Battery Maintenance

The D505 Dataloggers should not require recharge due to their low power requirements and solar panel recharging. Annual voltage checks are completed as part of the AGI to confirm the required voltage is maintained. The battery voltage can be monitored via the BeadedStream web portal listed above. The voltage must remain above 6.0 Volts to maintain data logging and transmission function. The battery thresholds are listed below:

- Full battery: 6.6 Volts or more

- Report low battery to EOR or BeadedStream: 6.15 Volts
- Transmission minimum: 6.0 Volts
- Datalogging minimum: 5.5 Volts

Additional steps of irregular battery maintenance (ie an on-site battery change) are listed in Appendix A2.

4.3.2 Desiccant Pack Maintenance

Each D505 Datalogger contains a desiccant pack. These packs absorb condensation moisture inside the housings to protect the internal electronics. If moisture or condensation is noted within the datalogger housing, notify the EOR for further instructions. Desiccant packs must be replaced or oven dried (standard vented oven at 93^{o}C) when moisture inside the datalogger housing is visible. However, replacement of the desiccant packs should only be carried out by someone qualified to do so.

4.4 Reporting Procedures

Any manually downloaded data should be provided in an Excel, *.csv or similar format. Any additional observations (such as noted damage or issues with the datalogger or cables) that may assist with data interpretations should be recorded and sent along with the compiled data downloads or the Visual Monitoring reports (Section 7). All data should be sent to the EOR jkurylo@srk.com, Peter Luedke, pluedke@srk.com, and the SRK team at hopebaymonitoring@srk.com.

5 Ground Survey Standard Operating Procedure

5.1 Objective

Ground surveys of the South Dam control points, monitoring points and the South Dam downstream toe are required to monitor for any deformation that may adversely impact the performance of the dam. The monitoring components include:

- Four Control Points surrounding the South Dam, these are rock bolts installed in bedrock outcrops and are used for survey control during construction and monitoring.
- The three Deep Settlement Points (DSP) are located on the downstream slope of the dam. The three deep settlement points are intended to track deformation of the foundation soils directly below the dam. These consist of rods attached to plates buried at the foundation of the dam. The rods are contained within a casing that allows free movement of the rod, independent of the dam fill.
- The twelve Crest (Fixed) Settlement Monitoring Points (SMP) are located along the crest of the dam. Six of which are intended to monitor deformation below the upstream crest near the upper GCL liner contact and six intended to monitor deformation below the downstream crest under 2m of transition material. These are similar to the DSPs in setup and function.
- The nineteen Surficial Settlement Points (SSP) are located at select locations on the crests and downstream shell of the dam. The surficial survey points are intended to track deformation of the dam shell and/or the foundation soils dependent on their installation location. These are boulders placed at the surface of the dam shell with rock bolts installed near the highest point on their surface. These allow a more dispersed network of surface settlement monitoring across the dam.
- The South Dam downstream toe interface between the ROQ rock fill and the native tundra (vegetation or bedrock)

Figure 1 shows a general arrangement, along with primary survey control points. Figure 2 presents a plan view of the instrumentation layout, including location names and UTM coordinates. Figure 5 shows typical details for the installed deformation monitoring instrumentation, deep settlement points, and surficial survey points.

5.2 Survey Procedures

The ground surveys for deformation monitoring are typically completed with Total Station survey instruments that have high degree of accuracy (typically ± 2mm). Due to control point locations and survey logistics, monitoring is currently completed by a mix of surveying with a Total Station for the Deep Settlement Points and a RTK GPS for the Crest Survey Monitoring Points and the Surficial Survey Monitoring Points. While the horizontal and vertical accuracy for the RTK GPS is ± 10 mm horizontal and ± 15 mm vertical, over time this is expected to provide an adequate indication of displacement trends, and balances accuracy with reduced base station moves in the field. If significant variability in readings is observed, obscuring any potential displacement trends, the EOR may require the monitoring procedure to return to a Total Station only approach, similar to the North Dam deformation monitoring. Surveys must be completed by a qualified TMAC surveyor or subcontractor.

The following outlines the procedure for surveying the deformation monitoring points (adapted from input provide by Sub-arctic Surveyors and previous site guidance):

5.2.1 Deep Settlement Points (DSP) and Crest Survey Monitoring Points (SMP) using a Total Station:

1) Setup at the SD2 Control Point. (Rock bolt in bedrock)
2) Use the SD1 Control Point as a back-sight. (Rock bolt in bedrock)
3) Use SD3 as a check measurement

For each of the 3 DSP:

4) Remove the top cap from the orange steel casing
5) Survey the exact center at the top of the inner pipe (within the casing) and replace the top cap.
6) Move on to the next location.

For each of the 13 SMP (shorter than the DSPs):

7) Open the hinged top-plate
8) Survey the exact center of the internal rebar (within the casing) and close the top-plate

A flashlight may be needed to see inside and centralize the prism on the DSP or SMP rod.

Any accumulated dirt or ice around these protective caps or plates should be removed. Before placing the cap back on the monument after the monthly ground survey, all caps should be cleaned. If the caps are moist, it is suggested that the insides of the caps be dried prior to being placed back over the monitoring points to avoid jamming or freezing.

5.2.2 Surficial Survey Point (SSP) with the RTK GPS.

1) Set up the GPS base station over the SD1 Control Point (Rock bolt in bedrock)
2) Using an epoch count of 5, make a check measurement at SD2 Control Point. This is also a rock bolt in bed rock that was used as a check/secondary base point for the South Dam construction. The results of this check measurement should be within 10mm in northing and easting, and 15mm in elevation.
3) Using the same 5 epoch count, all SSP on the South Dam can be surveyed and the results recorded.

5.2.3 South Dam Downstream Toe with the RTK GPS

1) Walk the South Dam toe and complete a survey pick-up of the interface between the ROQ fill and the tundra where snow-free.

2) Survey shots should be collected every 5m or as appropriate to capture the variability in the alignment.

3) When the dam toe is not completely free of snow or ponded water, survey the interface between the ROQ and snow or water, noting this in each of the survey point names

5.2.4 Additional Details

An additional reference on “Suggested guidelines of surveying at the North Dam”, with a Total Station, is presented in Appendix D (from Cornelissen 2013). While initially written for monitoring the North Dam, it is expected that this document may be generally applicable to the setup and potential sources of error at the South Dam. Specifically, these guidelines discuss:

- Expected manpower and time allocation;
- Equipment and accessories;
- Metadata/control points;
- Station set-ups; and
- General surveying and survey error reduction.

Any damage noted to any of the survey monitoring locations (DSP, SMP, SSP) should be recorded and submitted with the survey data.

In addition to the monitoring points and the downstream toe, one surveyed elevation of the water level in the TIA Reclaim Pond should be collected on the upstream face of the North Dam. While this is required under the North Dam SOP (SRK 2020a), a survey point taken by GPS is acceptable and may be done while set up at the SD-1 Control Point. This survey point must be collected at least once annually during open water season in the Reclaim Pond (typically completed in August). Additional water level shots during the monthly survey events may be recorded opportunistically, when conditions allow. The water elevation of this point is used to confirm the elevation constant used to convert the TIA-2 water level data collected from the pressure transducer to an elevation above sea level. Refer to the North Dam SOP (2020) for more detail.

5.3 Reporting Procedures

The survey data is expected to be supplied in Excel or *.csv format. For expedient monitoring, please indicate the correct point type and number in the point name to be easily recognizable (e.g. SSP04 or the full SD-SSP-04). Any additional observations (such as noted damage) that may assist with data interpretations should be recorded and sent along with the compiled survey data to the EOR jkurylo@srk.com, Peter Luedke, pluedke@srk.com, and the SRK team at hopebaymonitoring@srk.com.

6 Water Level Monitoring Standard Operating Procedure

6.1 Objective

The South Dam is designed and constructed as a tailings retaining dam with a minimum required tailings beach length, and not a water retaining structure. The minimum beach length of 100 m from the upstream Phase 1 South Dam crest to any open water in the TIA must be maintained (either the Reclaim Pond or other large isolated ponds on the tailings beach), and shoreline markers have been placed to help visually check this. The current beach slope of the tailings is between 0.5% and 1% and therefore this criterion can be approximated by ensuring the water level is at least 0.5 m to 1.0 m (respectively) lower than the minimum beach elevation at the South Dam.

As of August 2019 (previous open water season), the minimum beach elevation was 33 masl, therefore the water level must currently be maintained below 32 masl. The value will be rechecked annually as part of the TIA Annual Geotechnical Inspection.

Water level is a critical monitoring parameter and is currently recorded and transmitted to the online portal every five days.

6.2 Measurement Procedures

The water level is monitored at TIA-2 in the northeast end of the TIA, near Reclaim Barge. Details on the measurement procedures are provided in the North Dam SOP (SRK 2020a)

A visual estimate of the beach length with relation to the water level is required as part of the Visual Monitoring (Section 7).

6.3 Reporting Procedures

No additional reporting is required, however if any observations relating to the water level made (such as ponding water near the dam), please record the relevant information and send to the EOR jkurylo@srk.com, Peter Luedke, pluedke@srk.com, and the SRK team at hopebaymonitoring@srk.com.

7 Visual Monitoring Standard Operating Procedure

7.1 Objective

Formal visual (walk over) inspections of the South Dam, and immediate surrounding area, is required to act as an early notification for potential issues in areas not directly monitored by the installed instrumentation or other monitoring activities. Two levels of inspection are proposed:

1) Daily monitoring to identify issues or observations that may adversely impact the dam.

2) Full weekly visual (walk over) inspections.

7.2 Daily Visual Inspection

It is expected that the tailings deposition operations are monitored daily by qualified site staff at the TIA. The daily inspections are not intended to be an intensive exercise, rather it should include a walking or driving from one end of the dam to the other inspecting for major changes that have the potential to compromise its performance between weekly inspections. These inspections should include:

1. Settlement, depressions, sinkholes, cracking or signs of movement along the crest, the downstream or upstream face of the dam;

2. Significant changes in the observed seepage conditions compared to the prior weekly inspection;

3. Rapidly changing erosion conditions at the interface of the dam and the tundra;

4. The minimum beach length of 100 m from the upstream Phase 1 South Dam crest to any open water in the TIA, either the Reclaim Pond or other large isolated ponds on the tailings beach. Shoreline markers have been placed to help visually check this;

5. Leaks or unplanned discharges from the tailings discharge or reclaim pipeline

6. Any other atypical conditions observed that are concerning or have the potential to compromise the dam performance.

There is no reporting requirement for the daily visual inspections.

7.3 Weekly Visual (Walk Over) Inspection and Reporting

The upstream and downstream slopes, crest and downstream toe of the dam should be the focus during the walk over visual inspections. Specifically, the following should be noted:

1. Erosion
   (a) Any erosion of the dam fill or immediately surrounding tundra over 5 cm in depth should be noted. Erosion locations should be recorded (using a handheld GPS or survey) and photographed.
   (b) If erosion is notable then it should be monitored carefully to ensure that conditions do not worsen (i.e., getting larger, deeper, to greater extent).
   (c) If erosion can be safely measured, then simple visual estimates or measurements with a tape measure should be completed on the larger erosional features.
2. Settlements / Depressions / Sinkholes.
   (a) If observed, the location(s) should be recorded (using a handheld GPS or survey), photographed, and the dimension / extents estimated.
3. Cracks/ Movements

(a) If signs of cracking or movement are observed the locations should be recorded (using a handheld GPS or survey), photographed and the approximate crack dimensions should be measured.

4. Debris and Vegetation

   (a) Any debris or vegetation growing on the upstream and downstream slopes of the dam should be noted.

   (b) Materials should not be stockpiled on or against the dam surface. Any debris on the dam should be removed to assist with better performing visual inspections over these areas.

   (c) Snow can affect thermal performance of the dam. Natural snow drifting over 1.0 m should be noted, along with and snow should not be piled against the dam surface during snow clearing operations.

5. Seepage or Ponding

   (a) Seepage is defined as water flowing from the South Dam. Walk the full length of the downstream dam toe to identify any currently flowing seepage locations or location that appear to have evidence of past seepage (which can be monitored going forward).

   (b) If seepage water is found, note the location (by dam chainage/station or GPS), photograph and provide a preliminary estimate the seepage rate if possible.

   (c) Ponded water exists at the downstream toe of the dam. If new ponded areas are observed or the existing ponds appear to be expanding, note the location and approximate extent on the inspection form and photograph.

   (d) Notify the on-site environmental coordinator to conduct water quality sampling monitoring (Section 8).

6. Tailings Beach Development

   (a) Inspect the upstream side of the dam. The minimum length of 100 m from the upstream crest of the Phase 1 South Dam to any open water in the TIA must be maintained (either the Reclaim Pond or other large isolated ponds on the tailings beach), and shoreline markers have been placed to help visually check this. Figure 2 provides the 100 m buffer in plan view for reference.

7. Instrumentation

   (a) Look for visual damage to instrumentation (i.e., does all instrumentation appear to be intact or has it been damaged by equipment, animals or personnel?).

   (b) Inspect the dataloggers and confirm that:

      - The GTC cables are properly connected at the base of the data logger (they should not be disconnected or loose);

      - No moisture has condensed on the inside of the solar panel; or

- The solar panel faces the southern aspect (downstream side of the dam) and hoar frost or ice has not accumulated on the panel

(c) If damage or other issues are noted, then photographs and notes / observations should be collected to assist with determining if repair of the instrumentation is possible.

The South Dam Walkover Report is presented in Appendix D. This inspection form, along with any photos or notes from the inspection should be formally recorded and submitted to the EOR jkurylo@srk.com, Peter Luedke, pluedke@srk.com, and the SRK team at hopebaymonitoring@srk.com.

The EOR should be notified immediately after any inspection where notable changes to any of the areas / items listed above are observed. The EOR will work with TMAC to provide further guidance on monitoring or sampling requirements and to determine if mitigation measures are required.

8 Seepage and Ponded Water Monitoring Standard Operating Procedure

8.1 Objective

Seepage or contact water flowing from the toe of the South Dam must be monitored to confirm that the source of seepage is not seepage from the TIA (or if it is the TIA to better monitor seepage rates and to track flow paths). Additional monitoring of the water ponded (no apparent flow) on the tundra, downstream of the dam is also required (tundra pond water) to establish a record of baseline water chemistry in the former location of the ice wedge.

8.2 Procedure

Seepage is defined as water flowing from the South Dam (SDSEEP). Ponded water is defined as water near the dam without a notable flow rate and is present as shown in Figure 6 between Station 2+60 and 3+60. The primary sampling locations (SDPOND) for ponded water are (435650 m E, 7555910 m N) and (435630 m E, 7555907 m N) (UTM NAD83, Zone 13).

Monitoring and sample collection at the South Dam are to be performed by on-site environmental personnel trained in seepage identification and sample collection methods. The seepage and ponded water monitoring procedure at the South Dam toe is described as follows:

1. Complete a walk over survey on foot. This will consist of walking the full length of the downstream dam toe to identify any locations of currently flowing seepage, areas that appear to have evidence of past seepage (which can be monitored for seepage going forward) or areas of ponded water.
2. At each seepage location, collect water samples for the parameters listed in the laboratory analytical suite (LAS) in this SOP and record the following field data:

- o Pre-determine a Sample ID following the naming convention (SDSEEP-YYMMDD-SN)
  - SN is a sample number. This should be assigned an unique two digit number for that date, for example the first would be SDSEEP-200602-01.
- o GPS coordinates,
- o Photograph (upstream and downstream look directions include the sample location),
- o Volumetric flow rate estimates
  - For samples collected at the toe of the dam, flow volume and velocity can be estimated by taking a container of a known volume and recording the time it takes for the seepage to fill the known volume. Alternatively, estimate the cross-sectional area of the flow and the velocity of the water. To ensure accuracy of the measurement, at least three iterations of the estimate should be completed. Revisit subsection 2.2, bullet number 2 for additional details.
- o Field measurements: temperature, pH, electrical conductivity (EC), chloride, and oxidation reduction potential (ORP),
- o Date and time,
- o Name of sampler, and
- o The sampling frequency is **once per week** while seepage is occurring or at the discretion of the EOR.

3. At the primary pond locations (435650 m E, 7555910 m N) and (435630 m E, 7555907 m N) (UTM NAD83 Zone 13), and where any other independent large continuous ponds of water are observed at or near the downstream toe (typically between Station 2+80 and 3+40) (Figure 6), collect water samples from near the toe of the dam for the parameters listed in the laboratory analytical suite (LAS) in this SOP and record the following field data:
   - o Pre-determine a Sample ID following the naming convention (SDPOND-YYMMDD-SN)
     - SN is a sample number. This should be assigned a two digit number for that date, for example the first would be SDPOND-200602-01.
   - o GPS coordinates,
   - o Photograph (upstream and downstream shots (include the sample location)),
   - o Ponded area, and depth estimate,
     - A simple estimate of the pond size and visible depth will help quantify the scale. There is no need to physically measure the pond dimensions at this point.
   - o Identify any of the known seeps that are actively flowing into the pond from the rock fill or the downstream toe. Provide a sketch or identification of the active seeps flowing into the ponded water.

- o Field measurements: temperature, pH, electrical conductivity (EC), chloride, and oxidation reduction potential (ORP),
- o Date and time,
- o Name of sampler, and
- o The sampling frequency is **once per year** while the primary ponds are accessible under open water conditions or at the discretion of the EOR. Typically, there should be no ponding directly against the downstream toe of the South Dam, however if this condition does exist then this water should be sampled to help assess seepage potential.

4. Check upstream side of the South Dam for water. If water is observed near or against the upstream side of the dam, the following actions are to be taken:
   - o Ensure the EOR jkurylo@srk.com and hopebaymonitoring@srk.com has been notified if the Reclaim Pond is within 100 m of the upstream crest of the Phase 1 South Dam, or any large isolated pond has formed on the tailings beach.
   - o Where ponding is observed against the dam, collect water samples for lab parameters listed below (LAS) provided samples can be safely collected while standing on the dam.
   - o Record field measurements (temperature, pH, EC, chloride, ORP), and
   - o Record field notes as outlined above, e.g. GPS coordinates, photographs, etc.
5. Once per month, collect the following QA/QC samples to validate the geochemical data set:
   - o One field duplicate, one travel blank and one field blank for lab parameters listed below (LAS).
   - o For the field duplicates only, field measurements (temperature, pH, EC, chloride, ORP).
6. Once per month during routine sampling of SNP station TL-5 (tailings supernatant discharge from the mill), conduct the following for TL-5:
   - o Record field measurements (temperature, pH, EC, chloride, ORP), and
   - o Collect water samples for lab parameters listed below (LAS).
   - o This monthly sampling of TL-5 is a monitoring requirement of the South Dam however is also outlined in Section 9.2 of the North Dam Monitoring SOP (SRK 2020a). Separate samples for each dam monitoring program are not required.

8.3 Laboratory Analytical Suite (LAS)

The laboratory analytical suite (LAS) for the South Dam Seepage Monitoring SOP is as follows:

- Lab pH and EC
- SO_4, Cl
- Alkalinity

- Ammonia, NO_3, NO_2, Total N
- Total CN, Free CN, SCN, CNO
- Total metals (including sulphur and mercury)
- Dissolved metals (including sulphur and mercury)

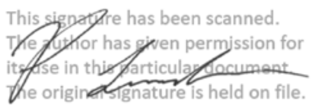
8.4 Sample Shipment and Reporting Procedure

Water samples are to be shipped to ALS Environmental. When samples are shipped, send the appropriate Chain of Custody (COC) form and field data to SRK, and notify the Engineer of Record (EOR) that samples have been collected and shipped. Upon receipt of the lab results, these should also be sent to SRK. All documentation and results should be sent to Lbarazzuol@srk.com (Lisa Barazzuol), rcocuaco@srk.com (Rosie Cocuaco), mting@srk.com (Maritess Ting) and Hopebaymonitoring@srk.com (SRK Hope Bay monitoring account).

9 Tailings Deposition Monitoring Standard Operating Procedure

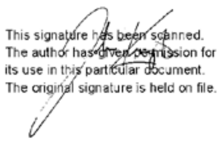
Performance of the Phase 1 South Dam is directly dependent on adherence to the tailings deposition plan (SRK 2020b, as per main text and Appendix N) and specifically establishment of adequate tailings beaches from the structure. Annual topographic surveys of the tailings beach above water and bathymetric surveys should be completed to confirm that deposition is consistent with the current plan. The deposition plan can be modified as necessary based on the annual data. To compliment these surveys monthly checks using satellite data (ex. Sentinel-2) should also be done to help track tailings beach development and tailings spigot movements. TMAC site staff should be familiar with the tailings deposition plan and work with SRK to ensure the plan is implemented as specified, any deviations from the plan must be discussed with and approved by the EOR.

This report, “Hope Bay Project, South Dam Monitoring: Standard Operating Procedures – Revision 1”, was prepared by SRK Consulting (Canada) Inc.



Peter Luedke, EIT
Consultant

and reviewed by:



John Kurylo, Meng, PEng
Senior Consultant

Chris Stevens, PhD
Senior Consultant (Permafrost)

Lisa Barazzuol, PGeo
Principal Consultant (Geochemistry)

All data used as source material plus the text, tables, figures, and appendices of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

10 References

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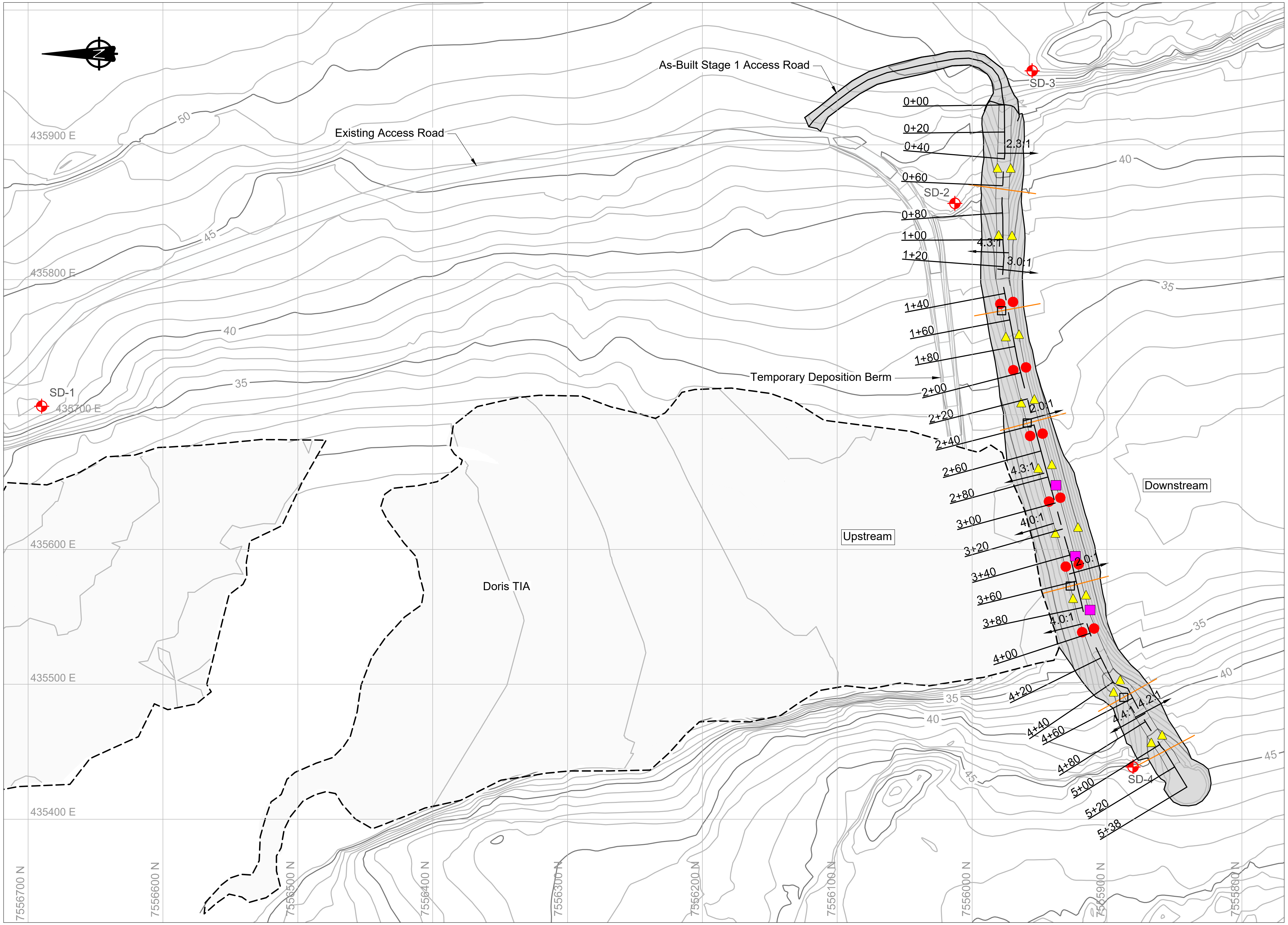
Figures



LEGEND

- Crest Survey Monitoring Point (SMP)
- Surficial Survey Point (SSP)
- Deep Settlement Point (DSP)
- Datalogger Location
- Control Point
- 2019 Sub-aerial Tailings Extent (approx.)

NOTES

1. Topographic and As-built data was provided by the Client
2. Contours shown at 1.0m interval.
3. All units shown are in meters unless otherwise stated.

REFERENCES

NAD83 UTM Zone 13.

PRIMARY CONTROL POINTS STAKE OUT TABLE

ID	Northing	Easting	Elev. (m)
SD-1	7556689.91	435706.20	43.34
SD-2	7556012.82	435856.58	43.16
SD-3	7555955.49	435954.91	52.20
SD-4	7555880.67	435438.74	46.28

0m 30 60 90 120

srk consulting

SRK JOB NO.: 1CT022.064

FILE NAME: 1CT022.064 - SD Instrumentation Plan.dwg

MAC RESOURCES

Doris TIA

South Dam Monitoring SOP

South Dam General Arrangement and Instrumentation

DATE:	APPROVED:	FIGURE:
June 2020	PL	1

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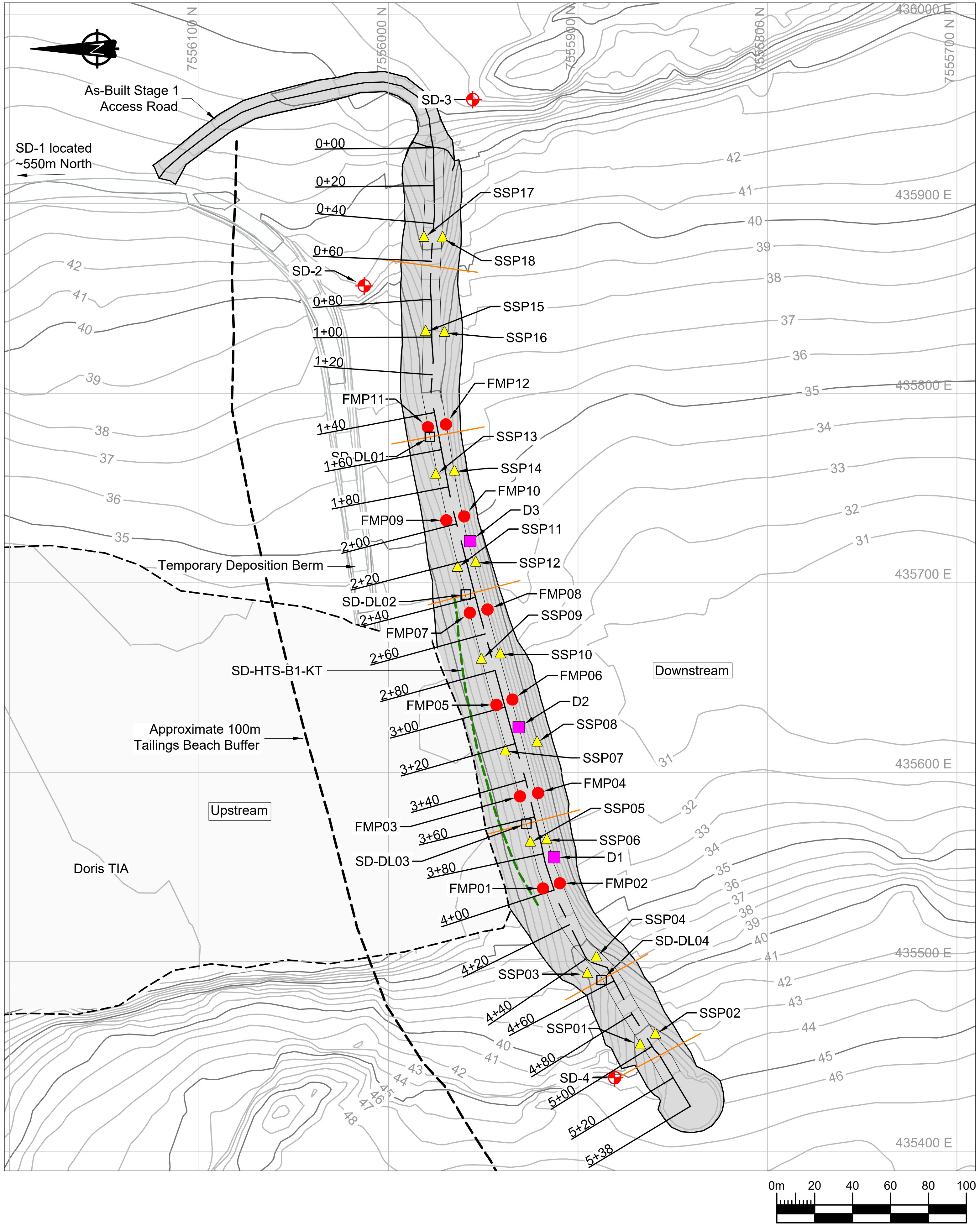

LEGEND

- As-Built Survey Monitoring Point
- Design Surface Monitoring Point
- Design Deep Settlement Point
- Datalogger Location
- Control Point
- 2019 Sub-Aerial Tailings Extent (Approx.)

NOTES

1. Topographic and As-built data was provided by the Client
2. Contours shown at 1.0m interval.
3. All units shown are in meters unless otherwise stated.

REFERENCES

NAD83 UTM Zone 13.

Node (2 Dataloggers)	GTC Name
SD-DL01	SD-VTS-065-KT
	SD-HTS-065-US
	SD-VTS-155-KTC
	SD-HTS-155-US
	SD-VTS-155-US
	SD-VTS-155-DS
	SD-VTS-155-KT*
SD-DL02	SD-HTC-240-KT
	SD-VTS-240-KT
	SD-HTS-240-US
	SD-VTS-240-US
	SD-VTS-240-DS
SD-DL03	SD-HST-365-KT*
	SD-VTS-365-KT
	SD-HTS-365-US
	SD-VTS-365-US
	SD-VTS-365-DS
	SD-VTS-US1
	SD-VTS-US2
SD-DL04	SD-VTS-460-KT
	SD-HST-460-KT
	SD-HTS-460-US*
	SD-VTS-460-US
	SD-VTS-460-DS
	SD-VTS-510-KT
	SD-HTS-510-US
	SD-HST-B1-KT

* denotes Not Connected

AS-BUILT SURFICIAL SURVEY POINT (SSP) STAKEOUT TABLE

ID	Northing	Easting	Elev. (m)
SD-SSP-01	7555867.82	435455.96	45.67
SD-SSP-02	7555858.65	435461.87	45.57
SD-SSP-03	7555891.61	435492.14	40.94
SD-SSP-04	7555888.48	435503.97	40.64
SD-SSP-05	7555923.75	435557.73	38.34
SD-SSP-06	7555914.52	435560.18	38.41
SD-SSP-07	7555936.52	435608.87	38.31
SD-SSP-08	7555927.20	435611.16	38.52
SD-SSP-09	7555950.16	435660.61	38.53
SD-SSP-10	7555941.74	435663.52	38.47
SD-SSP-11	7555963.07	435707.16	38.40
SD-SSP-12	7555954.46	435711.00	38.43
SD-SSP-13	7555974.12	435755.06	38.97
SD-SSP-14	7555964.83	435756.80	39.06
SD-SSP-15	7555981.95	435832.00	41.12
SD-SSP-16	7555971.80	435831.60	41.06
SD-SSP-17	7555982.30	435882.00	45.82
SD-SSP-18	7555971.81	435881.78	45.72
SD-SSP-19	7555869.96	435462.38	45.10

AS-BUILT SURVEY MONITORING POINT (SMP) STAKEOUT TABLE

ID	Northing	Easting	Elev. (m)
SD-SMP-01	7555918.41	435538.69	38.67
SD-SMP-02	7555909.54	435541.41	38.72
SD-SMP-03	7555930.58	435587.27	38.60
SD-SMP-04	7555920.99	435588.99	38.59
SD-SMP-05	7555943.00	435635.52	38.66
SD-SMP-06	7555934.56	435638.37	38.65
SD-SMP-07	7555957.03	435684.15	38.75
SD-SMP-08	7555947.77	435685.90	38.79
SD-SMP-09	7555969.45	435732.95	38.63
SD-SMP-10	7555960.05	435734.99	38.84
SD-SMP-12	7555969.66	435783.53	40.02
SD-SMP-13	7555979.11	435782.09	39.94

AS-BUILT DEEP SETTLEMENT POINT (D) STAKEOUT TABLE

ID	Northing	Easting	Elev. (m)
SD-DSP-01	7555914.31	435557.90	39.56
SD-DSP-02	7555924.06	435595.90	38.86
SD-DSP-03	7555937.19	435644.95	39.45

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MAC RESOURCES

South Dam Monitoring SOP

South Dam Instrumentation Layout

SRK JOB NO.: 1CT022.064

FILE NAME: 1CT022.064 - SD Instrumentation Layout.dwg

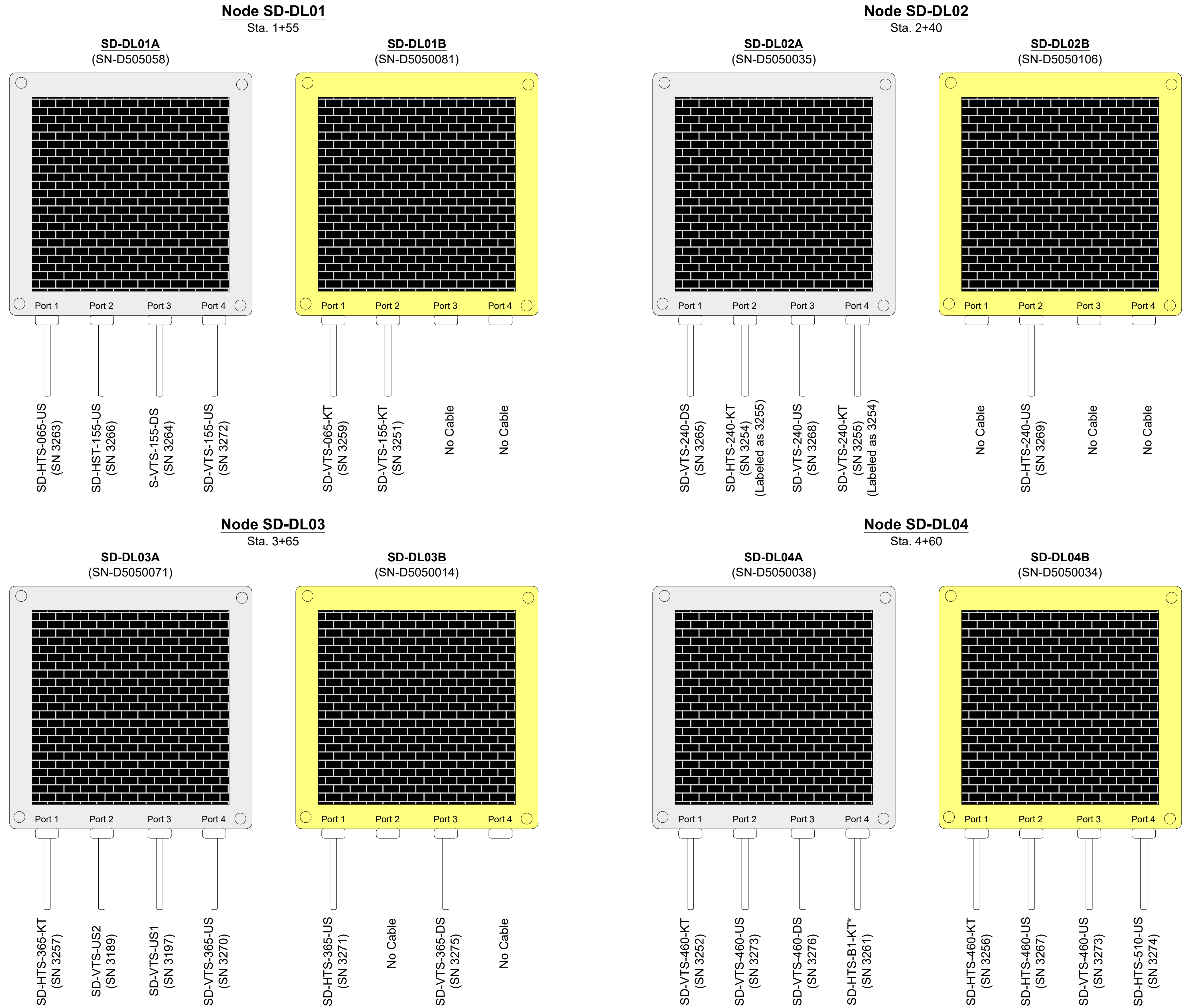
Doris TIA

DATE: June 2020

APPROVED: PL

FIGURE: 2

P:\Projects\01_SITES\Hope Bay\!ACAD\2019 Drawings\South Dam SOP\1CT022.064 - SD Instrumentation Layout.dwg



Datalogger Node	Datalogger ID	Nominal GTC station	ID	Serial Number	Number of Beads
SD-DL01	SD-DL01A	0+65	SD-HTS-065-US	3263	5
	SD-DL01B	0+65	SD-VTS-065-KT	3259	11
	SD-DL01A	1+55	SD-HTS-155-US	3266	5
	SD-DL01A	1+55	SD-VTS-155-US	3272	11
	SD-DL01A	1+55	SD-VTS-155-DS	3264	11
	SD-DL01B	1+55	SD-VTS-155-KT	3251	11
	Not connected	1+55	SD-HTS-155-KT	0	0
SD-DL02	SD-DL02A	2+40	SD-HTS-240-KT	3254	11
	SD-DL02A	2+40	SD-VTS-240-KT	3255	11
	SD-DL02A	2+40	SD-VTS-240-US	3268	11
	SD-DL02A	2+40	SD-VTS-240-DS	3265	11
	SD-DL02B	2+40	SD-HTS-240-US	3269	7
SD-DL03	SD-DL03A	3+30	SD-VTS-US1	3197	13
	SD-DL03A	3+30	SD-VTS-US2	3189	15
	SD-DL03A	3+65	SD-HTS-365-KT	3257	11
	SD-DL03A	3+65	SD-VTS-365-US	3270	11
	SD-DL03B	3+65	SD-HTS-365-US	3271	11
	SD-DL03B	3+65	SD-VTS-365-DS	3275	11
	Not connected	3+65	SD-VTS-365-KT	0	0
SD-DL04	SD-DL04A	4+60	SD-VTS-460-KT	3252	11
	SD-DL04A	4+60	SD-VTS-460-US	3273	11
	SD-DL04A	4+60	SD-VTS-460-DS	3276	11
	SD-DL04B	4+60	SD-HTS-460-KT	3256	11
	SD-DL04B	4+60	SD-HTS-460-US	3267	0
	Not connected	4+60	SD-VTS-460-US	3273	11
	SD-DL04B	5+10	SD-VTS-510-KT	3260	11
	SD-DL04B	5+10	SD-HTS-510-US	3274	5
	SD-DL04A	N/A	SD-HTS-B1-KT*	3261	20

Note:
*Located parallel to key trench

Datalogger ID	Color	Serial Number (SN)
SD-DL01A	Grey	D5050058
SD-DL01B	Yellow	D5050081
SD-DL02A	Grey	D5050035
SD-DL02B	Yellow	D5050106
SD-DL03A	Grey	D5050071
SD-DL03B	Yellow	D5050014
SD-DL04A	Grey	D5050038
SD-DL04B	Yellow	D5050034

LEGEND

3-watt solar panel with temperature compensated charge control circuit.

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MAC RESOURCES

SRK JOB NO.: 1CT022.064
FILE NAME: 1CT022.064 - South Dam Monitoring.dwg

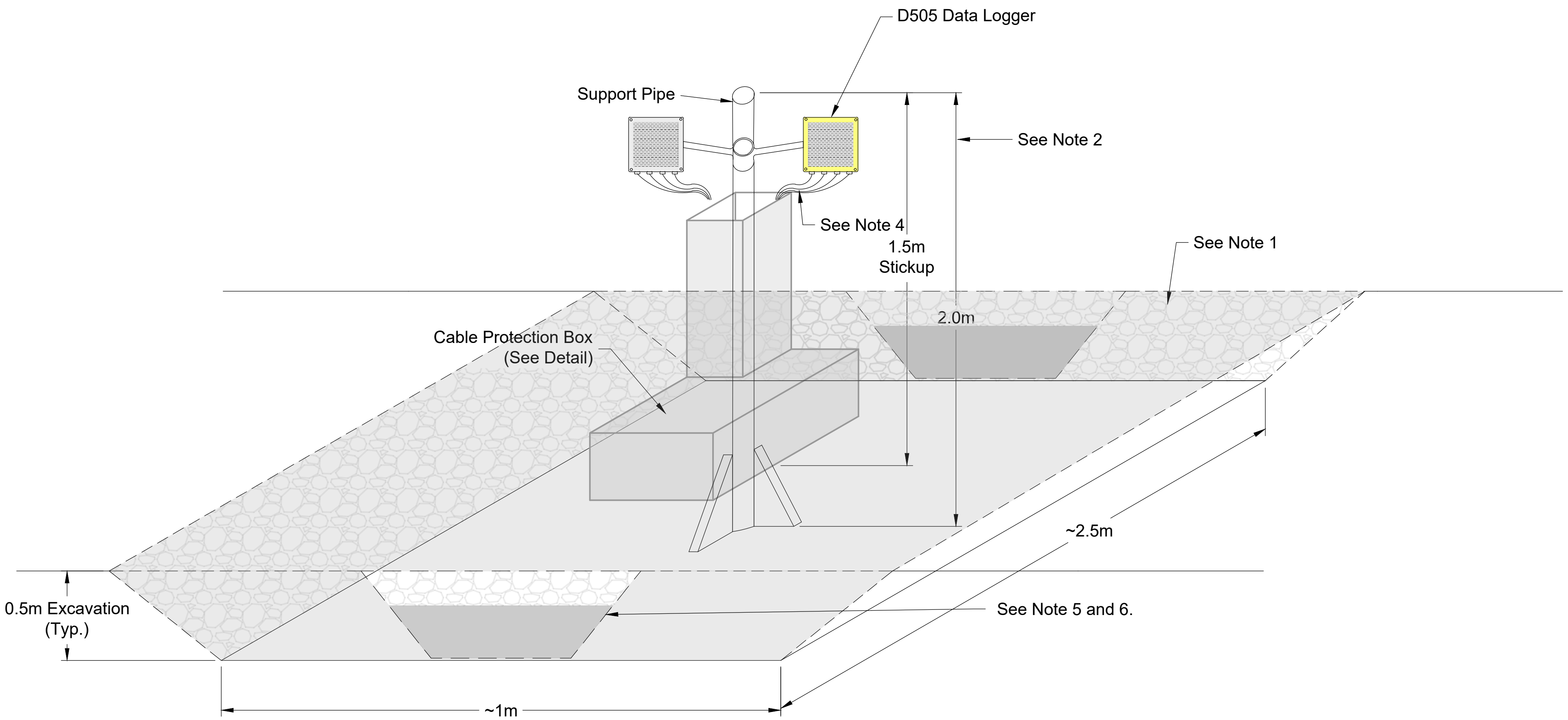
Doris TIA

South Dam Monitoring SOP

GTC Data Logger Nodes

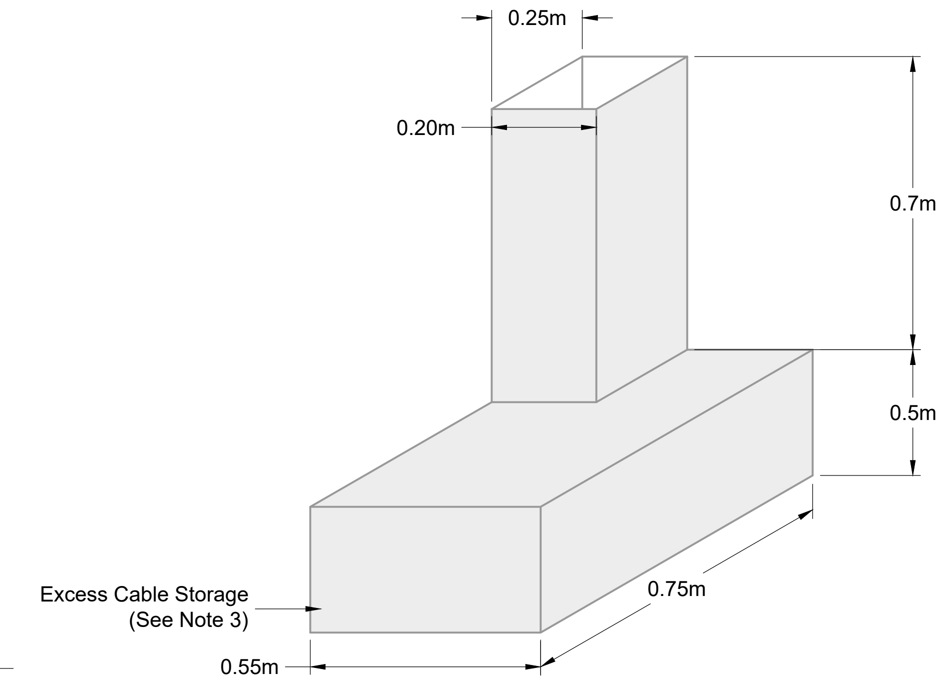
DATE: July 2020
APPROVED: PL
FIGURE: 3

P:\Projects\01_SITES\Hope Bay\!ACAD\2019 Drawings\South Dam SOP\1CT022.064 - South Dam Monitoring.dwg



Typical Installation Detail of Data Loggers SD-DL01 through SD-DL04

Not To Scale



Wood Cable Protection Box

Not To Scale

Installation at Node SD-DL03

NOTES

1. Following installation of the support pipe, the excavation was backfilled with ROQ material prior to installation of the cable protection box.
2. All dimensions are approximate.
3. Additional lead cable stored for protection from wildlife and the outdoor elements in Cable Protection Box.
4. Limited lead cable exposed between the Cable Protection Box and the Data Logger for protection from wildlife and the outdoor elements.
5. Ground temperature cables enter the Cable Protection Box through shallow trenches located near the upstream dam crest.
6. Crushed rock placed under and around ground temperature cables then backfilled with select ROQ.

P:\Projects\01_SITES\Hope Bay\!ACAD\2019 Drawings\South Dam SOP\1CT022.064 - South Dam Monitoring.dwg

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SRK JOB NO.: 1CT022.064

FILE NAME: 1CT022.064 - South Dam Monitoring.dwg

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South Dam Monitoring SOP

Typical Data Logger and GTC Install Details

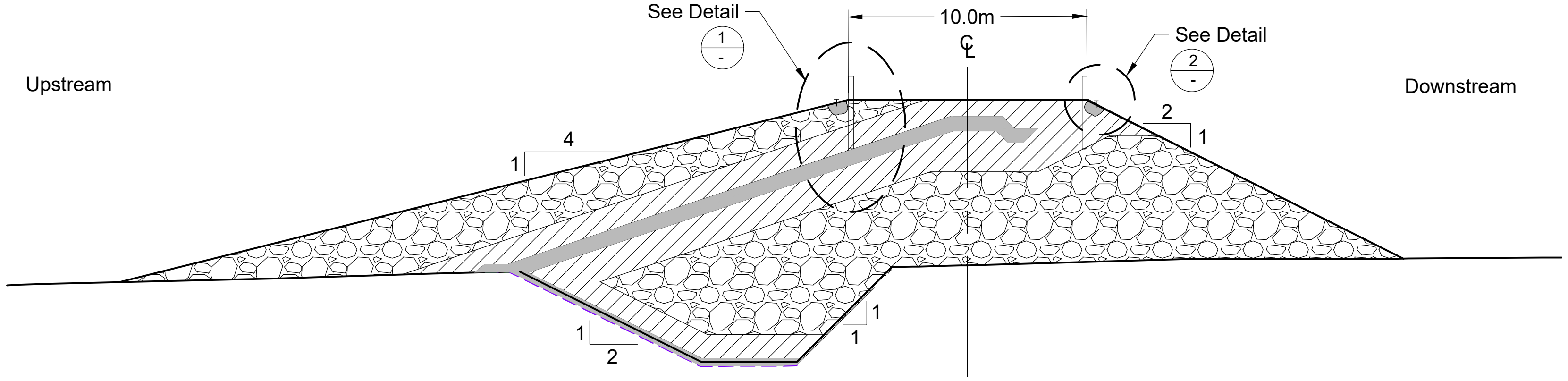
DATE:	APPROVED:	FIGURE:
June 2020	PL	4

LEGEND

- Lower GCL Liner
- Upper GCL Liner
- Bedding Material
- Transition Material
- Run of Quarry Backfill

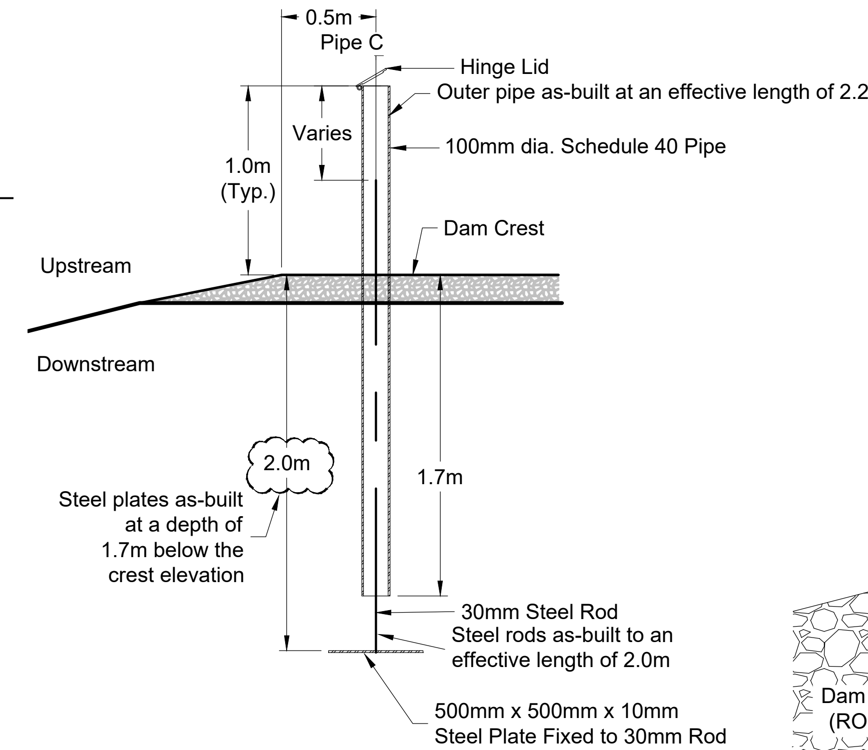
NOTES

1. All units shown are in meters unless otherwise stated.
2. D1 and D3 as-built using steel pipe, OD 102mm.
   D2 as-built using HDPE pipe OD 51mm.



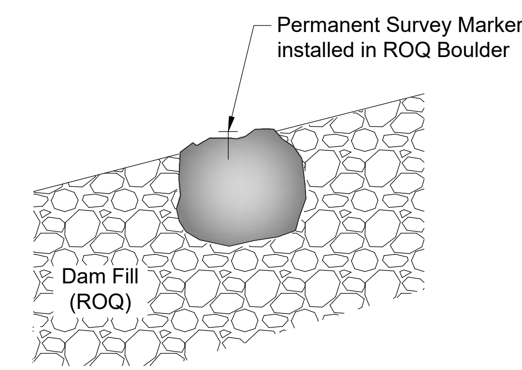
Near-surface Survey Monitoring Points (SSP and SMP) (Sta. 3+00 and 3+20)

0m 3 6 9 12



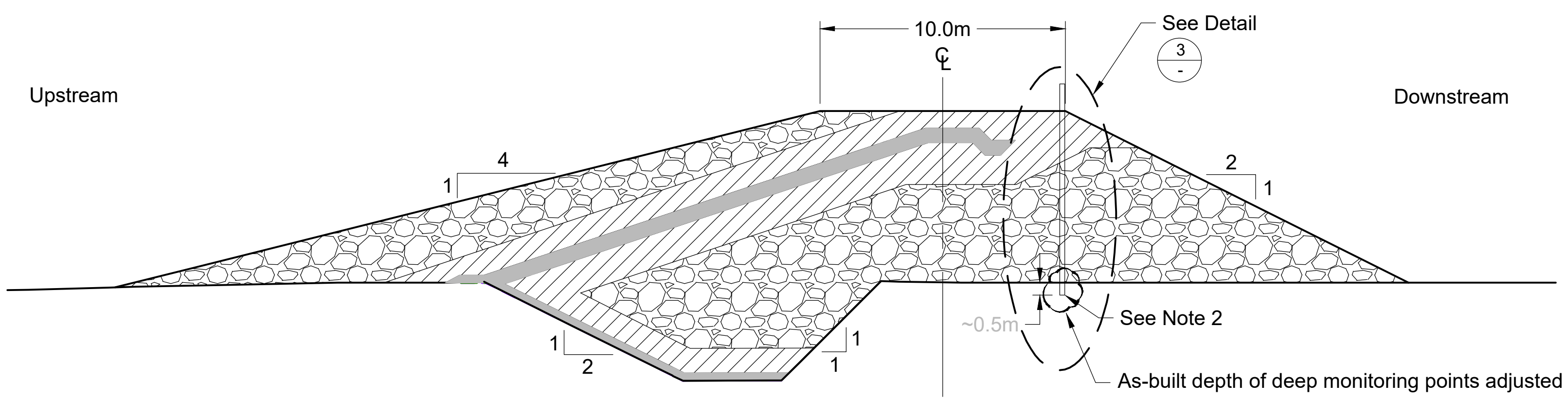
Detail 1 - Survey Monitoring Point Installation

0m 0.25 0.5 0.75 1.0



Detail 2 - Surficial Survey Point Installation

0m 0.25 0.5 0.75 1.0

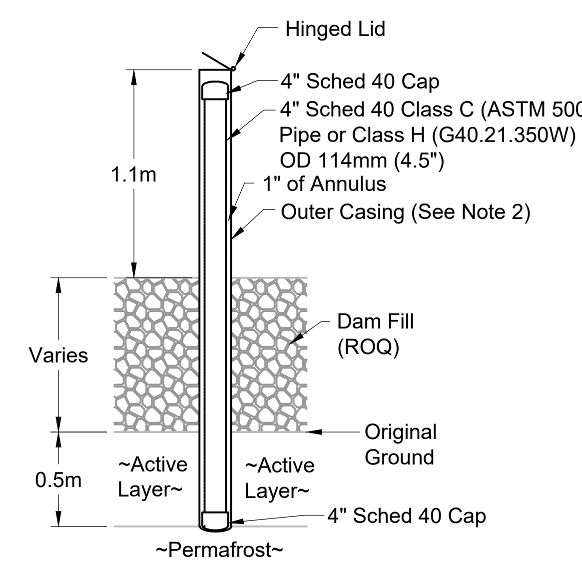


As-built depth of deep monitoring points adjusted as:

Monitoring Point ID	Depth below Dam Crest (m)	Approximate Elevation (m)
D1 = 3+80	6.2	31.8
D2 = 3+40	8	30
D3 = 2+90	5.4	32.6

Deep Settlement Points (Sta. 3+50)

0m 3 6 9 12



Detail 3 - Deep Settlement Point Installation

0m 0.25 0.5 0.75 1.0

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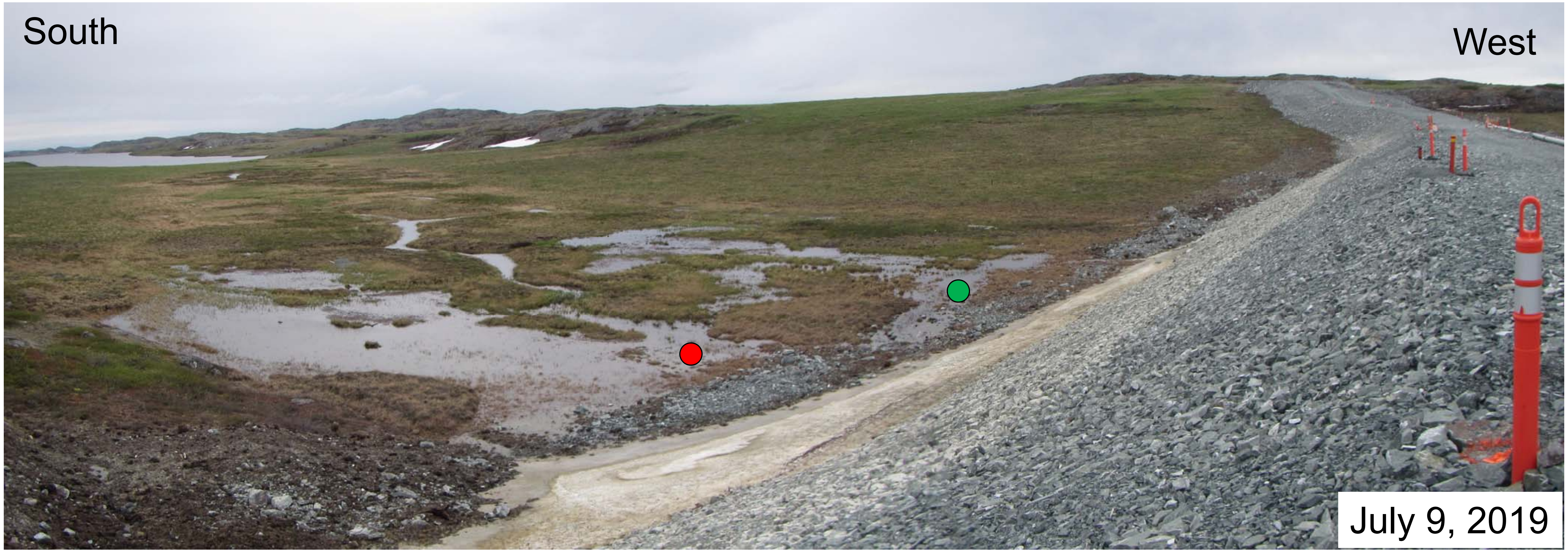
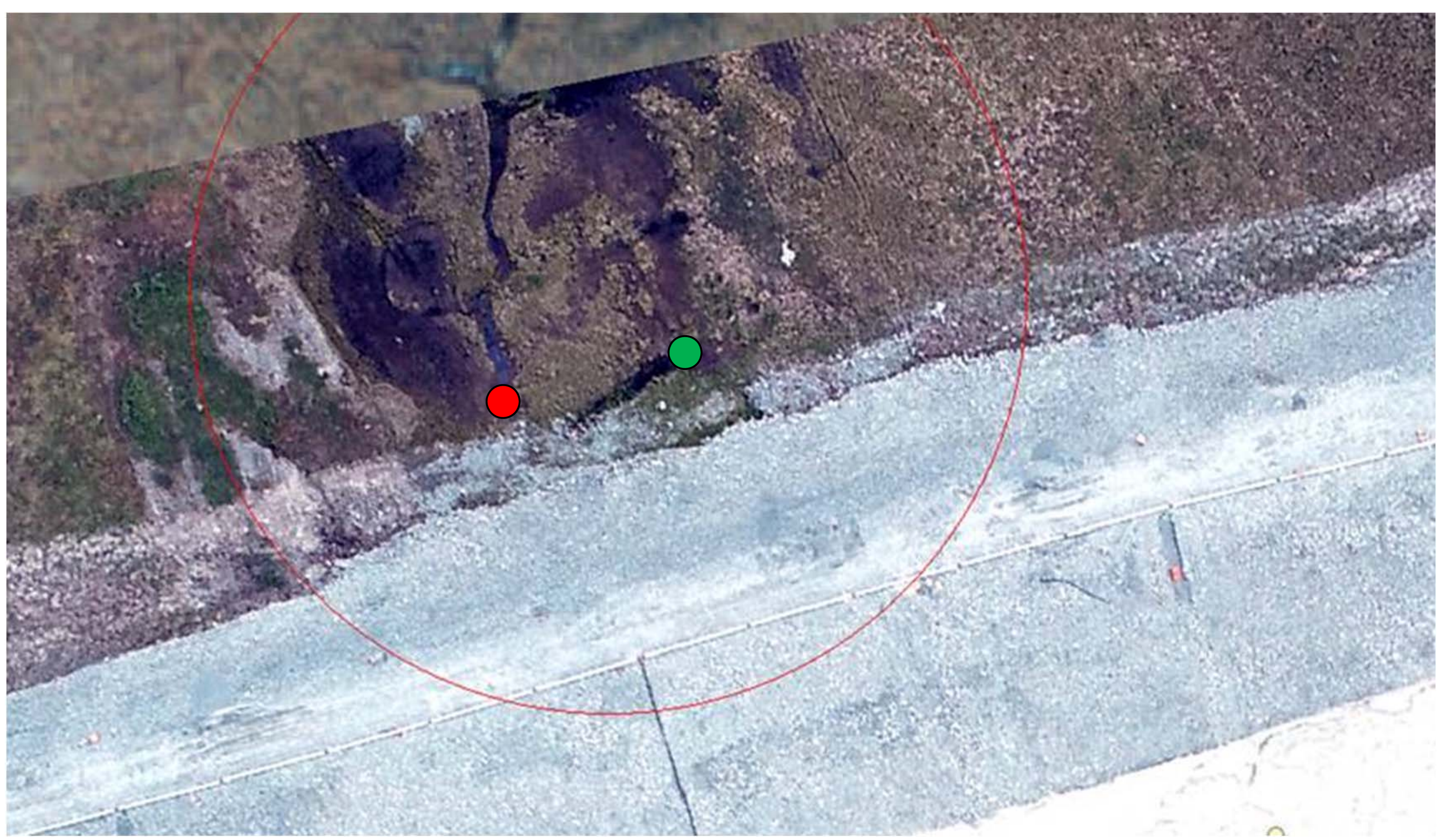
SRK JOB NO.: 1CT022.064		South Dam Monitoring SOP
FILE NAME: 1CT0022.064 - InstrumentationXS.dwg	Doris TIA	Typical Deformation Monitoring Point Details
DATE: June 2020	APPROVED: PL	FIGURE: 5

P:\Projects\01_SITES\Hope Bay\!ACAD\2019 Drawings\South Dam SOP\1CT0022.064 - InstrumentationXS.dwg





Legend

- 🟢 Ponded water sampling location (SDPOND01)
- 🔴 Ponded water sampling location (SDPOND02)

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TMAC RESOURCES

South Dam Monitoring SOP

South Dam Ponded Water Sample Locations

Job No: 1CT022.064

Filename: Figure_SDSOP_1CT022.064_20200604.pptx

Doris TIA

Date: June 2020

Approved: PL

Figure: 6

Appendix A - Operator’s Manuals

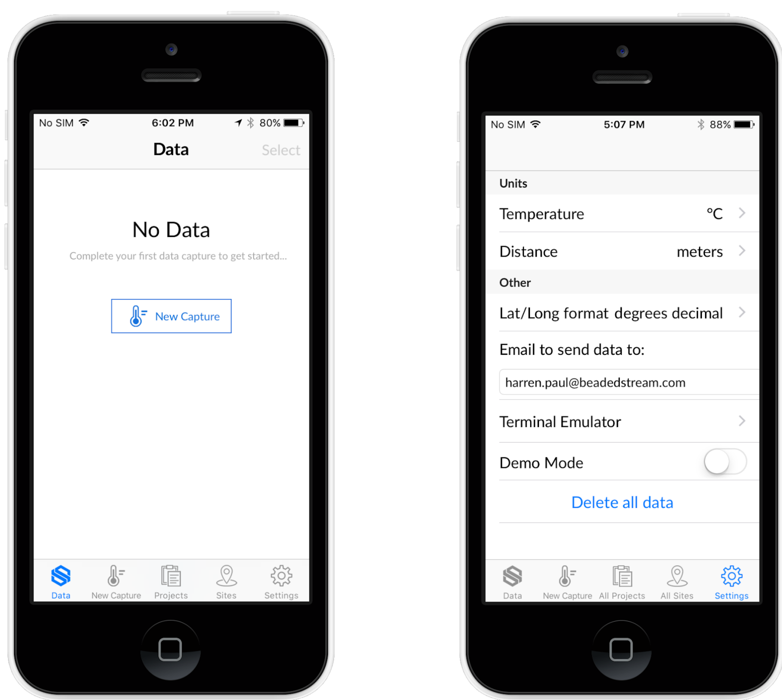
Appendix A1 - D505 Series Data ‘Capture App’ Guide

D505 & Torpedo 2 | *Capture* App Guide

"Capture by BeadedStream" is available free on the iOS App Store. The app connects via Bluetooth to D5XX loggers: the D505 (*satellite*) and the "Torpedo 2" (*portable*).

Getting started

On first launch of the app, the Data screen will show (*below, left*).

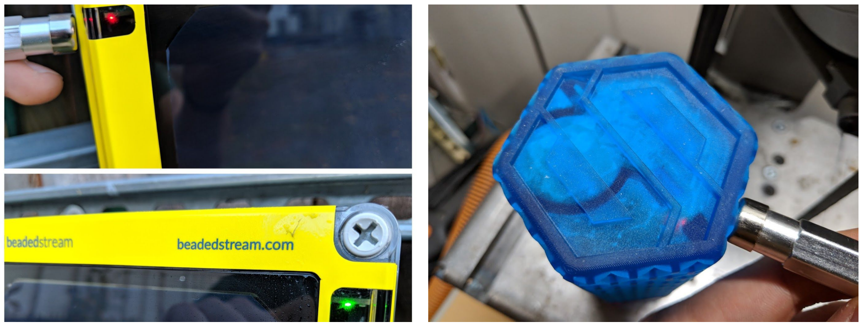


Settings should be configured (*above, right*):

- **Units:** "Distance" will affect sensor positions that display alongside temperature.
- **Lat/long format:** Stored with a [Site]. A "site" is any place instrumented with a temporary/dedicated cable.
- **Email:** The recipient for data export.
    - Note: *requires a functioning email account in Apple's "Mail" app.*

Wake the logger before connection

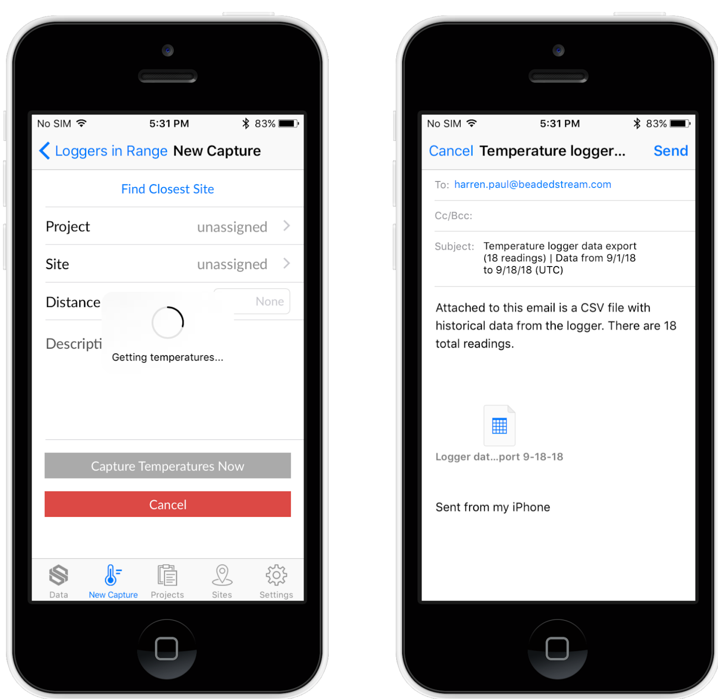
Required: Just before data capture/logger connection, blink the red LED with a magnet swipe:



***Swipe locations**: (Left) Left decal cutout for the D505 (Right) Bottom of the Torpedo 2 shell*

Download logger data

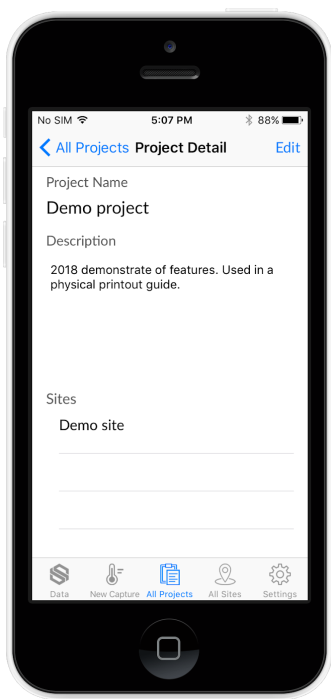
Starting at **New Capture**, select the logger, then [Download logger data] on the next screen. When process completes, hit [Send] on the email draft (*data is attached*):

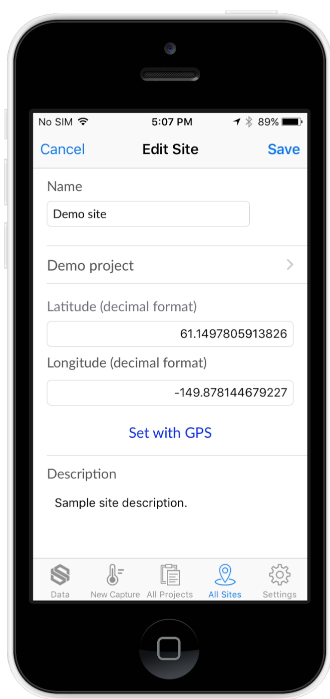


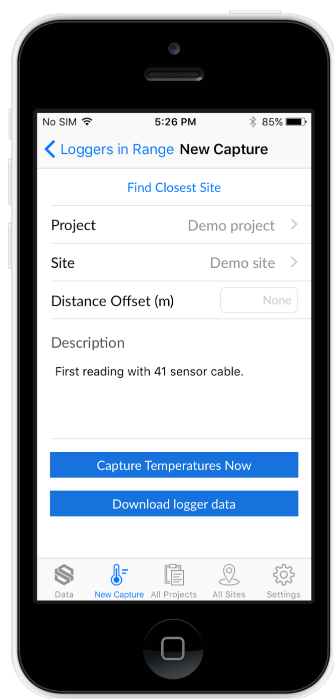
Spot capture

"Spot" capture is a manual temperature reading taken with a connected cable. Data will store on the iOS device, *not* the logger. To perform:

1. **Create a** **Project**: Give it a name and a description.
2. **Create** **Site(s)**: One for each location a cable will measure.
    - **Note:** Make sure sites are saved **in** a project
    - *Optional:* Lat/long can be added manually or [Set with GPS]
3. **Prepare and capture:** Starting at **New Capture**, select the logger, then choose a [Project] and [Site] then [Capture Temperatures Now]. Extra options:
    - **Find Closest Site**: Phone location is compared with lat/long configured in any sites, and the closest is auto-filled.
    - **Distance Offset:** *Positive value* means the top sensor is above a ground reference.
4. **Export data:** Go to **Data**, hit [Select], then select readings, days, or [Select all]. Hit [Send]. Hit [Send] on the email draft (*data is attached*)







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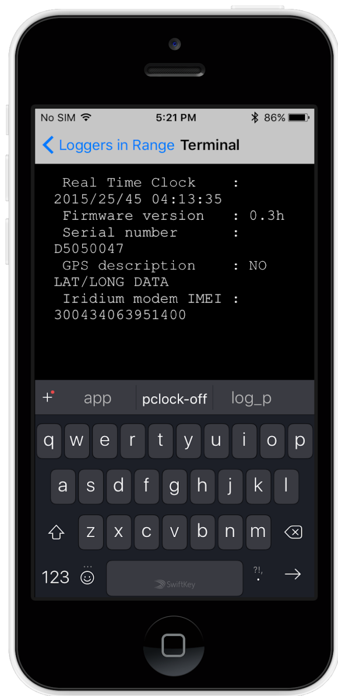
Deploying a logger in the field

Achieving a "terminal" connection with the data logger will allow verification of logger status and sensor function. Complete the [BeadedStream Logger Installation Checklist] before this step.

Starting in **Settings**, select [Terminal Emulator], then the logger. Upon connection, the **status** command will run and finish within 15 seconds. See Appendix B for details on commands.



The following command should be run and will **complete deployment**:

```
> deploy
```

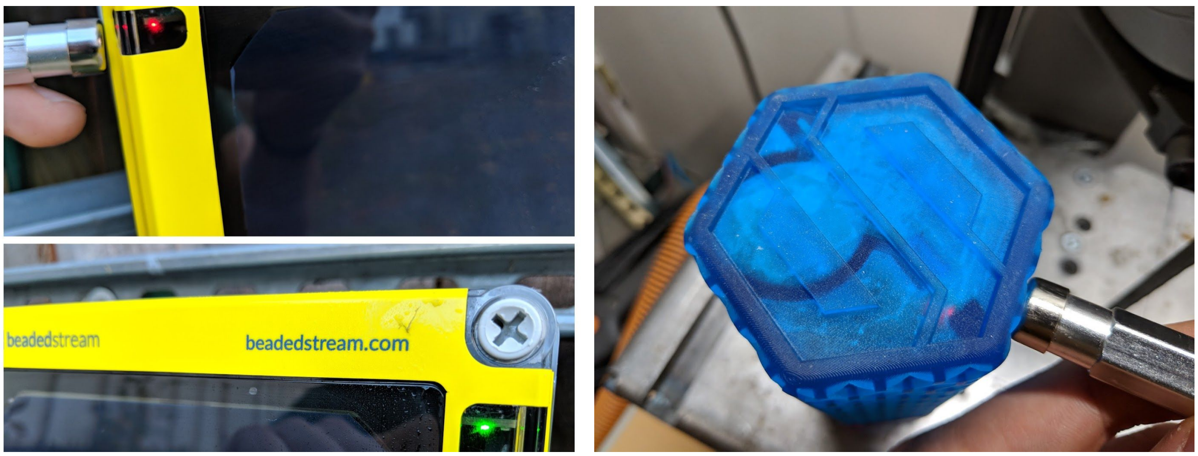
The command will automate a flow of final settings configuration and sensor checks. The last step will transmit logger configuration to Iridium.

- **Note:** If the final step *fails*, see the bottom of Appendix B (*see also for command detail*).

Appendix A | LED detail, logger states, magnet actions

D5XX data loggers share the same circuit board and the same three LEDs:

- Red (*below*): Lights when sensing a magnet. Blinks *every second* with constant hold.
- Green (*below*, *left*): Lights during processor activity.
- Blue (*unpictured*, *next to green*): Lights during Bluetooth connection/activity.



***Unpictured**: Green and blue LEDs for the Torpedo 2 - located opposite the red along the long edge of the enclosure.*

Data logger states are indicated by LED status:

- **On, idling**: Green blink every 7 seconds.
- **On, nap mode:** Green double blink every 7 seconds. See Nap Mode Notice for more.
- **On, processor awake**. *No LED indication*. Lasts a few minutes after boot up or after a magnet swipe. Scheduled readings/transmissions wake the processor.
- **On, busy**. Solid green. The logger is reading, transmitting, or moving data (Bluetooth).
- **On, active Bluetooth connection**. Solid blue while connected to an iOS device.
- **Rebooting**. All LEDs quickly flash after battery connection or a magnet-reboot.
- **Off - Unplugged/dead battery**. *No LED activity*. The battery molex connection can be checked through the blue/green LED decal cutout (*D505*).

Actions can be triggered with a magnet:

- **Wake the logger:** Swipe magnet for a red LED blink.
- **Force a reading/transmission:** Hold for—2 red LED blinks—and release.
- **Engage nap mode for 60 days:** Hold for—4 red LED blinks—and release.
- **Trigger a reboot:** Hold until the red LED goes *out* and all LEDs flash (*about 8s*).

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Appendix B | Useful terminal commands

Below lists useful terminal commands. **BOLD** indicates an input placeholder:

```
> ?
> status
> temps
> log_p H
> log_p HH:MM
> transmit_p H
> send
> lock
> deploy
```

Command detail:

?	Displays all commands. Many commands should be ignored.
status	Displays logger configuration. "Inbox rx period" is the satellite check interval (*hard coded to 24 hours*). **Note:** 6.6V+ is a full battery. Transmissions will fail at 6V (*dead battery*), but logging functions down to 5.5V.
temps	Queries all sensors and displays results
log_p **H**	Sets the logging interval in hours. Starts at (UTC) midnight.
log_p **HH:MM**	Finer control of logging. Allows sub-hour values (*e.g. 0:15 for 15 mins*)
transmit_p **H**	Sets the transmit interval. Transmits ONLY current reading, no batching.
send	Queries all sensors and transmits to Iridium.
lock	Acquires logger configuration and transmits to Iridium.
deploy	*Batches* these commands: status, log_p, transmit_p, temps, lock

Note: A satellite transmit session can commonly send data successfully but **not** receive a confirmation response. This will show as a FAIL TO SEND in the app. Retry a few times till success and/or contact BeadedStream for full confirmation.

Appendix A2 - Quick Reference for the D405/505 Battery

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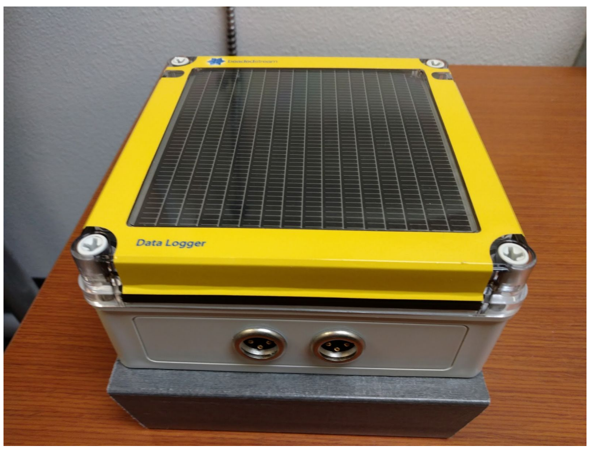
Quick Reference for the D405/505 Battery

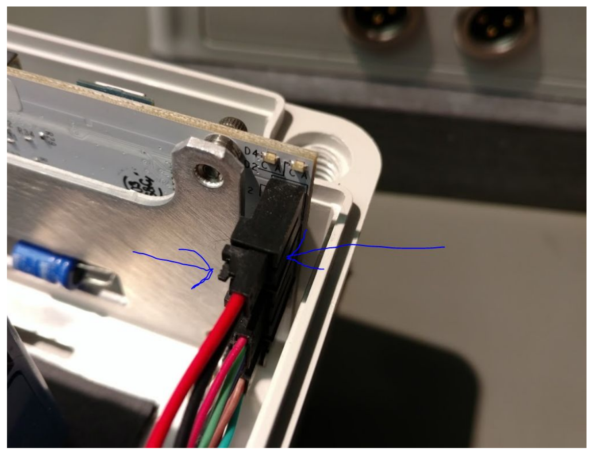
- When preparing to change or connect/disconnect the D405/505 battery, first make sure the logger has spent about 30 minutes acclimating to a warm and dry environment.

If the above is not possible, be extra careful with the torque on the screws or they can snap in the cold!

- Start by removing the plastic Vynckier screws, seen below in the first image.

Take care when removing the lid- there will be a small wire connecting the solar panel in the lid to the circuit board in the body of the enclosure.





- With the lid off, follow the red and black wire pair from the battery to the two-pin molex connector. The second image above shows the connection.
- **Simultaneously**, lightly support the female molex receptacle while squeezing the tab on the male connector and pull to release the battery connection. When reconnecting, look/listen for the click of the small locking tab.

When re-attaching the lid...

- Make sure that no wires are caught in the seal or the edges.
- Make sure **not to overtorque** the screws, they only need to be turned to the limit of a light screwdriver grip (fingertip) and then a final 180° turn to complete. The black seal between the lid and base should visibly compress as the screws receive the final twist - *this is a good indicator of enough torque.*

If the battery is being changed...

- Use a 5/16" hex bit to loosen the hose clamp. Alternatively a flathead screwdriver can be used.
- Grip and twist the old battery initially to break the contact adhesion with the rubber pad below.

Appendix A3 - D400 Series Data Logger
(Alternative Resource NOT THE MODEL INSTALLED)

D400 SERIES DATA LOGGER

Manually connecting to the D400 series loggers and other useful information

The D401 and D405 Data Loggers are extremely low-powered, programmable units used to log and/or transmit temperature data from BeadedStream TACs. The D401 has been engineered to be easily deployed and log data locally for site visits and manual downloads, while the D405 transmits data in real-time, through the Iridium Satellite Network, to the Internet.

Contents

Direct Communication with D400 Series Loggers

D400 Loggers are shipped ready to be deployed in the field (unless specifically stated otherwise). *However, in the event that the Iridium Link is not used, a manual connection is necessary to configure the logger and download data*.

Terminal Emulator Instructions for Windows

For direct communication with BeadedStream Data Loggers, we use command line software called *RealTerm*. Realterm is a terminal emulator specially designed for capturing, controlling and debugging binary and other difficult data streams. By using Realterm, BeadedStream users will be able to configure data loggers and download temperature data.

Downloading Realterm

Realterm is free command line software that can be downloaded from:

http://sourceforge.net/projects/realterm/files/Realterm/ if not provided directly by BeadedStream.

By downloading the latest version of Realterm, an executable (.exe) file will be placed in your default downloads location. Double-clicking on this executable will initiate installation of Realterm. Follow the installation prompts and accept default settings. Realterm should install on your PC in just a few moments. You may need to restart your computer; otherwise a desktop icon should be available for immediate access to Realterm.

Connecting to your BeadedStream D400 Series Data Logger

To connect to your data logger you will need:

1. A laptop or desktop computer with Realterm installed
2. A standard USB to mini-USB connector cable
3. A data logger

Locate the mini USB connector port within the logger enclosure and firmly plug in the mini-USB. Plug the other end of the cable into your computer.

NOTE: If your USB connection is not working, there are a few potential reasons.

1. *Please check settings on your PC with regards to being able to automatically download USB drivers from the internet.*

2. *The logger can hold a communication connection even if not powered with a battery. In the event that a battery is dead or not connected and a connection is needed, the logger can be powered through the USB connection.* ***In the event that USB power is needed – attach the USB and wait at least 5 minutes – this will allow time for capacitors on the logger to charge and function.***
3. *D400 Loggers require a unique driver that may or may not install automatically on your computer. You can obtain the proper driver by visiting this website >* http://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx < Select the correct driver that corresponds to your operating system.

Open Realterm in your computer by double clicking on the Realterm icon on your desktop. Realterm has many advanced applications; however, here we will explain only the steps necessary to interface with your BeadedStream Data Logger.

The Realterm command prompt is characterized by a black window; this is where commands are typed. Below this window there are 10 tabs. **We will only be concerned with the first three (Display, Port and Capture).**

DISPLAY

To begin, we will set some parameters under the display tab. We accept most of the default settings, however under 'Rows' change the default from 16 to 30. This will make the command window larger. The number of rows can be set to any desired number. Additionally check the box for 'Scroll back'. This will allow for the ability to scroll to previous command entries and returns.

PORT

Your computer needs information regarding the nature and location of devices in order to communicate. This is designated by assigning ports. At this point, using your USB connector cable, connect your Data Logger to the USB interface on your computer. To determine what port is being used, you'll need to access the '**Device Manager',** when using a Windows platform. To access the Device Manager, you can type 'Device Manager' in the search bar or right click on '**My Computer'**. This will prompt a menu, where you'll want to select '**Manage'**. This will further prompt the '**Computer Management'** dialog box. Select '**Device Manager'**. Double-clicking on '**Ports (COM & LPT**)' will reveal which USB Serial Port is being used (i.e. COM5 would mean that your computer assigned Port 5 arbitrarily to this device).

Back in Realterm, *change the baud rate to 115200*, enter the port number and click '**Open**'. Open initiates communication between your computer and the data logger, however you must also click '**Change'** in order for communication prompts to be actualized.

At this point, the data logger is synced to your computer and active communication can begin.

Terminal Emulator Instructions for MAC

For direct communication with BeadedStream Data Loggers using a Mac, most new Macs come stocked with a terminal emulator called 'CoolTerm'

Connecting to your BeadedStream D400 Series Data Logger

To connect to your data logger you will need:

1. A laptop or desktop computer with Cool Term installed
2. A standard USB to mini-USB connector cable
3. A data logger

Locate the mini USB connector port on the bottom of the logger enclosure and firmly plug in the mini-USB. Plug the other end of the cable into your computer.

NOTE: If your USB connection is not working, there are a few potential reasons.

1. *Please check settings on your PC with regards to being able to automatically download USB drivers from the internet.*
2. *The logger can hold a communication connection even if not powered with a battery. In the event that a battery is dead or not connected and a connection is needed, the logger can be powered through the USB connection.* ***In the event that USB power is needed – <u>attach the USB and wait at least 5 minutes</u> – this will allow time for capacitors on the logger to charge and function.***
3. *D400 Loggers require a unique driver that may or may not install automatically on your computer. You can obtain the proper driver by visiting this website >* http://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx < Select the correct driver that corresponds to your operating system.

Open CoolTerm from your Mac Desktop.

- Select 'Options'
- In the Serial Port menu, 'Re-Scan Serial Ports'
- In Port, select 'SLAB_USBtoUART'.
- Set the BaudRate to 115200
- Click 'OK'
- Choose 'Connect' amongst the menu icons.

At this point, the data logger is synced to your computer and active communication can begin.

BLE Dongle Instructions

D400 Loggers have a BlueTooth Low Energy (BLE) Radio that can be used instead of a USB cable to establish a connection with either a MAC or PC. The dongle does not come standard with BeadedStream equipment, but can be useful if a wireless connection is necessary using a laptop. The instructions below describe how to use the dongle.

Connect to the Logger via Bluetooth

1. Plugging the BLE dongle into a USB port will prompt your PC to find and download necessary drivers automatically. In your Bluetooth Radios tab under 'Device Manager' – you should now have 'Broadcom 20702 Bluetooth 4.0 Adapter' – or something similar.

2. Your logger will need to be powered (Battery or USB) in addition to having a BLE connection. Plug the logger to your PC via USB and also have the BLE dongle plugged in. You should have one COM port connection at this point. On my computer, <u>the logger has been assigned to COM5 via Bluetooth. *Ignore the COM50 connection specified here.*</u>

3. Back in RealTerm – in the below example, I set a Baud of 115200 and set the port to COM5. I then click 'open' and then 'change'***. My Bluetooth connection has not been made yet*** – there are a few commands to enter.

4. To conserve power on the logger, the Bluetooth Radio is turned off of unless prompted by magnet swipe over a hall effect sensor (labeled MAG on the outside of your logger enclosure). To initiate Bluetooth pairing between the logger and Dongle Radio, you'll need to swipe a magnet over this switch. This will activate the logger for **60 seconds –** to which you will need to go through the sequence below …. Really just a couple of commands

5. Click in the terminal window and type the following command (don't forget you've only got 60 seconds once you've tripped the switch with your magnet) – you may not receive an echo in the terminal, but once you hit carriage return, it should work.

   a. *Type :* atdile (with carriage return)
   b. *Receive:*
      OK

      DISCOVERY,2, **ECFE7E10557C**,0,-070,4,020106-020A04-051208001000-1107796022A0BEAFC0BDDE487962F1842BDA

DISCOVERY,6, **ECFE7E10557C**,0,-070,2,05FF85000000-1109426C7565526164696F73313035333330

DONE,1,1

c. *<u>NOTE: this shows that the Bluetooth Dongle Radio 'sees' the Logger radio. If no 'Discovery' has been made, you may not have triggered the mag swtich. Try again, the connection should be immediate within the 60 second window.</u>*

6. Next you need to type another command – notice the x's below need to be substituted with the bold scratchpad material above:
   a. Type: atdmle, **xxxxxxxxxxxx,** 1
   b. *Type or copy and paste:* atdmle, **ECFE7E10557C,** 1 (with carriage return)
   c. *Receive:*
      OK

      CONNECT,0,1,0,ECFE7E105330

      BRSP,0,1
   d. Note: there will be a couple of error messages – just ignore those. **YOU SHOULD NOW BE CONNECTED TO THE LOGGER VIA BLUETOOTH!!**

Communicating with your BeadedStream D400 Series Data Logger

Click in the black, command prompt box and follow some example syntax below. Commands that you would type are presented in **bold** *italics.* Returns are presented in normal *Italics*.

Help Menu

To set basic parameters in your data logger, start by typing the following commands and pressing ENTER:

help

HELP	*# show monitor commands*
VERSION	*# show firmware version*
DATE [yy/mm/dd]	*# set/get the current year/month/day*
TIME [hh:mm]	*# set/get the current hours:minutes*
SITE [site description]	*# set/get the site description*
SERIAL [serial number]	*# set/get the unit serial number*
DEPLOY [yy/mm/dd]	*# set/get the deployment date*
GPS [lat, long]	*# set/get the latitude and longitude*
LOG_P [hh:mm]	*# set/get the logging period*
TRANSMIT_P [hh:mm]	*# set/get the satellite TX period (hours)*
BAT_V	*# read battery voltage*
TEMPS	*# read current temperatures*
CLEAR	*# erase the log*
DATA [NEW]	*# get all or only NEW logged temperature data*
SEND	*# take a reading and transmit it via satellite*
STATUS	*# show unit status*

Date and Time

Setting Date and Time Manually

To set the time, it is necessary to find an accurate time source, such as www.time.gov . At BeadedStream we generally set the time to Zulu, however, the time can be set to any time zone.

Example Syntax:

date 13/12/31

2013/12/31 22:12:29

time 1:13

2013/12/31 01:13:00

Setting Date and Time with Iridium

If the logger is in contact with Iridium, the time and date will update automatically.

Setting Date and Time using the GPS radio

Similarly, if the logger does not have an Iridium link, the time can be set using the GPS radio by typing the following command while a having a clear view of the sky (likely outside). Entering a time (in seconds) after the command will prompt the GPS radio to attempt connection for that duration. The default time value is 60 seconds

Example Syntax:

rtc-set-from-gps

waiting max 60 seconds for gps update…

61 11.357380 N, 149 59.332136 W

2013/11/11 22:18:35

RTC UPDATED

Status Command

Similar steps are used to set site, deployment date, GPS coordinates, and the logging interval. Once these parameters are set, they can all be easily checked simultaneously by typing:

Status

Real Time Clock : 2013/11/11 22:23:37
Site description : SITE - NOT SET
Serial number : DLB00056
Site deployment : DEPLOYED - NOT SET
GPS description : GPS - NOT SET
Number of sensors: 8
Logging period : 12:00
Transmit period : 12:00
Inbox rx period : 24:00
Unit temperature : 17.37 C
Battery voltage : 6.574 volts
Storage used : 24 of 14600

Using Status is an easy way to get all necessary information regarding your logger in one swoop. Both date and time are presented as well as site description, serial number, site deployment, GPS points, and the number of sensors on your cable (this quickly shows that your logger is in fact reading a Temperature Acquisition Cable (TAC). In addition, the logging period shows that the logger logs cable temperatures every 12 hours, and also transmits them every 12 hours. There is current battery voltage, low battery threshold flag, and storage used. The logger 'know's whether or not it is Iridium enabled (D405). In the case that it is not (D401), only the logging interval is available to set.

Logging and Transmitting Intervals

The logging and transmission intervals, 'log_p' and 'transmit_p', can only be set to factors of a 24 hour day with a minimum of 5 minutes. NOTE: if using a D401, only the logging interval is settable. If using a D405, the logging and transmitting intervals are both settable. The logging interval is displayed in 'status', however, it can also be accessed by typing:

log_p

4:00

To change the logging period to 2 hours, type:

log_p 02:00

To make sure the change has been made, type:

log_p

2:00

Reading Temperature Data

To obtain temperature readings from your logger outside of the normal logging interval, simply type:

Temps

If not connected to a TAC, the logger will return:

Temperature sensors:
0 sensors found
FAULTS: 1

When connected to a TAC, the logger will read and return sensor serial numbers, and temperatures for each sensor.

Temperature sensors: 4 sensors found
1) 02000002CBC8CC28 temp = 19.93 C
2) 15000002CBC02C28 temp = 20.06 C
3) 06000002CBC02228 temp = 20.06 C
4) 0C000002CBD1ED28 temp = 20.00 C

Here, the logger is connected to a 4 – sensor TAC, where ambient air temperatures are at room temperature.

To access all recorded data on your logger simply type:

Data

According to the ‘status’ readout above, there are 24 entries out of 14600. In addition, headers are not included, but they are shown below to identify what data is returned with the ‘data’ command. There is date, time, snow depth (In the event that your logger has a depth sensor) and battery voltage. Panel Temp is the onboard temperature reading, while T1 – T4 are the four sensors on the attached cable. Sensor ID uniquely identifies the TAC by the serial number of the first sensor. If more than one TAC is attached to the logger (maximum of 4 TACs), the temperature data from each TAC will be preceded by the sensor ID of the first sensor of each TAC.

Data Flag, Date, Time, Panel Temp, Battery Voltage, Sensor ID (TAC 1), byte flag, T1, T2, T3, T4, Sensor ID (TAC 2), byte flag, T1, T2, T3, T4

02, 11/11/2013, 22:22:55, 17.37, 6.570, 00 00 04 29 c9 fc, 05, 16.63, 14.69, 15.75, 16.81, 00 00 04 29 b9 d4, 06, 16.81, 15.13, 14.76, 15.26
02, 11/11/2013, 22:23:16, 17.31, 6.574, 00 00 04 29 c9 fc, 05, 16.56, 14.63, 15.69, 16.75, 00 00 04 29 b9 d4, 06, 16.81, 15.01, 14.63, 15.07

Verifying Iridium Functionality

In the field, to verify that a D405 logger is working properly, we can use the ‘Send’ command to have the logger show us that 1. It is reading the TACs correctly, and 2. It is able to successfully send a transmission through Iridium. In this example, there are two, four-sensor TACs connected. In the terminal, we first see what data is going to be transmitted, and secondly, we see if that transmission was successful or not. The ‘Faults’ can be ignored.

Send

02, 11/11/2013, 22:22:20, 17.49, 6.578, 00 00 04 29 c9 fc, 05, 16.88, 14.88, 15.94, 17.00, 00 00 04 29 b9 d4, 06, 17.00, 15.32, 15.07, 15.63
transmitting ... please wait
SUCCEEDED, 241 tx attempt(s) since last successful tx
FAULTS: 1

Recording Temperature Data from the Logger

Capture Function in Windows

To save logger data onto your computer, we will do what is called a ‘capture’. In Realterm select the third tab called, ‘capture’ and follow these steps:

1. Next to ‘File’, select the desired output location of the file that will hold your captured data. Name this something that reflects the data that you are capturing.

2. Uncheck the box that selects 'Direct Capture'. This will allow you to see the commands that you are typing while they are being captured.
3. If starting a new capture, select 'Start Overwrite'. If appending data to an existing capture file, select 'Start Append'. Upon selecting one of these options, the interface will turn RED. This is good and indicates that capturing is imminent.
4. Now you will type commands into the command window. Anything that is typed into this window during a capture will be captured in the output file.
5. Some suggestions would be to type **'status'**, and then '**data'.**
6. When all data has been captured, simply select, 'Stop Capture'.
7. All data is now available in the capture output file designated in Step 1.

Capture Function for Mac

1. Select the 'Connection' tab from the main CoolTerm Menu bar
2. Select 'Capture To Textfile'
3. Use options to 'Start | Pause | Stop'

Logger LEDs

Windows in the lid decal of the logger give visual access to LED indicator lights. There are three different LED colors with combined behavior that indicates elements of logger status. In the right hand window you will see activity from a BLUE and GREEN LED, while in the left, a RED LED.

1. GREEN
    a. With regular logging, **between** logging intervals, the logger will blink GREEN about every 8 seconds. This serves as a 'heartbeat' indicating that the logger is functioning normally.
    b. With regular logging, **during** logging intervals, the logger will turn solid GREEN indicating that it is communicating with the TAC to obtain, store and transmit temperature readings.
    c. A flashing BLUE LED coupled with flashing GREEN LED for ~ 30 seconds indicates a logger reset.
2. RED
    a. When the magnet is used to reset the logger, the RED LED will go solid.
    b. When the magnet is used to issue an automatic log and/or transmission, the RED LED will flash briefly
3. BLUE
    a. A solid BLUE LED indicates a Bluetooth connection
    b. A flashing BLUE LED coupled with flashing GREEN LED for ~ 30 seconds indicates a logger reset.

Hall Effect Switch

D400 Data Loggers are built with an externally accessible hall effect sensor that varies its voltage output in response to a magnetic field. Holding a magnet over the left side of the logger (as indicated in Figure 2) will prompt the logger to do either 1) a one-time temperature reading and transmit outside of the set logging interval. In addition this will allow the BLE radio to advertise for a five minute duration, or 2) reboot the logger.

1) Perform a one-time temperature transmit (and advertise BLE):
   a. Hold the magnet in the vicinity of the sensor. When the sensor is tripped the RED LED will shine solid – quickly remove the magnet. Upon removing the magnet, the GREEN LED will shine solid GREEN, indicating that temperatures are being recorded. Once the LED turns GREEN start counting the seconds that it stays GREEN. Most transmissions will take on the order of 10 -25 seconds. In the event that the light stays GREEN for more than 90 seconds, assume the transmission was unsuccessful and try again. The LED will turn off automatically when finished.

2) Reboot the logger:
   a. Hold the magnet in position, wait until the LED shines RED, hold the magnet in place until the RED light turns off (about 7 or 8 seconds).
   b. Next you'll get some flashing of the BLUE and GREEN LEDs.
   c. Then, you'll get some solid GREEN – the logger is searching for a USB connection.
   d. Flashing BLUE – the logger is searching for a Bluetooth connection
   e. In the end, what you really want to see is the logger returning to the Idle mode (above) → GREEN LED blinks every 8 seconds.

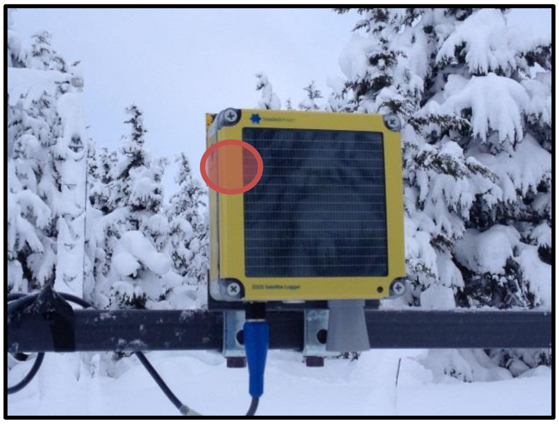


Figure 2: Photo of the D405. The circle demonstrates where the magnet needs to be placed on the outside of the logger enclosure to trip the magnetic switch.

Charging the Battery

D405 and D401 Loggers with Solar Recharge (Lead – Acid)

Each unit is solar rechargeable, thus if the logger is installed properly with the solar panel facing a southerly aspect, the logger should stay charged. Each logger ships with a full battery – ready to deploy. However, the units are always running. If you anticipate not using the logger for an extended period, it is recommended that you either open up the lid and unplug the battery, **OR EVEN BETTER** – just change the logging interval to something infrequent, like once every 24 hours. If the logger has been dormant for a while and you're about to deploy it, either open up the lid and put the battery on a 6V trickle charger (be sure to unplug the power leads from the logger board), **OR EVEN BETTER** – stick the logger out in the sun for a couple days.

D401 Loggers without Solar Recharge (Lithium Ion)

These batteries are a 7.2 V Tadiran Li-Ion, NON-RECHARGEABLE battery. Do not attempt a recharge, these batteries are made custom for BeadedStream – contact us if you need a replacement.

Two-way Communication through Iridium

D405 Loggers have the unique characteristic of being able to receive and process certain commands remotely. Essentially a text message can be emailed to Iridium that will ultimately find its way to the specified D405 Logger. This allows BeadedStream to remotely perform the following actions

- Change logging and transmitting intervals
- Update the RTC
- Determine which TACs are attached to the logger

This has been proven useful to confirm TACs being used, and change intervals either to save power through a long winter or obtain finer temporal resolution during thermal monitoring.

TAC XLR Connector

Each D400 Logger comes standard with 2 ports. These are male-ended XLR connectors. Matching female-ended XLR connectors can be found on the TAC itself. These XLR connectors are pretty darn strong. A couple points to be made here:

1. We recommend a conductive paste when coupling the XLR connectors in harsh, humid environments to prevent corrosion.
2. Make sure you hear a 'click' when plugging the connectors into the logger. Then do a 'tug test ' – they should not come out without needing to press the release tab!

Appendix A4 - BeadedStream Logger Installation Checklist

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BeadedStream Logger Installation Checklist

Logger:

- ❏ Oriented to true south (*northern hemisphere*)
- ❏ Minimal vertical tilt**
  Photo left shows large but acceptable tilt.

Sonic sensor:

- ❏ Mounted well above minimum reading distance of 30 cm (~1 foot)
- ❏ Clear path to the ground
- ❏ Flat target on the ground
  Brush cleared/plywood set down

Air temperature sensor:

- ❏ Secured in radiation shield gland shield.

Cables:

- ❏ Connector face coated with **small** amount of "Stuf" paste
- ❏ Connector locked into bulkhead receptacle (*push hard, light tug test, repeat until success*)

System status:

- ❏ Checked out with the Capture app.

Tilt **will DRASTICALLY REDUCE satellite antenna performance. No tilt means logger bottom ports point straight down. In locations with snow, no tilt is a good balance of direct sun and energy reflected from the snow.

See Buoy Installation Instructions for marine environment logger deployments.

Questions? Email us at contact@beadedstream.com or call 844-488-4880

Appendix A5 - Understanding the health of a deployed D505 satellite and sensor system

Understanding the health of a deployed D505 satellite and sensor system

A D505 transmits a few types of data (*alongside connected sensor data*) that contribute to understanding the system's health. This data is accessible in the **Legend** on any data site page on the [BeadedStream web application](#).

Data site page | Core logger metrics

Below is a snapshot of transmitted data. Additional information below in the table and notes:

Data type	Axis	Operating range/detail
Battery	R	6.6V+ (full charge) | **6.3V** (half) | **6.15V** (*very low*) | **6V** dead *See Note 1*
Comm. Status	R	Number of attempts to transmit data. **0-5** (normal) **6-15** *See Note 2*
Panel Temp	L	Internal temperature of the logger. *See Note 3*

Note 1: The logger does not protect itself at a "dead" voltage of 6V - it will continue programmed routines unless remotely commanded to slow or stop. Draining below 6V will permanently harm battery capacity. Transmission will not function reliably. Logging will function down to <5.5V. The **6.15-6.25V** range is a good time to check in with BeadedStream.

Note 2: If the logger begins to or consistently takes many attempts to transmit each data set, battery life and endurance will be impacted. More on this below.

Note 3: Internal temperature is not a reliable air temperature because of the "oven baking" effect: UV radiation penetrates the enclosure, generated infrared heat stays trapped inside.

Changes and trends in cable or logger data

A deployed data logger can experience many undesirable events that have an adverse affect on transmit performance and battery levels. Examples include:

- **Snow stackup on logger:** Reduced transmit performance.
    - *Dry is better, but wet on the antenna (water content) harshly reduces performance.*
- **Logger articulation disturbed:** Reduced solar recharge and transmit performance.
- **Solar panel frosted:** Reduced solar recharge.
- **Temporary/permanent obstruction:** Reduced solar recharge and transmit performance.
    - *The logger antenna functions best with an unobstructed hemisphere above the unit. Metal specifically has a negative effect but is sometimes unavoidable, see the thermosiphon mount below:*

Events can be indirectly identified by analysis of one or more of the following:

- **Battery voltage:** latest/recent. Sharper decline is a concern.
- **Transmit attempts:** (*comm. status*) latest/recent. Spikes and increases are a concern.
- **Unit temperature:** latest/recent. Extreme cold will co-indicate reduced charging and increase battery load during function.
- **Loss of all data from a data site/cable:** can indicate disconnected/damaged cable at or near the logger, or cable damage anywhere between the connector and first sensor.
- **Sharp shift in value of one or more temperatures:** cable may have been pulled out of the ground and some/all sensors are tracking closely with the air temperature.

    Note: Partial cable/sensor loss on one or more cables can also occur. If this problem occurs, reach out to pm@beadedstream.com for help.

Appendix B - GTC Specifications and Calibration Certificates

Appendix B1 - D505 Data Logger Specifications

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35140-01

D505 | Our latest satellite data logger.

Log your data without logging the miles. The BeadedStream D505 Data Logger is purpose built for remote deployments and reliable performance in extreme conditions. Now with enhanced solar and Bluetooth performance.

Specifications

Hardware / Firmware	• Ultra low-power, high performance industrial microcontroller. • Multi-threaded custom embedded OS. Free firmware updates.
Storage	• Capacity for over 1 million temperature readings. • Non-volatile flash memory survives even if battery dies.
Real Time Clock	• ± 5 minutes per year (temperature compensated). • Periodically synchronizes with GPS network.
Communication	• Bluetooth 4.2 wireless interface. • Compatible with *Capture*, our all new iOS app.
Connections	• Up to 4 DTC ports, up to 2 additional ports for other sensors, power, etc. • 5V driver available to power DTC sensors if needed.
Ultra Low Power	• 6 to 10 VDC (max) input. • Sleep mode: 90 µA typical. Active mode: 70 mA typical.
Battery	• Rechargeable 6V 5.5 Ah sealed lead-acid battery. • 2 months typical w/o solar recharge (Transmitting hourly).
GPS	• Embedded 40-channel dedicated GPS processing module. • 34-second time to first fix (typical). Integrated 1575.42 MHz antenna.
Worldwide Telemetry	• Embedded two-way satellite transceiver and Iridium antenna. • Uses Iridium's mesh network, 66 satellites, 100% pole to pole coverage.
Operating Range	• -40° C to +85° C (-40° F to +185° F). NEMA Type 4X/IP68.
Weight and Dimensions	• 2.3 kg (5.1 lbs) (*without mount*). 7.1" x 7.1"x 3.1" (18 cm x 18 cm x 7.9 cm).
Mounting	• Multi-function pivoting arm mount comes standard.

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35140-01

Specifications (continued)

Integrated Solar	• 3 Watt nominal solar panel with temperature compensated charge control circuit to protect and prolong battery life.
Contactless Switch	• Built-in magnetic switch is immune to dust, dirt, mud and water. • Triggers through the case for spot readings and Bluetooth wake.
Optional Rangefinder	• Small, lightweight, rugged. An ultrasonic outdoor sensor for snow and water level measurement. IP67 rated. • Long narrow detection zone with a 1 cm resolution, minimum detection range of 50 cm, 1 meter maximum. • Filtering algorithms yield excellent noise tolerance and clutter rejection.

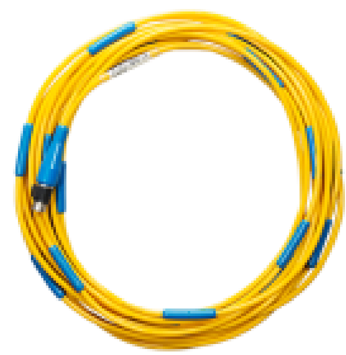
Appendix B2 - GTC (DTC) Cable Product Specifications

35110-04

Digital Temperature Cable (DTC)

Standard High Visibility Yellow

It all starts with BeadedStream's all-digital temperature cables. DTCs increase the speed and ease of obtaining temperature data and deliver accurate, highly resolved measurements in digital form.



Specifications

Application	• Multi-use industrial temperature monitoring
Length	• Customizable; user specified • Standard maximum length of 450 m (1500 ft)
Diameter	• Cable is 7.0 mm ± 0.1 mm • Straight sensor housing is 11 mm ± 0.5 mm
Maximum Operating Temperature Range	• -55° C to 125° C (-67° F to 257° F)
Field Conditions	• Wet / Dry / Frozen
Colors	• High-visibility yellow; gray (reinforced cable); white • Black or white heat shrink available for sensor sections
Outer Jacket	• BeadedStream S724EX polyurethane jacket formulated for low temperature durability and flex with reduced diameter and weight • Gray option with reinforced shielding for added protection from wildlife and improved crush resistance • UV stabilized • Cut and abrasion resistant • Flexing minimum temperature -40° C/F
Central Strength Member	• Built-in Aramid fibers increase strength in tension and minimize cable stretch
Conductors	• Stranded tinned copper; 22 AWG; Number: 3
Maximum # of Sensors	• 110
Sensor Accuracy	• ± 0.1° C from -10° C to 30° C (14° F to 86° F)

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35110-04

DTC Specifications (continued)

Sensor Spacing	• Customizable; user specified • Variable spacing available upon request • Minimum standard spacing: 10 cm • Closer spacing available – please inquire
Additional Sensor Features	• Requires only one signal line for bidirectional communication • Each sensor has a unique ID for individual communication • Operates using input voltage between 3.0 V and 5.5 V • Converts temperatures in 750 ms (max)

Appendix B3 - GTC Order Sheets

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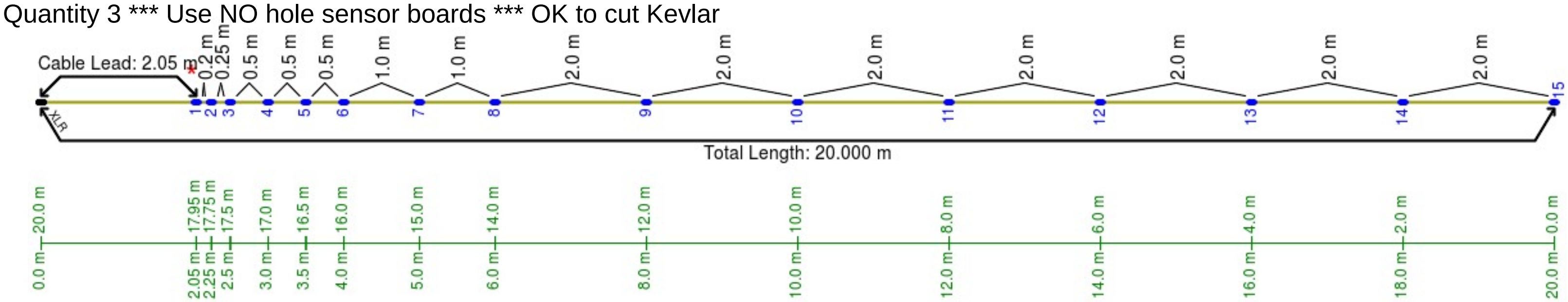
DTC Order Sheet

Customer: SRK Consulting
Project Name: 2018 - Point Hope Phase 1
Order Date:

DTC Name: 15 sensor profiler for the following locations: SRK17-STH-DH-02, SRK17-STH-DH-03, Spare #1
Serial Number: 2839
Units: meters

Object	Mold	Cable	Distance
XLRConnector	**XLR Mold**	**Yellow**	**2.05m**
Protection/Sensor 1	**Straight**	**Yellow**	**0.2m**
Sensor 2	**Straight**	**Yellow**	**0.25m**
Sensor 3	**Straight**	**Yellow**	**0.5m**
Sensor 4	**Straight**	**Yellow**	**0.5m**
Sensor 5	**Straight**	**Yellow**	**0.5m**
Sensor 6	**Straight**	**Yellow**	**1.0m**
Sensor 7	**Straight**	**Yellow**	**1.0m**
Sensor 8	**Straight**	**Yellow**	**2.0m**
Sensor 9	**Straight**	**Yellow**	**2.0m**
Sensor 10	**Straight**	**Yellow**	**2.0m**
Sensor 11	**Straight**	**Yellow**	**2.0m**
Sensor 12	**Straight**	**Yellow**	**2.0m**
Sensor 13	**Straight**	**Yellow**	**2.0m**
Sensor 14	**Straight**	**Yellow**	**2.0m**
Sensor 15	**End**	**N/A**	**N/A**

Comments: Quantity 3 *** Use NO hole sensor boards *** OK to cut Kevlar



* indicates that this sensor contains a protection unit

Return signed order sheet to BeadedStream at
e-mail: contact@beadedstream.com
call: 844-488-4880 for support

Approved

Date

beadedstream

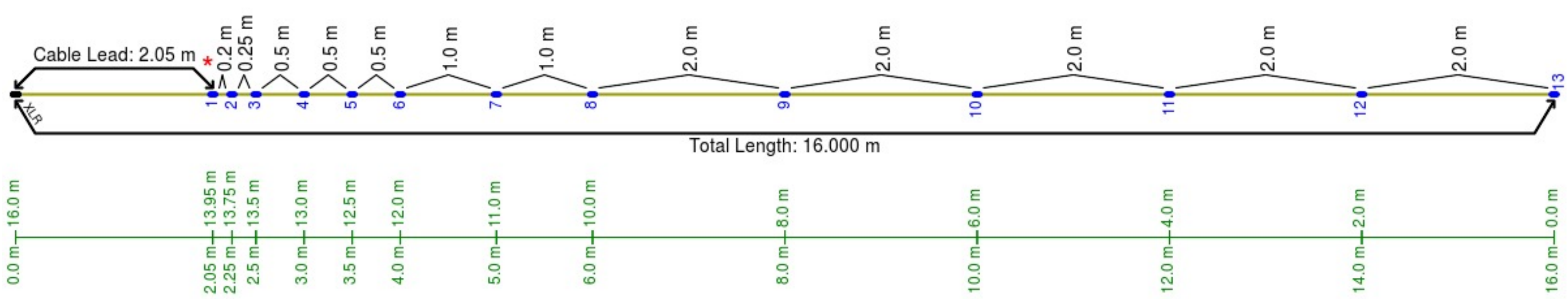
DTC Order Sheet

Customer: SRK Consulting
Project Name: 2018 - Point Hope Phase 1
Order Date:

DTC Name: 13 sensor profiler for: SRK17-BWRP-DH-01, Spare #2
Serial Number: 2841
Units: meters

Object	Mold	Cable	Distance
XLRConnector	XLR Mold	Yellow	2.05m
Protection/Sensor 1	Straight	Yellow	0.2m
Sensor 2	Straight	Yellow	0.25m
Sensor 3	Straight	Yellow	0.5m
Sensor 4	Straight	Yellow	0.5m
Sensor 5	Straight	Yellow	0.5m
Sensor 6	Straight	Yellow	1.0m
Sensor 7	Straight	Yellow	1.0m
Sensor 8	Straight	Yellow	2.0m
Sensor 9	Straight	Yellow	2.0m
Sensor 10	Straight	Yellow	2.0m
Sensor 11	Straight	Yellow	2.0m
Sensor 12	Straight	Yellow	2.0m
Sensor 13	End	N/A	N/A

Comments: Quantity 2 *** Use NO hole sensor boards *** OK to cut Kevlar



* indicates that this sensor contains a protection unit

Return signed order sheet to BeadedStream at
e-mail: contact@beadedstream.com
call: 844-488-4880 for support

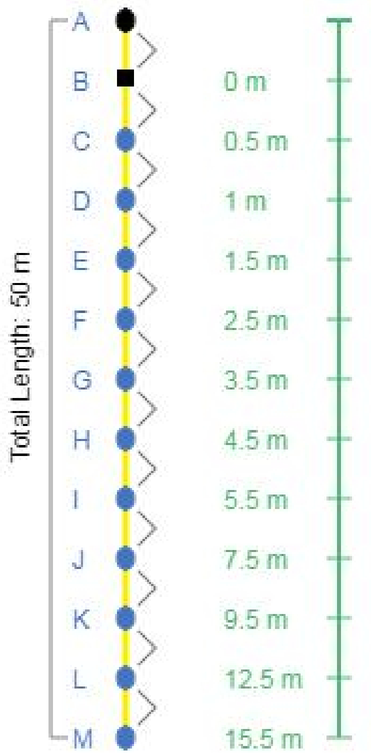
Approved

Date

Customer: SRK Consulting (Alaska)	Date Generated: 02-20-2018
Project: Hope Bay - South Dam	DTC Name: SD-VTS-155-KTC and SD-VTS-460-KTC
Quantity: 2	Serial Number(s): 3251, 3252

Client Notes:
Priority 1

Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	34.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-

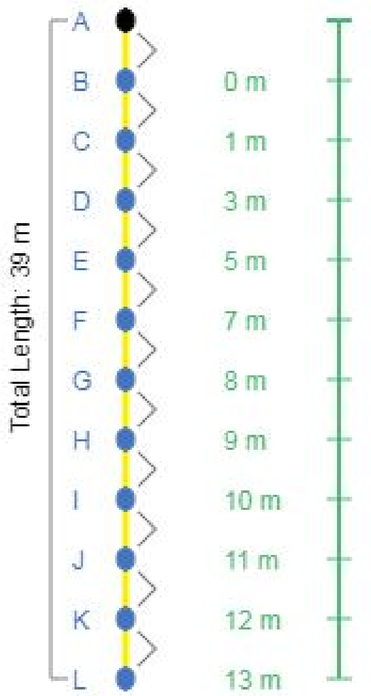


DTC Order Sheet

Customer: SRK Consulting (Alaska)		Date Generated: 02-20-2018
Project: Hope Bay - South Dam		DTC Name: SD-HTS-155-KT and SD-HTS-460-KT
Quantity: 2	Serial Number(s): 3253, 3254	

Client Notes:
Priority 2

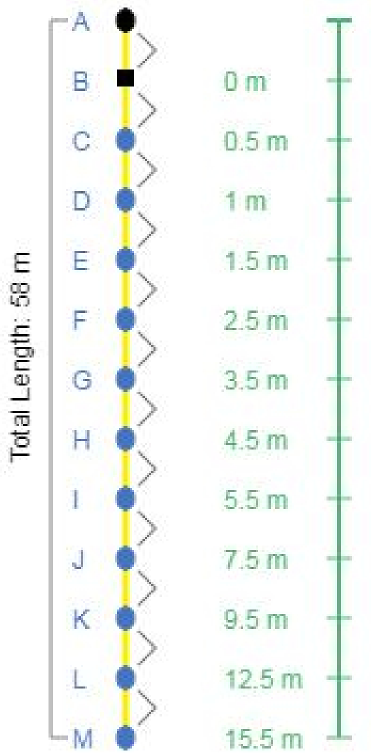
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	26 m	yellow
Protection/Sensor 1	Straight	0 m	1 m	yellow
Sensor 2	Straight	1 m	2 m	yellow
Sensor 3	Straight	3 m	2 m	yellow
Sensor 4	Straight	5 m	2 m	yellow
Sensor 5	Straight	7 m	1 m	yellow
Sensor 6	Straight	8 m	1 m	yellow
Sensor 7	Straight	9 m	1 m	yellow
Sensor 8	Straight	10 m	1 m	yellow
Sensor 9	Straight	11 m	1 m	yellow
Sensor 10	Straight	12 m	1 m	yellow
Sensor 11	End Mold	13 m	- m	-



Customer: SRK Consulting (Alaska)	Date Generated: 02-20-2018
Project: Hope Bay - South Dam	DTC Name: SD-VTS-240-KTC
Quantity: 1	Serial Number(s): 3255

Client Notes:
Priority 1

Component	**Mold**	**Position**	**Section**	**Cable**
XLR	XLR Mold	-	42.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-

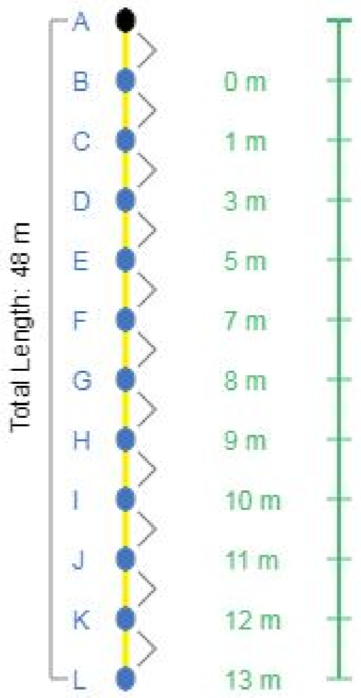


DTC Order Sheet

Customer: SRK Consulting (Alaska)		Date Generated: 02-20-2018
Project: Hope Bay - South Dam		DTC Name: SD-VTS-240-KT
Quantity: 1	Serial Number(s): 3256	

Client Notes:
Priority 2

Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	35 m	yellow
Protection/Sensor 1	Straight	0 m	1 m	yellow
Sensor 2	Straight	1 m	2 m	yellow
Sensor 3	Straight	3 m	2 m	yellow
Sensor 4	Straight	5 m	2 m	yellow
Sensor 5	Straight	7 m	1 m	yellow
Sensor 6	Straight	8 m	1 m	yellow
Sensor 7	Straight	9 m	1 m	yellow
Sensor 8	Straight	10 m	1 m	yellow
Sensor 9	Straight	11 m	1 m	yellow
Sensor 10	Straight	12 m	1 m	yellow
Sensor 11	End Mold	13 m	- m	-

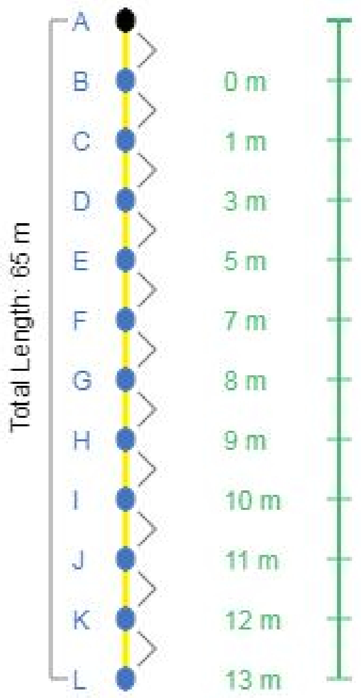


DTC Order Sheet

Customer: SRK Consulting (Alaska)	Date Generated: 02-20-2018
Project: Hope Bay - South Dam	DTC Name: SD-HTS-365-KT
Quantity: 1	Serial Number(s): 3257

Client Notes:
Priority 2

Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	52 m	yellow
Protection/Sensor 1	Straight	0 m	1 m	yellow
Sensor 2	Straight	1 m	2 m	yellow
Sensor 3	Straight	3 m	2 m	yellow
Sensor 4	Straight	5 m	2 m	yellow
Sensor 5	Straight	7 m	1 m	yellow
Sensor 6	Straight	8 m	1 m	yellow
Sensor 7	Straight	9 m	1 m	yellow
Sensor 8	Straight	10 m	1 m	yellow
Sensor 9	Straight	11 m	1 m	yellow
Sensor 10	Straight	12 m	1 m	yellow
Sensor 11	End Mold	13 m	- m	-

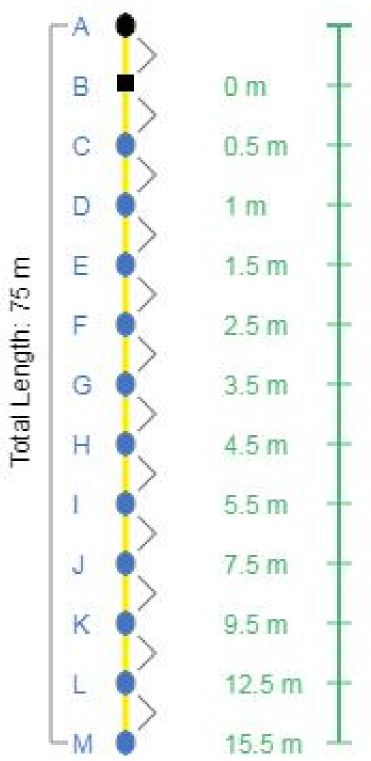


DTC Order Sheet

Customer: SRK Consulting (Alaska)	Date Generated: 02-20-2018
Project: Hope Bay - South Dam	DTC Name: SD-VTS-365-KTC
Quantity: 1	Serial Number(s): 3258

Client Notes:
Priority 1

Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	59.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-

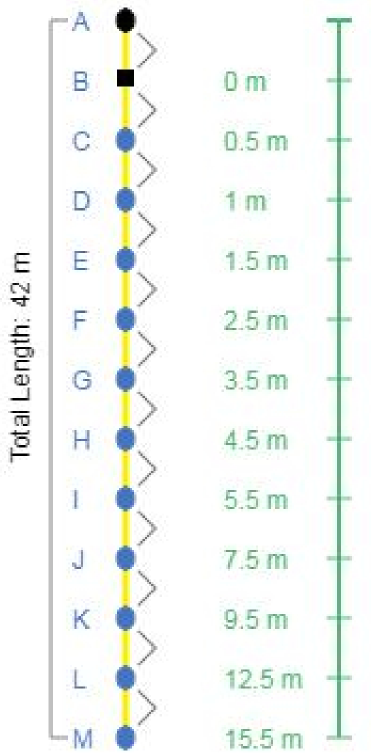


DTC Order Sheet

Customer: SRK Consulting (Alaska)		Date Generated: 02-20-2018
Project: Hope Bay - South Dam		DTC Name: SD-VTS-065-KTC
Quantity: 1	Serial Number(s): 3259	

Client Notes:
Priority 1

Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	26.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-

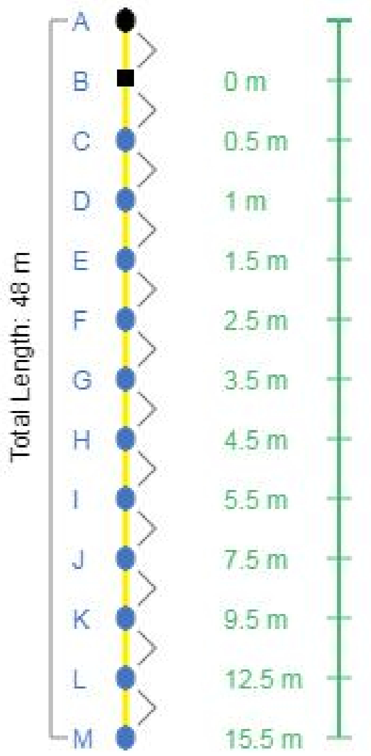


DTC Order Sheet

Customer: SRK Consulting (Alaska)		Date Generated: 02-20-2018
Project: Hope Bay - South Dam		DTC Name: SD-VTS-510-KTC
Quantity: 1	Serial Number(s): 3260	

Client Notes:
Priority 1

Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	32.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-

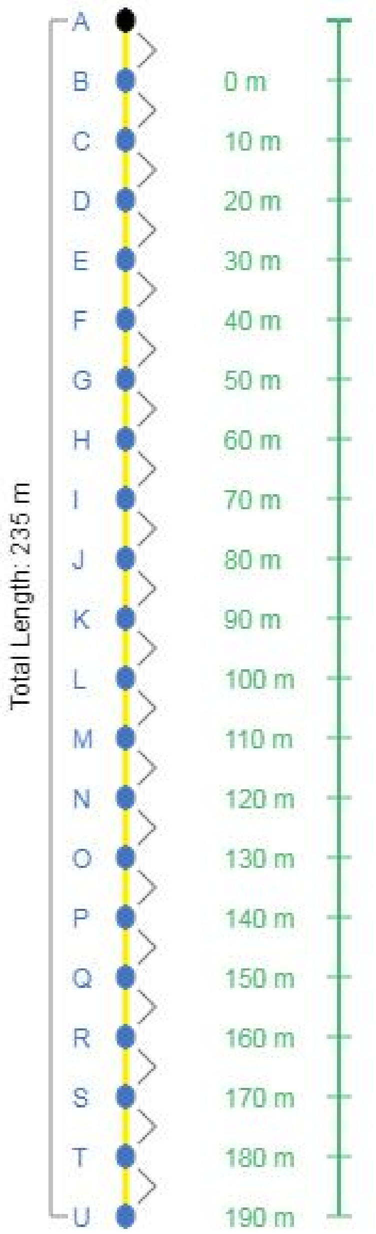


DTC Order Sheet

Customer: SRK Consulting (Alaska)		Date Generated: 02-20-2018
Project: Hope Bay - South Dam		DTC Name: SD-HST-B1-KT
Quantity: 1	Serial Number(s): 3261	

Client Notes:
Priority 3

Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	45 m	yellow
Protection/Sensor 1	Straight	0 m	10 m	yellow
Sensor 2	Straight	10 m	10 m	yellow
Sensor 3	Straight	20 m	10 m	yellow
Sensor 4	Straight	30 m	10 m	yellow
Sensor 5	Straight	40 m	10 m	yellow
Sensor 6	Straight	50 m	10 m	yellow
Sensor 7	Straight	60 m	10 m	yellow
Sensor 8	Straight	70 m	10 m	yellow
Sensor 9	Straight	80 m	10 m	yellow
Sensor 10	Straight	90 m	10 m	yellow
Sensor 11	Straight	100 m	10 m	yellow
Sensor 12	Straight	110 m	10 m	yellow
Sensor 13	Straight	120 m	10 m	yellow
Sensor 14	Straight	130 m	10 m	yellow
Sensor 15	Straight	140 m	10 m	yellow
Sensor 16	Straight	150 m	10 m	yellow
Sensor 17	Straight	160 m	10 m	yellow
Sensor 18	Straight	170 m	10 m	yellow
Sensor 19	Straight	180 m	10 m	yellow
Sensor 20	End Mold	190 m	- m	-

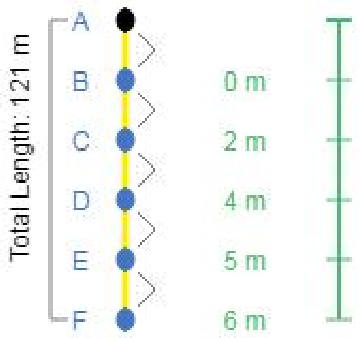


DTC Order Sheet

Customer: SRK Consulting (Alaska)		Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2		DTC Name: SD-HTS-065-US
Quantity: 1	Serial Number(s): 3263	

Client Notes:
Priority 1

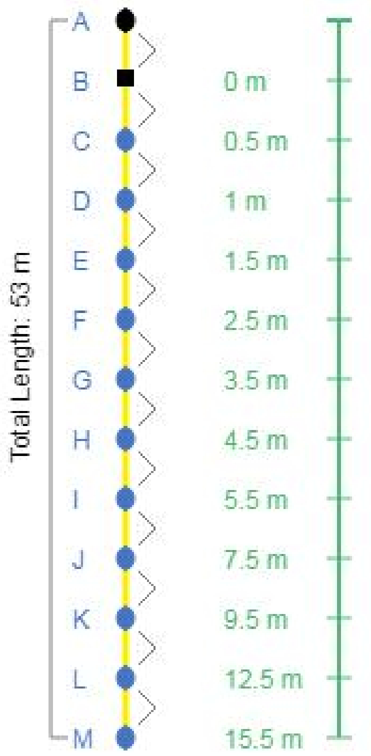
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	115 m	yellow
Protection/Sensor 1	Straight	0 m	2 m	yellow
Sensor 2	Straight	2 m	2 m	yellow
Sensor 3	Straight	4 m	1 m	yellow
Sensor 4	Straight	5 m	1 m	yellow
Sensor 5	End Mold	6 m	- m	-



Customer: SRK Consulting (Alaska)		Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2		DTC Name: SD-VTS-155-DST and SD-VTS-240-DST
Quantity: 2	Serial Number(s): 3264, 3265	

Client Notes:
Priority 3

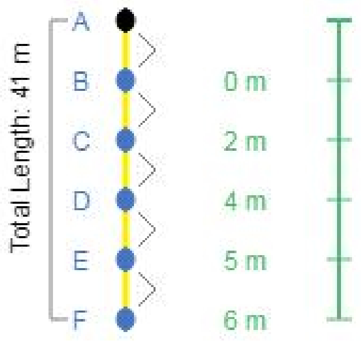
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	37.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-



Customer: SRK Consulting (Alaska)	Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2	DTC Name: SD-HTS-155-US and SD-HTS-460-US
Quantity: 2	Serial Number(s): 3266, 3267

Client Notes:
Priority 1

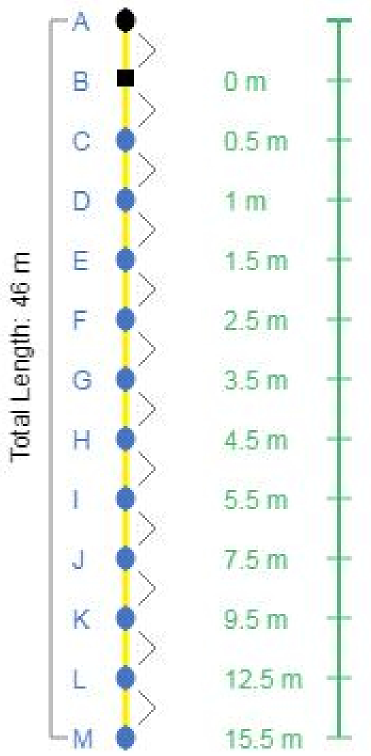
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	35 m	yellow
Protection/Sensor 1	Straight	0 m	2 m	yellow
Sensor 2	Straight	2 m	2 m	yellow
Sensor 3	Straight	4 m	1 m	yellow
Sensor 4	Straight	5 m	1 m	yellow
Sensor 5	End Mold	6 m	- m	-



Customer: SRK Consulting (Alaska)	Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2	DTC Name: SD-VTS-240-UST
Quantity: 1	Serial Number(s): 3268

Client Notes:
Priority 2

Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	30.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-

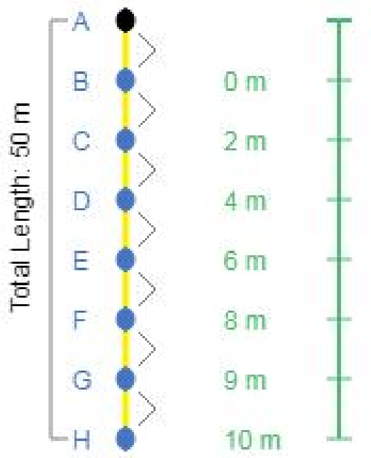


DTC Order Sheet

Customer: SRK Consulting (Alaska)		Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2		DTC Name: SD-HTS-240-US
Quantity: 1	Serial Number(s): 3269	

Client Notes:
Priority 1

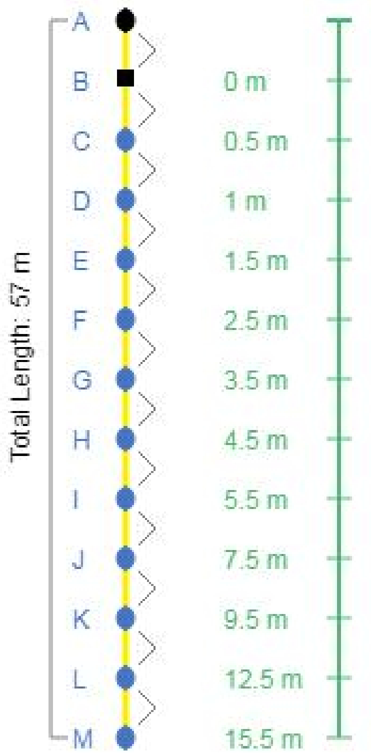
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	40 m	yellow
Protection/Sensor 1	Straight	0 m	2 m	yellow
Sensor 2	Straight	2 m	2 m	yellow
Sensor 3	Straight	4 m	2 m	yellow
Sensor 4	Straight	6 m	2 m	yellow
Sensor 5	Straight	8 m	1 m	yellow
Sensor 6	Straight	9 m	1 m	yellow
Sensor 7	End Mold	10 m	- m	-



Customer: SRK Consulting (Alaska)	Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2	DTC Name: SD-VTS-365-UST
Quantity: 1	Serial Number(s): 3270

Client Notes:
Priority 2

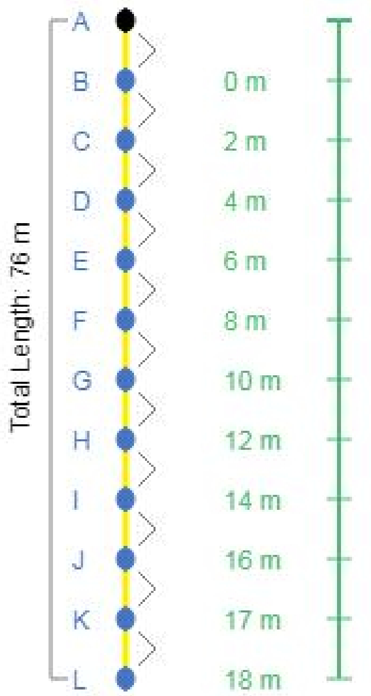
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	41.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-



Customer: SRK Consulting (Alaska)	Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2	DTC Name: SD-HTS-365-US
Quantity: 1	Serial Number(s): 3271

Client Notes:
Priority 1

Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	58 m	yellow
Protection/Sensor 1	Straight	0 m	2 m	yellow
Sensor 2	Straight	2 m	2 m	yellow
Sensor 3	Straight	4 m	2 m	yellow
Sensor 4	Straight	6 m	2 m	yellow
Sensor 5	Straight	8 m	2 m	yellow
Sensor 6	Straight	10 m	2 m	yellow
Sensor 7	Straight	12 m	2 m	yellow
Sensor 8	Straight	14 m	2 m	yellow
Sensor 9	Straight	16 m	1 m	yellow
Sensor 10	Straight	17 m	1 m	yellow
Sensor 11	End Mold	18 m	- m	-

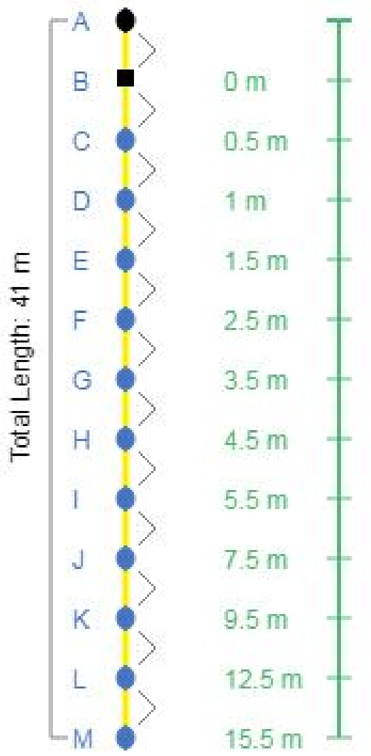


DTC Order Sheet

Customer: SRK Consulting (Alaska)	Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2	DTC Name: SD-VTS-155-UST, SD-VTS-460-UST
Quantity: 2	Serial Number(s): 3272, 3273

Client Notes:
Priority 2

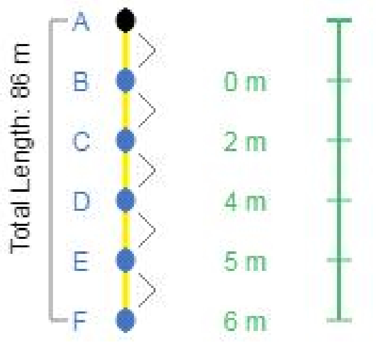
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	25.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-



Customer: SRK Consulting (Alaska)		Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2		DTC Name: SD-HTS-510-US
Quantity: 1	Serial Number(s): 3274	

Client Notes:
Priority 1

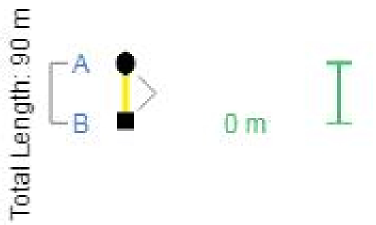
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	80 m	yellow
Protection/Sensor 1	Straight	0 m	2 m	yellow
Sensor 2	Straight	2 m	2 m	yellow
Sensor 3	Straight	4 m	1 m	yellow
Sensor 4	Straight	5 m	1 m	yellow
Sensor 5	End Mold	6 m	- m	-



DTC Order Sheet

Customer: SRK Consulting (Alaska)	Date Generated: 03-16-2018
Project: Hope Bay - South Dam - Order 2	DTC Name: Extensions for SD-VTS-065-KTC, 510-KTC
Quantity: 2	Serial Number(s): 3277, 3278

Client Notes:
The "zero marker" on the end of this extension represents the opposite gender XLR connector.



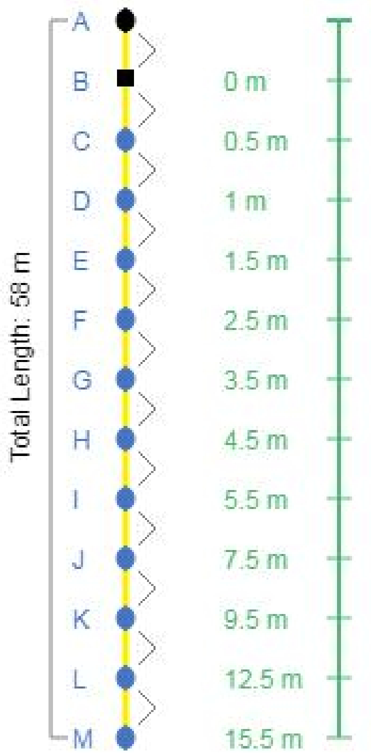
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	90 m	yellow
Zero Marker	None	0 m	- m	-

DTC Order Sheet

Customer: SRK Consulting (Alaska)	Date Generated: 03-16-2018
Project: Hope Bay - South Dam - Order 2	DTC Name: SD-VTS-365-DST, SD-VTS-460-DST
Quantity: 2	Serial Number(s): 3275, 3276

Client Notes:
Priority 3

Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	42.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-



Appendix B4 – GTC Calibration Certificates

beadedstream

DTC Calibration Certificate
SRK - Hope Bay Phase 1

This certificate verifies and displays the results of calibration for the digital temperature cables with serial numbers **3187 to 3201**. **3188** had repair work started but was then superseded by replacement cable **3201**. The values are shown in the tables below.

Offset values are a result of BeadedStream's rigorous calibration process where each offset is determined with measurement in a **0.000 °C ice bath** confirmed with our NIST traceable secondary reference platinum RTD (Resistance temperature detector).

When temperature readings are taken with a D405 Datalogger or NetGate (Ethernet Bridge), the offset values are first subtracted from the raw temperature and then are driven to **+/- 0.1 °C accuracy** using BeadedStream's proprietary characteristic error curve correction algorithm.

Sensor	Sensor ID	Offset
	Serial 3187	
1	E6 00 00 07 12 68 2F 28	0.250
2	BC 00 00 08 40 A4 88 28	1.000
3	94 00 00 08 40 4C 14 28	0.438
4	2B 00 00 08 40 EA 8C 28	0.375
5	A3 00 00 08 40 A4 EC 28	0.875
6	66 00 00 08 40 B6 02 28	0.938
7	2F 00 00 08 41 31 A2 28	0.438
8	65 00 00 08 41 06 62 28	0.250
9	37 00 00 08 40 C5 F2 28	0.438
10	29 00 00 08 41 4C B6 28	0.375
11	78 00 00 08 41 30 C1 28	0.375
12	2C 00 00 08 41 06 F9 28	0.375
13	45 00 00 08 40 9D 55 28	1.000
14	DE 00 00 08 40 6B 5D 28	0.438
15	15 00 00 08 41 36 03 28	0.375
	Serial 3189	
1	29 00 00 07 12 09 21 28	0.375
2	B2 00 00 08 40 4C 08 28	0.500

*Calibrations performed by **Lindsey Bohnert** (Tech Ops Associate) on **January 24th 2018***
*Cable 3201 calibrated and added and certificate completed by **Paul Harren** (Project Manager) on **February 1st 2018***

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3	F1 00 00 08 40 6B 88 28	0.438
4	EE 00 00 08 40 5D 38 28	1.000
5	D1 00 00 08 40 8F F4 28	0.375
6	52 00 00 08 41 22 0C 28	0.438
7	98 00 00 08 41 38 D6 28	0.438
8	C0 00 00 08 3F F1 41 28	0.563
9	BD 00 00 08 41 49 D1 28	0.313
10	E0 00 00 08 40 A5 31 28	1.000
11	87 00 00 08 40 64 D9 28	0.750
12	05 00 00 08 41 30 CD 28	0.438
13	3A 00 00 08 40 64 23 28	0.813
14	EE 00 00 08 40 64 6B 28	1.000
15	EF 00 00 08 41 36 1B 28	0.313
	Serial 3190	
1	65 00 00 07 12 67 9A 28	0.188
2	A5 00 00 08 40 5D B0 28	0.938
3	38 00 00 08 41 22 28 28	0.250
4	DB 00 00 08 40 19 58 28	0.875
5	CA 00 00 08 40 64 64 28	0.938
6	D5 00 00 08 3F CD 54 28	0.313
7	76 00 00 08 40 11 F2 28	0.563
8	55 00 00 08 40 92 4A 28	0.500
9	59 00 00 08 40 64 CE 28	1.000
10	F4 00 00 08 40 8F 7E 28	0.125
11	65 00 00 08 41 22 0D 28	0.375
12	3B 00 00 08 3F B0 D3 28	0.875
	Serial 3191	
1	A0 00 00 07 12 7A F3 28	0.250
2	70 00 00 08 41 49 C8 28	0.625
3	D5 00 00 08 41 22 18 28	0.313
4	E4 00 00 08 40 64 34 28	0.875
5	6E 00 00 08 40 38 FC 28	0.750
6	AC 00 00 08 3F FD FC 28	0.313
7	C6 00 00 08 3F B1 62 28	1.125

*Calibrations performed by **Lindsey Bohnert** (Tech Ops Associate) on **January 24th 2018***
*Cable 3201 calibrated and added and certificate completed by **Paul Harren** (Project Manager) on **February 1st 2018***

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11	CE 00 00 08 40 19 63 28	1.000
12	B0 00 00 08 41 38 B3 28	0.500
	Serial 3197	
1	B0 00 00 07 12 08 CD 28	0.438
2	2E 00 00 08 3F D1 EC 28	0.375
3	57 00 00 08 40 EB 1C 28	0.438
4	4B 00 00 08 40 59 72 28	0.250
5	53 00 00 08 40 7A 86 28	1.125
6	F7 00 00 08 3F B1 56 28	0.938
7	3A 00 00 08 40 EA 91 28	0.438
8	03 00 00 08 40 8F 89 28	0.500
9	F6 00 00 08 40 A4 85 28	0.938
10	25 00 00 08 40 8F 95 28	0.375
11	41 00 00 08 40 11 F3 28	0.438
12	89 00 00 08 41 38 CB 28	0.375
13	79 00 00 08 40 90 3B 28	0.063
	Serial 3198	
1	2F 00 00 07 12 09 14 28	0.250
2	66 00 00 08 40 D9 98 28	0.375
3	32 00 00 08 40 7A 78 28	0.875
4	47 00 00 08 40 A5 0C 28	1.000
5	3E 00 00 08 40 9D 6C 28	0.813
6	E7 00 00 08 40 A5 81 28	1.000
7	2C 00 00 08 40 72 51 28	0.250
8	72 00 00 08 3F CD 69 28	0.500
9	4A 00 00 08 40 57 69 28	0.438
10	97 00 00 08 41 22 59 28	0.375
11	AC 00 00 08 40 FE 75 28	0.563
12	53 00 00 08 40 D6 0D 28	0.375
13	2C 00 00 08 40 D1 5D 28	0.938
	Serial 3199	
1	29 00 00 07 12 AF 50 28	0.188
2	9C 00 00 08 40 D9 80 28	0.188
3	43 00 00 08 40 9D 60 28	0.938

*Calibrations performed by **Lindsey Bohnert** (Tech Ops Associate) on **January 24th 2018***
*Cable 3201 calibrated and added and certificate completed by **Paul Harren** (Project Manager) on **February 1st 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

DTC Calibration Certificate
SRK - Hope Bay South Dam

This certificate verifies and displays the results of calibration for the digital temperature cables with serial numbers **3251 to 3261**. The values are shown in the tables below.

Offset values are a result of BeadedStream's rigorous calibration process where each offset is determined with measurement in a **0.000 °C ice bath** confirmed with our NIST traceable secondary reference platinum RTD (Resistance temperature detector).

When temperature readings are taken with a D405 Datalogger, NetGate, or Recite, the offset values are first subtracted from the raw temperature and then are driven to **+/- 0.1 °C accuracy** using BeadedStream's proprietary characteristic error curve correction algorithm.

Sensor	Sensor ID	Offset
	Serial 3251	
1	B2 00 00 07 11 F6 10 28	0.250
2	EA 00 00 07 12 11 00 28	0.188
3	C3 00 00 07 12 46 30 28	0.375
4	21 00 00 07 12 42 98 28	0.250
5	37 00 00 07 12 46 51 28	0.125
6	43 00 00 07 12 60 C9 28	0.250
7	A7 00 00 07 12 27 69 28	0.250
8	CF 00 00 07 12 24 75 28	0.375
9	35 00 00 07 12 7B 75 28	0.250
10	88 00 00 07 12 9E C3 28	0.188
11	73 00 00 07 12 51 E3 28	0.250
	Serial 3252	
1	54 00 00 07 12 09 2D 28	0.313
2	C5 00 00 07 12 1C 60 28	0.250
3	C8 00 00 07 12 AD 38 28	0.125
4	7D 00 00 07 12 19 44 28	0.250
5	84 00 00 07 12 9D 82 28	0.188
6	D3 00 00 07 12 6F 72 28	0.250
7	23 00 00 07 12 01 B6 28	0.250

*Calibrations performed by **Lindsey Bohnert** (Tech Ops Associate) on **March 2nd 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

8	2A 00 00 07 12 2B 8E 28	0.250
9	DD 00 00 07 12 9A CE 28	0.313
10	6D 00 00 07 11 FD 61 28	0.188
11	22 00 00 07 12 77 F1 28	0.250
	Serial 3253	
1	60 00 00 07 12 A0 4C 28	0.313
2	1C 00 00 07 11 E3 10 28	0.313
3	46 00 00 07 12 49 B0 28	0.063
4	8F 00 00 07 12 A3 44 28	0.313
5	C8 00 00 07 11 F8 32 28	0.250
6	16 00 00 07 11 F3 C6 28	0.313
7	52 00 00 07 12 3D FE 28	0.375
8	B0 00 00 07 12 42 21 28	0.250
9	B1 00 00 07 12 01 99 28	0.313
10	91 00 00 07 12 42 8D 28	0.188
11	8C 00 00 07 12 96 2D 28	0.188
	Serial 3254	
1	20 00 00 07 12 A1 07 28	0.313
2	26 00 00 07 12 78 50 28	0.250
3	4B 00 00 07 11 FC 64 28	0.250
4	9E 00 00 07 12 64 2C 28	0.188
5	35 00 00 07 12 74 F2 28	0.125
6	5C 00 00 07 12 5E B1 28	0.313
7	5B 00 00 07 12 10 89 28	0.188
8	18 00 00 07 12 49 03 28	0.063
9	D3 00 00 07 12 AC 63 28	0.188
10	DE 00 00 07 12 78 5B 28	0.188
11	07 00 00 07 12 2C 07 28	0.188
	Serial 3255	
1	41 00 00 07 12 6A 20 28	0.250
2	17 00 00 07 12 4E B0 28	0.250
3	6A 00 00 07 12 78 68 28	0.125
4	36 00 00 07 11 F0 C4 28	0.250
5	1B 00 00 07 12 48 8C 28	0.188

*Calibrations performed by **Lindsey Bohnert** (Tech Ops Associate) on **March 2nd 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

6	53 00 00 07 12 2D F2 28	0.313
7	81 00 00 07 12 45 5A 28	0.313
8	34 00 00 07 12 2A 76 28	0.375
9	CC 00 00 07 12 60 91 28	0.188
10	4A 00 00 07 12 19 45 28	0.250
11	96 00 00 07 12 27 5D 28	0.125
	Serial 3256	
1	94 00 00 07 12 93 84 28	0.250
2	55 00 00 07 11 EC 0C 28	0.188
3	61 00 00 07 11 E3 1C 28	0.188
4	C8 00 00 07 12 A7 C2 28	0.125
5	35 00 00 07 12 42 26 28	0.250
6	92 00 00 07 12 33 96 28	0.250
7	A2 00 00 07 12 00 8E 28	0.125
8	D5 00 00 07 12 8C 5D 28	0.125
9	56 00 00 07 12 0C 43 28	0.125
10	03 00 00 07 12 5A E3 28	0.188
11	0F 00 00 07 12 50 73 28	0.188
	Serial 3257	
1	B4 00 00 07 12 91 9F 28	0.063
2	E8 00 00 07 12 AC 08 28	0.125
3	11 00 00 07 12 90 A8 28	0.188
4	C6 00 00 07 12 AC 58 28	0.250
5	37 00 00 07 12 14 FC 28	0.313
6	78 00 00 07 12 A2 AA 28	0.313
7	82 00 00 07 11 E8 B6 28	0.313
8	19 00 00 07 12 A7 29 28	0.250
9	2F 00 00 07 12 78 99 28	0.250
10	24 00 00 07 11 F8 87 28	0.313
11	95 00 00 07 12 08 47 28	0.188
	Serial 3258	
1	27 00 00 07 12 7A E7 28	0.313
2	F3 00 00 07 11 F9 40 28	0.188
3	25 00 00 07 12 38 D0 28	0.000

*Calibrations performed by **Lindsey Bohnert** (Tech Ops Associate) on **March 2nd 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

4	05 00 00 07 12 77 68 28	0.313
5	94 00 00 07 12 2B E2 28	0.313
6	0D 00 00 07 11 F1 B6 28	0.313
7	3D 00 00 07 12 00 4E 28	0.438
8	5D 00 00 07 12 15 C1 28	0.313
9	78 00 00 07 12 0A 45 28	0.250
10	62 00 00 07 11 EC 0D 28	0.313
11	E9 00 00 07 12 33 AF 28	0.250
	Serial 3259	
1	20 00 00 07 11 E9 31 28	0.313
2	64 00 00 07 12 98 20 28	0.250
3	28 00 00 07 12 2A 84 28	0.188
4	70 00 00 07 12 9A AC 28	0.250
5	2A 00 00 07 12 36 B2 28	0.313
6	E0 00 00 07 12 0D 7A 28	0.313
7	42 00 00 07 12 16 8E 28	0.250
8	03 00 00 07 12 08 4E 28	0.250
9	AD 00 00 07 12 3E 6E 28	0.313
10	27 00 00 07 12 00 89 28	0.188
11	B9 00 00 07 12 A8 23 28	0.313
	Serial 3260	
1	BB 00 00 07 12 9D CF 28	0.313
2	DB 00 00 07 11 FC 58 28	0.250
3	86 00 00 07 12 45 EA 28	0.250
4	57 00 00 07 11 ED 06 28	0.188
5	58 00 00 07 11 F0 C6 28	0.250
6	85 00 00 07 12 01 0E 28	0.250
7	8A 00 00 07 12 97 01 28	0.375
8	5A 00 00 07 11 F0 D5 28	0.313
9	04 00 00 07 12 4B C3 28	0.563
10	8B 00 00 07 12 01 77 28	0.250
11	94 00 00 07 11 FD EF 28	0.438
	Serial 3261	
1	A6 00 00 07 12 39 FB 28	0.250

Calibrations performed by ***Lindsey Bohnert*** *(Tech Ops Associate) on* ***March 2nd 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

2	27 00 00 07 12 01 90 28	0.313
3	FD 00 00 07 12 A7 D0 28	0.563
4	22 00 00 07 12 55 C8 28	0.563
5	7B 00 00 07 12 2A D8 28	0.500
6	53 00 00 07 11 E9 44 28	0.375
7	63 00 00 07 11 F1 B4 28	0.563
8	F7 00 00 07 12 2E 72 28	0.688
9	F3 00 00 07 11 FB 72 28	0.500
10	51 00 00 07 12 4B AA 28	0.563
11	AA 00 00 07 12 A7 AA 28	0.250
12	94 00 00 07 12 42 2E 28	0.375
13	68 00 00 07 12 10 AE 28	0.313
14	B7 00 00 07 12 45 DE 28	0.438
15	6F 00 00 07 12 17 51 28	0.438
16	36 00 00 07 12 79 D1 28	0.125
17	26 00 00 07 12 01 15 28	0.313
18	12 00 00 07 12 08 53 28	0.375
19	1D 00 00 07 11 ED 0B 28	0.375
20	BF 00 00 07 12 44 8B 28	0.375

*Calibrations performed by **Lindsey Bohnert** (Tech Ops Associate) on **March 2nd 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

DTC Calibration Certificate
SRK - Hope Bay South Dam Order 2

This certificate verifies and displays the results of calibration for the digital temperature cables with serial numbers **3263 to 3276**. The values are shown in the tables below.

Offset values are a result of BeadedStream's rigorous calibration process where each offset is determined with measurement in a **0.000 °C ice bath** confirmed with our NIST traceable secondary reference platinum RTD (Resistance temperature detector).

When temperature readings are taken with a D405 Datalogger, NetGate, or Recite, the offset values are first subtracted from the raw temperature and then are driven to **+/- 0.1 °C accuracy** using BeadedStream's proprietary characteristic error curve correction algorithm.

Sensor	Sensor ID	Offset
	Serial 3263	
1	9D 00 00 07 12 7F D0 28	0.188
2	92 00 00 07 11 F3 44 28	0.375
3	E7 00 00 07 12 39 2C 28	0.125
4	04 00 00 07 12 29 EC 28	0.188
5	DE 00 00 07 11 F6 01 28	0.250
	Serial 3264	
1	5D 00 00 07 11 E9 3D 28	0.188
2	36 00 00 07 11 F8 0C 28	0.313
3	CF 00 00 07 11 F8 82 28	0.313
4	D8 00 00 07 12 AF 92 28	0.313
5	B4 00 00 07 12 2A D2 28	0.188
6	23 00 00 07 12 5A CA 28	0.250
7	1F 00 00 07 11 EC 01 28	0.063
8	4C 00 00 07 12 87 4B 28	0.188
9	00 00 00 07 11 F3 6B 28	0.188
10	AD 00 00 07 12 0D C7 28	0.250
11	2E 00 00 07 12 7B 37 28	0.188
	Serial 3265	

*Calibrations performed by **Lindsey Bohnert and Trevor Sprague** (Tech Ops Associates) on **April 7th 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

1	0B 00 00 07 12 32 7A 28	0.063
2	38 00 00 07 12 9C E4 28	0.250
3	37 00 00 07 11 F5 3C 28	0.313
4	C7 00 00 07 12 61 52 28	-0.063
5	42 00 00 07 12 87 32 28	0.125
6	F3 00 00 07 11 F3 BA 28	0.375
7	C9 00 00 07 12 2A DE 28	-0.063
8	4C 00 00 07 12 10 A1 28	0.125
9	6F 00 00 07 12 0E 09 28	0.125
10	AE 00 00 07 12 A8 0B 28	0.250
11	AD 00 00 07 12 8D EB 28	0.250
	Serial 3266	
1	7B 00 00 07 12 7F 3A 28	0.313
2	8E 00 00 07 12 4B 38 28	0.188
3	0F 00 00 07 12 75 05 28	0.188
4	39 00 00 07 12 14 85 28	0.125
5	5D 00 00 07 12 46 75 28	0.125
	Serial 3267	
1	CB 00 00 07 11 E9 34 28	0.250
2	46 00 00 07 12 3D 40 28	0.125
3	DB 00 00 07 12 91 18 28	0.438
4	2A 00 00 07 12 2D D8 28	0.125
5	DC 00 00 07 12 02 26 28	0.250
	Serial 3268	
1	87 00 00 07 12 08 CC 28	0.313
2	19 00 00 07 12 64 38 28	0.188
3	FF 00 00 07 12 A8 44 28	0.125
4	9A 00 00 07 12 64 0A 28	0.313
5	C5 00 00 07 12 87 26 28	0.063
6	17 00 00 07 11 F6 3E 28	0.188
7	95 00 00 07 12 3C A1 28	0.438
8	E5 00 00 07 11 EC 19 28	0.250
9	65 00 00 07 11 F5 E5 28	0.125
10	6A 00 00 07 12 33 9D 28	0.125

*Calibrations performed by **Lindsey Bohnert and Trevor Sprague** (Tech Ops Associates) on **April 7th 2018***

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11	C6 00 00 07 12 32 63 28	0.125
	Serial 3269	
1	6E 00 00 07 12 93 9C 28	0.188
2	F5 00 00 07 11 FC 08 28	0.250
3	09 00 00 07 12 3B B8 28	0.188
4	4B 00 00 07 11 F4 AC 28	0.313
5	EA 00 00 07 12 17 56 28	0.125
6	5F 00 00 07 12 AC AD 28	0.000
7	CE 00 00 07 11 FC 63 28	0.188
	Serial 3270	
1	18 00 00 07 12 09 15 28	0.313
2	8C 00 00 07 12 2D 60 28	0.438
3	10 00 00 07 12 4A 64 28	0.250
4	44 00 00 07 12 2B 8C 28	0.063
5	3F 00 00 07 12 A6 2C 28	0.250
6	2B 00 00 07 12 75 0A 28	0.188
7	24 00 00 07 12 10 96 28	0.188
8	BD 00 00 07 12 04 8E 28	0.188
9	55 00 00 07 12 74 89 28	0.250
10	BB 00 00 07 12 A5 85 28	0.250
11	DF 00 00 07 12 85 D3 28	0.125
	Serial 3271	
1	2B 00 00 07 12 AF 43 28	0.375
2	52 00 00 07 12 01 D0 28	0.438
3	FC 00 00 07 12 81 08 28	0.313
4	16 00 00 07 12 5A D8 28	0.125
5	86 00 00 07 12 5A E4 28	0.125
6	3F 00 00 07 12 7B 2A 28	0.125
7	7E 00 00 07 11 ED E6 28	0.375
8	2D 00 00 07 11 F8 4E 28	0.125
9	71 00 00 07 12 3D 41 28	0.250
10	4B 00 00 07 12 2A 69 28	0.250
11	7C 00 00 07 12 91 25 28	0.063
	Serial 3272	

*Calibrations performed by **Lindsey Bohnert and Trevor Sprague** (Tech Ops Associates) on **April 7th 2018***

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1	ED 00 00 07 11 F0 70 28	0.125
2	98 00 00 07 12 9D 70 28	0.125
3	22 00 00 07 12 02 18 28	0.250
4	ED 00 00 07 11 F8 B8 28	0.375
5	56 00 00 07 12 AC 64 28	0.313
6	4D 00 00 07 12 01 B4 28	0.125
7	5B 00 00 07 12 1B 6A 28	0.313
8	4C 00 00 07 12 02 1A 28	0.188
9	BA 00 00 07 12 99 2E 28	0.313
10	5C 00 00 07 12 01 A9 28	0.125
11	F7 00 00 07 12 6F 7D 28	0.125
	Serial 3273	
1	98 00 00 07 12 AF C0 28	0.188
2	BF 00 00 07 12 9C F0 28	0.250
3	B1 00 00 07 11 F8 18 28	0.250
4	AB 00 00 07 12 16 98 28	0.125
5	D6 00 00 07 12 2C EC 28	0.250
6	54 00 00 07 12 A1 C2 28	0.188
7	CE 00 00 07 12 85 CE 28	0.250
8	B8 00 00 07 12 95 91 28	0.188
9	54 00 00 07 12 2E 69 28	0.125
10	D5 00 00 07 11 F4 E9 28	0.250
11	26 00 00 07 12 2E 99 28	0.250
	Serial 3274	
1	7B 00 00 07 12 90 8C 28	0.250
2	EA 00 00 07 12 4A 7C 28	0.125
3	0F 00 00 07 12 59 A2 28	0.188
4	4B 00 00 07 12 5D B2 28	0.000
5	B6 00 00 07 11 F6 36 28	0.188
	Serial 3275	
1	41 00 00 07 11 E8 D6 28	0.250
2	FB 00 00 07 12 60 90 28	0.188
3	AA 00 00 07 12 6F 58 28	0.125
4	9F 00 00 07 12 04 B4 28	0.313

*Calibrations performed by **Lindsey Bohnert and Trevor Sprague** (Tech Ops Associates) on **April 7th 2018***

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5	E6 00 00 07 12 23 DA 28	0.250
6	49 00 00 07 12 A2 9E 28	0.188
7	92 00 00 07 12 02 0D 28	0.250
8	54 00 00 07 12 18 BD 28	0.250
9	31 00 00 07 11 FF F3 28	0.375
10	6C 00 00 07 12 1B 6B 28	0.063
11	AD 00 00 07 11 FD 97 28	0.313
	Serial 3276	
1	54 00 00 07 12 8B 33 28	0.125
2	09 00 00 07 12 75 30 28	0.188
3	CC 00 00 07 11 FC 70 28	0.438
4	12 00 00 07 12 9A C4 28	0.188
5	D5 00 00 07 12 01 C4 28	0.250
6	CD 00 00 07 12 2E 9C 28	0.250
7	23 00 00 07 11 EC DA 28	0.313
8	E4 00 00 07 12 00 E9 28	0.125
9	75 00 00 07 11 EC 25 28	0.250
10	30 00 00 07 11 EB 9B 28	0.188
11	69 00 00 07 12 52 0F 28	0.188

*Calibrations performed by **Lindsey Bohnert and Trevor Sprague** (Tech Ops Associates) on **April 7th 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

Appendix C - Suggested Guidelines for Surveying at the North Dam

NOTE: Example procuderes provided for the North Dam.

If control points are set-up specifically at the South Dam then a description of those control points should be added to these guidelines. Suggest that specific control points be set-up at the South Dam in 2020.

Suggested guidelines for surveying at the North Dam

Introduction

In the upcoming years, it is expected that at regular interval, monitoring surveys will take place at the North Dam. Various surveyors may be called up to do the work. Following those suggested guidelines will provide consistency in the data acquisition process.

Manpower & Time allocation

If the surveyor is flying to the mine site for the work, three days should be allocated for this work.

- Day one: Fly to site, orientation, equipment testing and calibration.
- Day two: Surveying, data processing.
- Day three: Final data preparation, packing of equipment and fly out.

Equipment and accessories

- Robotic total station and accessories, including barometer and thermometer.
- Back sight kit.
- Extensions for the mini prism for the surveying of the crest monitoring points.
- A source of light to shine into the casing for the surveying of the crest monitoring points.
- A transparent template with circles at 5mm increment to pin point exactly the center of the deep settlement points.

Metadata

There are five control points: ND1, ND2, ND3, ND4 and ND5. Each control point consists of 1 inch Hilti bolt with an approximate height of 15 centimeters (~ 6 inch) from ground. The control points at the North Dam were originally surveyed by GNSS method. Closed leveling loops were performed in 2012 (ND3-ND2) and 2013 (ND3-ND2-ND1). ND5 appears to be weak, being located on a large flat boulder, 2013 survey indicates that it could have shifted.

The data is grid. Scale factor at DN1 is 0.99965099.

Station set-up

For consistency from one survey to the next, the total station should set-up at control point ND1. From this station, all points to be surveyed are visible. Back sight point is ND4. Once the station set-up is completed, it is suggested to transfer the elevation to the total station from ND3. Most total stations have this capability (whether called elevation transfer, remote benchmark, etc). This method helps in reducing the error that could have been introduced in measuring the height of the station with a tape. Once the station is set-up is in orientation and elevation, a check shot on ND2 should be carried before commencing the monitoring surveys.

Surveying - general

As a minimum, each surveyed point should have face 1 and 2 observations. Taking measurements with both faces eliminate the following systematic errors of the total station:

- HZ collimation error
- Tilting axis error
- Compensator index error
- vertical index error

Once all points have been surveyed, if time allows, additional data should be obtained to confirm the observations. Should multiple prisms be used, it is recommended to use prisms that have the same prism constant. By doing so, the chances of introducing a prism constant error are reduced.

Conclusion

This document was simply prepared to help out the surveyor who will do the work. By following the same method in the station set-up as well as using the right coordinate system will help in providing reliable data to the engineering team.

Those guidelines were prepared for the scenario of having only one (1) surveyor allocated to the work. Should there be additional manpower, some of the work should also include traditional leveling method.

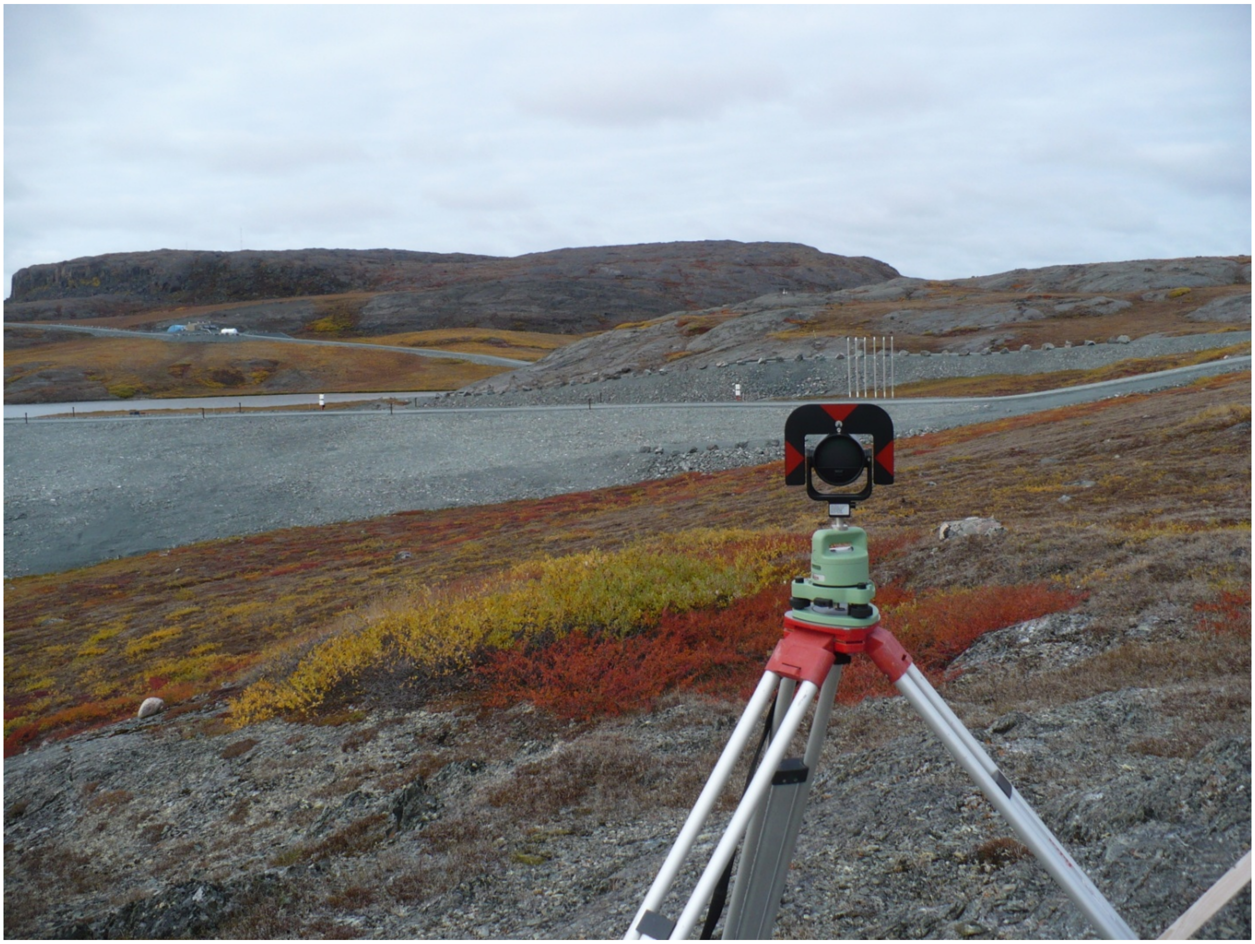
In the following pages are pictures and supplementary information for this work.

Prepared by:

Georges Cornelissen, C.E.T.
E-mail: gc@yk.com
Hopebay, Nunavut
September 10, 2013

A robotic total station kit

Station at ND1



Back sight at ND4

Control Point ND5

Note: Could be weak, not recommended to use for set-up.

Mini-prisms

Note: some points require greater than 40 cm height.

Consistent prism constants

Deep settlement point

Note: Placing a transparent template with circles at 5mm Increment (example) would help to pin point exactly the center of the deep settlement points.

View inside the casing of a crest monitoring point

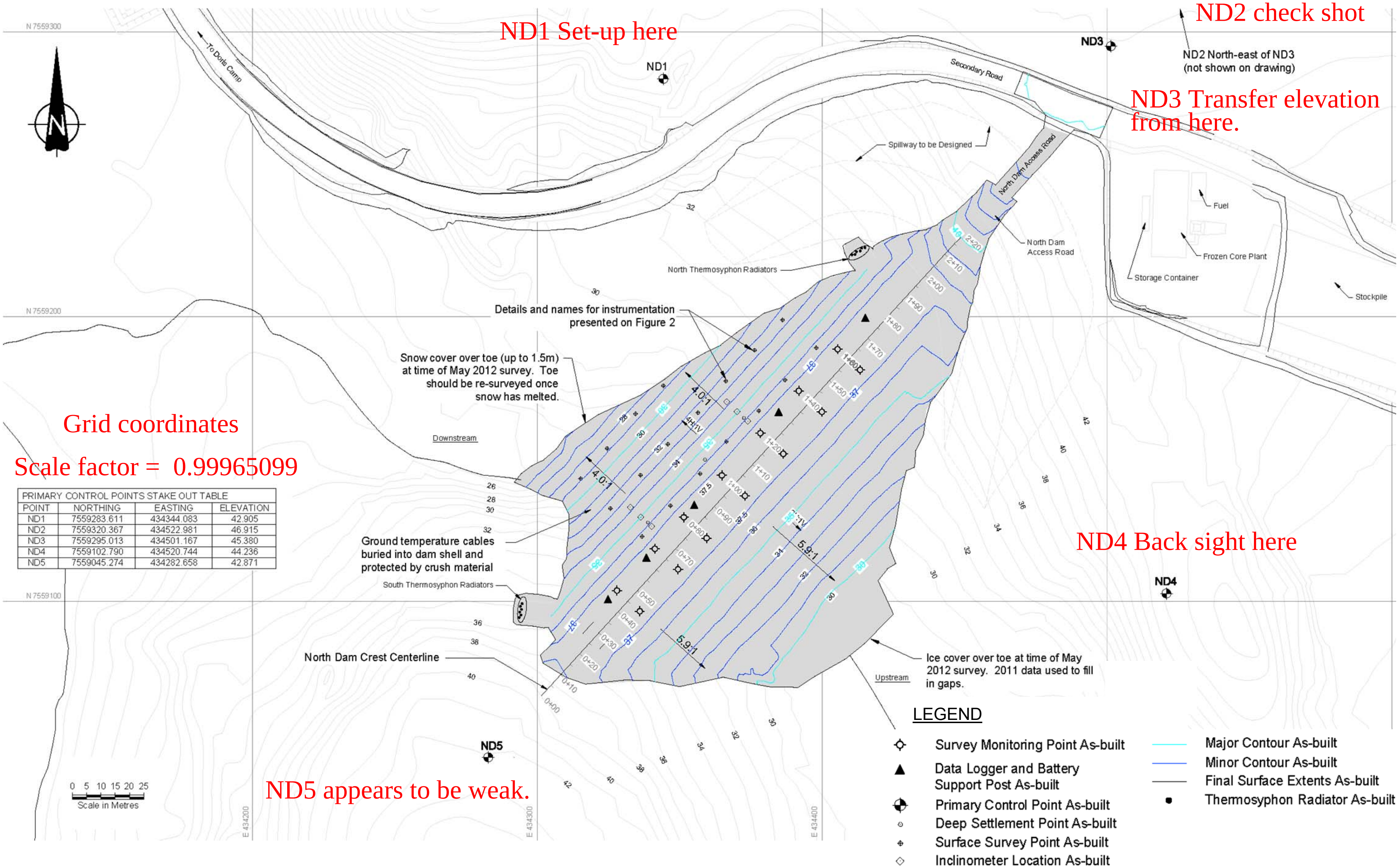
The surface survey points are constructed with same material as control points.

Please remember

The data is grid.

Scale factor at ND1 is 0.99965099.

J:\01_SITES\Hope.Bay\!ACAD\2013 Drawings\North Dam



Grid coordinates

Scale factor = 0.99965099

PRIMARY CONTROL POINTS STAKE OUT TABLE			
POINT	NORTHING	EASTING	ELEVATION
ND1	7559283.611	434344.083	42.905
ND2	7559320.367	434522.981	46.915
ND3	7559295.013	434501.167	45.380
ND4	7559102.790	434520.744	44.236
ND5	7559045.274	434282.658	42.871

srk consulting

MAC RESOURCES

North Dam Monitoring SOP

North Dam General Arrangement and Primary Control Points

Job No: 1CT022.000

Filename: HopeBay_NorthDamMonitoringSOP_NodeFIGS_1CT022.000_im_jbk_20130709.pptx

Hope Bay

Date: July 2013

Approved: IM / JBK

Figure: 1

Appendix D - South Dam Visual Inspection / Checklist Form

South Dam
Walkover Report

Frequency: Weekly or as specified by EOR

Date:	
Inspected By:	
Conditions:	(ie. snow on ground, clear)

Visual Inspection:

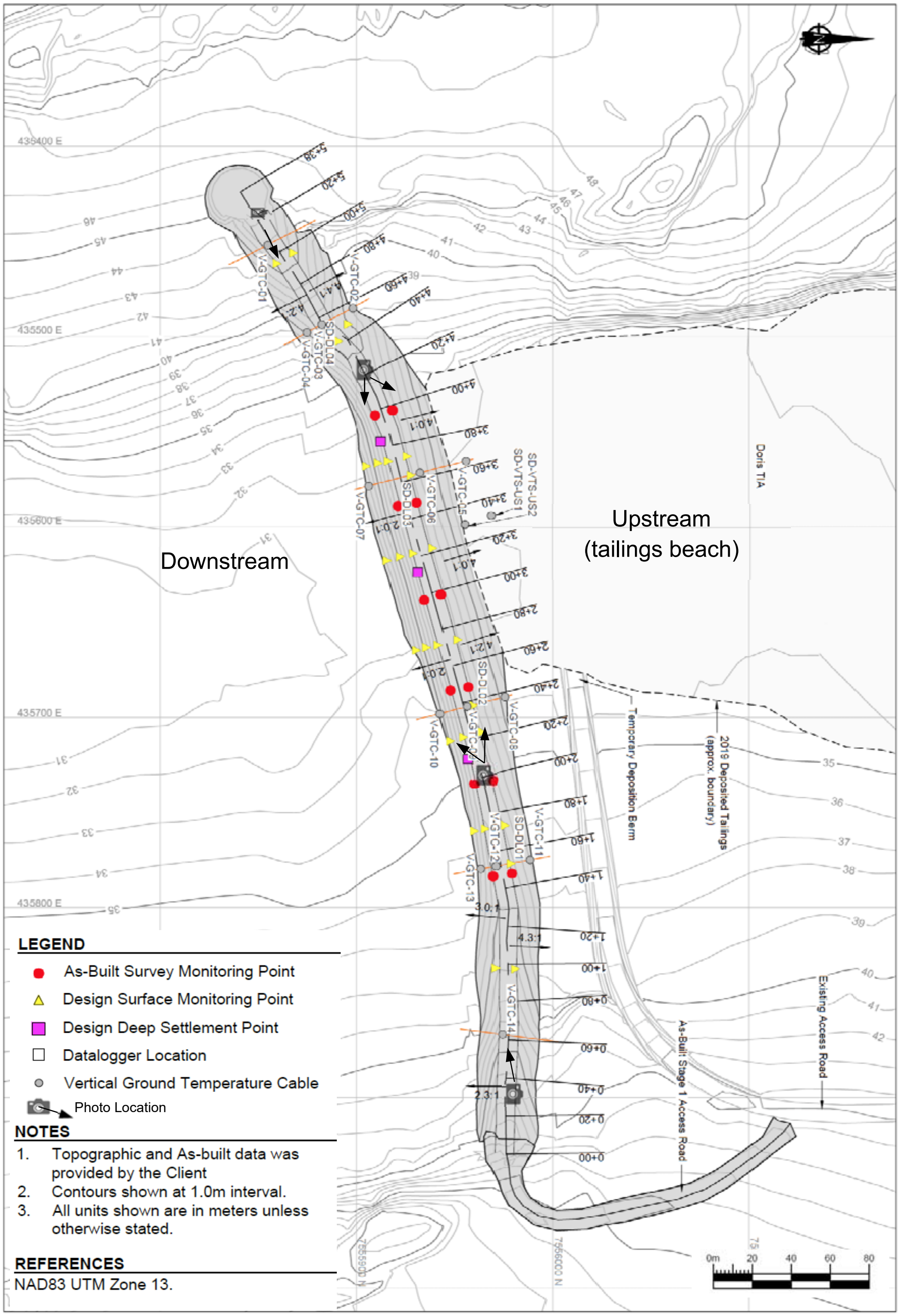
This weekly walkover survey report is a means to track the condition on the **South Dam**, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam (Overall)		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	No
Downstream Side of Dam (Overall)		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	No
Crest of Dam (Overall)		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	No
Tailings Beach on the Upstream Side		
Is the beach within the operating limits? (Beach length of 100 meters, no water ponding or pooling near the dam etc.) * Use shoreline markers indicating 100 meters from the crest for visual reference*	Yes	No
Active Tailings Discharge Spigot		
Indicate the active discharge spigot location (Spigot number or S on the figure provided)		
Settlement Instrumentation (on crest and downstream side)		
Any visible concerns? (significantly rusted or otherwise damaged, etc.)	Yes	No
Thermistors and Dataloggers		
Any visible concerns? (cables frayed, disconnected or damaged, boxes cracked, etc.)	Yes	No
Water at the Toe of the Downstream Side of the Dam		
Is water visible on the downstream side of the dam?	Yes	No
Is the water visibly flowing?	Yes	No
Walk over inspection of the downstream toe complete? (May to November)		
Inspector should walk the length of the downstream toe inspecting for seepage or slumping once most of the snow has melted (May to November)	Yes	No
If you answered yes to any of the questions above, or made other observations, please provide details and photos. Observations can be sketched on the figure provided below. NOTES: If seepage has been noted estimate the flow (high/medium/low) and report to TMAC Environmental Superintendent:		

Photos:

Please collect the following photos:

- Photo from the crest looking W along the dam crest (Station 0+30) ☐
- Photo from the crest looking SW over the downstream toe along the dam (Station 2+00) ☐
- Photo from the crest looking W over the tailings beach (Station 2+00) ☐
- Photo from the crest looking NE over the tailings beach (Station 4+20) ☐
- Photo from the crest looking E over the downstream toe along the dam (Station 4+20) ☐
- Photo from west end looking E along the dam crest (Station 5+20) ☐



QUALITY ASSURANCE AND QUALITY CONTROL PLAN

AGNICO EAGLE
HOPE BAY

HOPE BAY, NUNAVUT

MARCH 2022

Quality Assurance and Quality Control Plan

Plain Language Overview:

This Plan describes the quality assurance and quality control procedures to be used at the Agnico Eagle Mines Limited - Hope Bay site when conducting environmental sampling, analysis and reporting. This Plan outlines 1) the criteria for sample collection, preservation, documentation, transportation, and 2) data management and reporting practices associated with environmental sampling.

Hope Bay, Nunavut

Publication Date: March 2022

Agnico Eagle - Hope Bay
145 King St. East, Suite 400
Toronto, Ontario, M5C 2Y7
Phone: 1-416-947-1212

Revisions

Revision #	Date	Section	Changes Summary	Author	Approver
0	Feb 2002	Original	Original Document	MHBL	MHBL
1	Mar 2004	Throughout	Review	MHBL	MHBL
2	Oct 2007	Throughout	Review to include NWB specific concerns	MHBL	MHBL
3	Mar 2008	Throughout	Review to include changes	HBML	HBML
4	Feb 2009	Throughout	Annual Review	HBML	HBML
5	Jan 2011	Throughout	Annual Review	HBML	HBML
6	Jun 2011	Throughout	Added ST-6a and b, ST-11 to the required sampling stations; added ST-1, ST-2, ST-4, and ST-6a and b to the current sample stations; incorporated 2BE-HOP0712 and 2BB- BOS0712 within the document	HBML	HBML
7	Jun 2012	Throughout	Added ash characterization sampling, waste oil sampling, flow meter calibration and equipment blanks. Updated photos and samples lists to reflect camp status.	HBML	HBML
8	Nov 2012	Throughout	Minor edits, updated licence numbers. No technical content changes.	HBML	HBML
9	Jan 2017	Throughout	Updated to TMAC ownership and format; revision to section regarding soil sampling to expand beyond sampling hydrocarbon contaminated soils. Included subsequent Modules A, B and C to provide details for each site and the associated water licence.	TMAC	TMAC
10	Mar 2019	Section 1.3 Section 1.4 Section 5 Section 6 Appendix D through F Module A, C, D and E	Revised Table 1-2 reference to management plans. Updated Roles and Responsibilities. Included Maxxam and Nautilus Labs in Section 5. Update to Section 6 with change from EQWin to MonitorPro database management software. Update to Appendix D (ALS CALA Certificates and Scope). Addition of Appendix E and F (Maxxam and Nautilus Labs CALA Certificates and Scope). Updated SNP Stations and Conformity tables in Modules A and C for amended 2AM-DOH1335 and renewed 2BB-BOS1727 licences. Added Modules D and E for 2BB-MAE1727 and 2AM-BOS1835.	TMAC	TMAC

11	Mar 2020	Section 1.3 Section 1.4 Section 2.1 Section 5 Section 6 Appendix B Appendix C Appendix D Appendix E Appendix F Module A Module B	Revised Table 1-2 reference to management plans. Updated Roles and Responsibilities. Additional of sampling Final Discharge Point as outlined in the Metal & Diamond Mining Regulations. Addition of reporting required under the Metal & Diamond Mining Regulations. Addition of Bureau Veritas Canada Inc. (formally Maxxam Analytics) in Section 5. Updated bottle/preservative requirements in Appendix B. Updated ALS QC Protocols in Appendix C. Updated ALS CALA Certificate/Scope for Vancouver and Yellowknife laboratories in Appendix D. Updated Bureau Veritas CALA Certificate/Scope in Appendix E. Updated Nautilus Environmental CALA Certificate in Appendix F. Updated sample location figures in Module A and Module B.		
12	Mar 2021	Throughout	Updated to Agnico Eagle Mines Ltd ownership and format. Updated Roles and Responsibilities. Updated Bureau Veritas SCC Certificate and Scope	Agnico Eagle	Agnico Eagle
13	Mar 2022	Throughout	Update to ALS-Vancouver CALA certificate and removal of ALS – Yellowknife's certifications Update to SNP sampling station testing requirements	Agnico Eagle	Agnico Eagle

Contents

Tables

Figures

No table of figures entries found.

Glossary

Term	Definition
Agnico Eagle	Agnico Eagle Mines Ltd.
Accuracy	A measure of the closeness of the analytical result to the true value
ALS	ALS Environmental Laboratories
CCME	Canadian Council of Ministers of the Environment
Composite Sample	Obtained by combining portions of multiple grab samples or by using specially designed automatic sampling devices. Provide a more representative sampling of heterogeneous matrices in which the concentration of the analytes of interest may vary over short periods of time and/or space
Grab Sample	An undiluted quantity of material collected at a particular time and place that may be representative of the total substance being sampled at the time and place it was collected
INAC	Indigenous and Northern Affairs Canada
NWB	Nunavut Water Board
Precision	A measure of the closeness with which multiple analyses of a given sample agree with each other
Quality Assurance (QA)	The system of activities designed to better ensure that quality control is done effectively
Quality Control (QC)	The use of established procedures to achieve standards of measurement for the three principal components of quality: precision, accuracy and reliability
Reliability	A measure of the frequency at which the standards of precision and accuracy are achieved

1 Introduction

This Hope Bay Quality Assurance and Quality Control Plan (the Plan) has been prepared by Agnico Eagle Mines Limited (Agnico Eagle) in accordance with various water licences held by Agnico Eagle associated with developments throughout the Hope Bay region.

The Plan is intended primarily for use by Agnico Eagle and its contractors to ensure that best practices with respect to conducting environmental sampling, analysis and reporting are followed, and that the conditions of water licences and associated regulations are met.

This Plan is structured in a manner such that one document pertaining to quality assurance and quality control is approved and implemented across all Agnico Eagle Hope Bay project sites, while still addressing site- and licence-specific needs: the main document outlines Agnico Eagle's approach to conducting environmental sampling, analysis and reporting as it pertains to all Agnico Eagle Hope Bay developments; subsequent modules provide details for each site and the associated water licence. In the event of a new water licence, or an existing licence amendment, only the specific modules pertaining to that licence and site will need to be revised. This is intended for consistency and efficiency across operations and for compliance management.

1.1 Objectives

The main objective of this Plan is to outline a set of operating principles that, if strictly followed during sample collection and analysis, will produce data of known and legally defensible quality. Consistent with Agnico Eagle's intent to be a responsible operator, the following objectives will be applied to achieve a high level of quality assurance:

- Provide standard procedures for sample collection, preservation, documentation and transportation, to achieve precision, accuracy and reliability in data quality;
- Ensure personnel involved in sampling and analysis are trained and competent;
- Utilize high quality laboratory supplies and sampling equipment that are reliable and maintained in good working condition;
- Ensure that all chemical analyses are conducted at a certified external laboratory;
- Describe a standard process for managing analytical data results and completing internal and external reporting;
- Establish and review Data Quality Objectives (DQOs) to ensure that data required for environmental management is available;
- Implement quality control programs, based on recognized best operating practices, to assess the quality of analytical data, provide warning of unacceptable analytical or sample errors, and initiate prompt remedial action when deficiencies are identified;
- Apply these principals to all environmental samples, whether analyzed for the purpose of regulatory compliance monitoring, or for the purpose of internal environmental management.

1.2 Relevant Legislation and Guidance

Table 1-1 provides a summary of federal and territorial regulations governing this Plan and associated guidelines. Additional regulations and standards govern other Agnico Eagle plans which are implemented in conjunction with this Plan.

Table 1-1. List of federal and territorial regulations governing the Quality Assurance and Quality Control Plan

Regulation	Year	Governing Body	Relevance
Quality Assurance and Quality Control Guidelines For Use by Class "A" Licensees	1996	INAC Water Resources Division	Describes information to be included in the development of a QA/QC Plan
Standard Methods for the Examination of Water and Wastewater	1999		Provides procedures and methods of analysis for examination of water quality
Guidance Manual on Sampling, Analysis and Data Management for Contaminated Sites Volume I	1993	CCME	Technical support document which provides approach to sampling, analysis and data management.

1.3 Related Documents

The documents listed in Table 1-2 are expected to be referenced and utilized in conjunction with the QA/QC Plan.

Table 1-2. List of documents related to the Quality Assurance and Quality Control Plan

Document Title	Year	Relevance
Hope Bay Project Aquatic Effects Monitoring Plan	2018	Describes the monitoring schedule, sampling methods, analysis and determination of environmental effects, and the quality assurance and quality control procedures to be conducted in aquatic environments.
Hope Bay Project Doris-Madrid Water Management Plan	2022	Describes effluent discharge quality, monitoring programs and sampling locations associated with water management at Doris and Madrid.
Hope Bay Project Boston Water Management Plan	2018	Describes effluent discharge quality, monitoring programs and sampling locations associated with water management at Boston.
Hope Bay Project Groundwater Management Plan	2022	Describes monitoring schedule and analysis procedures associated with monitoring of mine groundwater.
Hope Bay Project Incinerator Management Plan	2017	Describes characterization sampling of incinerator bottom ash.
Hope Bay Project Hydrocarbon Contaminated Material Management Plan	2018	Describes sampling of soil and effluent placed in the Landfarm facility. Outlines remediation criteria for hydrocarbon contaminated soil.
Hope Bay Project Hazardous Waste Management Plan	2020	Describes waste oil and bottom ash characterization sampling.
Hope Bay Project Waste Rock, Ore and Backfill Management Plan	2022	Describes environmental monitoring required in pollution control ponds and seep sampling programs.

Document Title	Year	Relevance
Hope Bay Project, Phase 2 Doris Tailings Impoundment Area – Operations, Maintenance and Surveillance Manual	2020	Describes sample schedule, documentation and reporting required for confirmatory monitoring of tailings geochemical characterization and thermal monitoring of infrastructure associated with the TIA.
Hope Bay Project Boston Tailings Management Area – Operations, Maintenance and Surveillance Manual	2017	Describes sample schedule, documentation and reporting required for confirmatory monitoring of tailings geochemical characterization and thermal monitoring of infrastructure associated with the TMA.

1.4 Plan Management

In accordance with the requirements of the General Conditions (Part B) of the applicable water licences, this plan will be immediately implemented following its submission, subject to any modifications proposed by the NWB as a result of the review and approval process.

This plan will be reviewed annually and updated as necessary. Personnel responsible for implementing and updating the QA/QC Plan are identified in Table 3.

Table 1-3. Roles and Responsibilities

Role	Responsibility
VP Environmental Affairs	Overall responsibility for and implementation of this management plan; Provide the on-site resources to operate and maintain environmental sampling in accordance with this plan.
Environmental Superintendent	Review and update this plan as required; Ensure Environmental staff are trained in monitoring and quality assurance and quality control procedures; Support implementation of this management plan.
Environmental Supervisor/Coordinator	Provide training and support to environmental staff on the procedures contained in this plan; Ensure that required sampling is carried out in accordance with this plan and licence/permit requirements; Conduct regular inspections of the monitoring stations and audits of the maintenance records; Manage analytical data in accordance with this plan; Assess whether samples have met applicable regulatory standards and guidelines; Ensure sampling gear is in good working order and calibrated; Prepare and submit compliance reports to regulatory agencies.

2 Sample Collection in the Field

Environmental sampling is conducted to provide information required by Agnico Eagle for effective environmental management of the site, to provide information on follow-up monitoring of previous spill sites, and to monitor regulatory compliance. It is necessary to ensure sample integrity is maintained for all samples collected whether for regulatory compliance or internal management decisions.

2.1 Sample Locations

The Surveillance Network Program (SNP) is required by each water licence. The SNP defines a specific water-sampling program for the site, including sampling locations, sampling frequency and analytical parameters.

The SNP samples must always be taken at the same location and these sampling stations must be clearly identified in the field by posted signs. The location of signs and the precise location of sampling will be approved by the designated Inspector for the site. Sampling locations will be relocated as required by the water use permits or as recommended by the designated site Inspector. The appended modules provide information on the SNP stations to be monitored for each of the water licence areas.

Additional sampling sites will be added on an as needed basis in response to regulatory requirements or an identified internal monitoring need. These include samples at Final Discharge Points required under the Metal & Diamond Mining Effluent Regulations, samples taken under ice to compare water quality before and after a drilling effort, sites of new or previous petroleum product or chemical spills, and spring runoffs associated with construction activities. GPS coordinates of all sampling sites will be recorded using a handheld GPS and maintained on file.

2.2 Sample Types

Different sample types, such as composites or grabs, can be collected at various sampling locations. Water and liquid effluent samples (ie., natural lakes, streams, treatment ponds, process streams, sumps, effluent discharges) will generally be grab samples. Solid material samples (i.e., soil, ash, tailings solids) will usually be composite samples, although the purpose of the sampling program will dictate whether grab samples or composite samples will be used (i.e., characterization, delineation). For example, monitoring of the remediation levels in the land treatment area will usually require a composite sample within a homogenized area. Sampling hydrocarbon contaminated sites may require grab samples from various locations within the area to delineate a zone of contamination.

2.3 Sample Bottles

The laboratory analytical method and the parameter of interest will dictate the size and type of bottle (i.e., glass, plastic, amber glass) to be used for the sample. All sample bottles will be prepared and supplied by the contracted laboratory. Only clean unused bottles will be used to collect all samples to limit field generated contamination or preservation errors. If there is a need for bacterial testing, the bottles must be autoclaved (sterilized) by the contracted laboratory prior to use. New powder-free nitrile gloves will be worn at all times when handling sample bottles.

Some sampling bottle types require rinsing with the water to be sampled prior to collecting the sample. The contracted laboratory can provide instruction for the type of bottle and the rinsing requirements for each analytical parameter. If the sample bottle requires rinsing, the sample bottle should be partially filled with the water to be sampled and rinsed with the cap in place three times. Rinse water will be emptied away from the sampling point so that surface water is not contaminated and sediments are not disturbed. As a general rule:

- Plastic bottles require triple rinsing
- Glass bottles should not be triple rinsed because hydrocarbons can adsorb to the glass surface and increase sample concentrations during the rinsing process
- Sample bottles that are pre-charged with preservative must not be rinsed to prevent loss of the sample preservative

Bottles should be filled to near full capacity while allowing enough room for the preservative addition and mixing. Some bottles must be filled to the indicated fill-line on the bottle. Some analytical parameter samples must be collected without leaving head-space, which means that the bottle will be filled in such a way to prevent inclusion of air or bubbles. This is very important when sampling volatile parameters (e.g., volatile organic carbon or chlorine) which may evaporate out of solution if airspace is present. Typically, the easiest way to accomplish this is to place the cap on the bottle while the bottle is submerged. This can also be accomplished by filling the bottle to form a meniscus at the top and then carefully replacing the cap to ensure no water is lost. The contracted laboratory can provide instruction for the specific bottle filling requirements for each analytical parameter.

The sample bottles necessary for the different analyses required by the water licence SNPs are provided in the Appendix B.

2.4 Field Sampling Log Book

Details of all sampling activities are recorded in a field logbook. The sampler will record the sampling stations visited, the samples taken at each station, the date and time for each sample collected and the names of the individuals collecting the sample. The results of any field measurements (i.e., temperature, pH, etc.) will be recorded as well as information on sample preservation.

The sampler will also record any information that may influence the analytical results, such as weather conditions, stream flow rates, and unusual conditions at the site. Any necessary deviations from standard procedures or sampling location need to be documented and reasons for the change included in the field log book.

A scanned copy of the field log book pages should be made as soon as possible after sample collection and filed on the Environment server. This copy serves as backup in the event the log book were lost or destroyed, and as a reference for others who may need to review this data.

Field notes and the field log book are considered legal documents and should be kept legibly in permanent ink. In the event that an error is made it should be crossed out with a single line and initialled by the one making the correction. Pages should never be removed and space or pages being left blank should be labelled with a single diagonal line and the phrase “intentionally left blank”. When filled, the field log book should be filed and retained in case of future need.

The log book shall periodically be scanned and backed up to the company drive in order to preserve the previous records should the book be damaged or lost. Both electronic and paper copies of the book shall be filed and kept once the book is filled.

2.5 Sampling Methods

The following sections discuss methods that should be used to collect samples in different sampling locations. The bottle rinsing and filling techniques described in Section 2.3 will be incorporated into each of these methods.

2.5.1 Streams

The sample should be collected as close as practical to the middle of the stream, where water flows freely and is free of debris. If wading into the stream to collect the sample, the sampler should face upstream and wait to allow any sediment that may have been stirred up to settle or wash away. A sample pole may also be used to collect the sample from shoreline in situations where it is unsafe to enter the flowing stream. If a sample pole is used, the collection end of the pole will be cleaned prior to arriving at the sample location, transported to the sample site covered in a plastic bag and then rinsed in the water to be sampled prior to inserting the sample bottle into the collection end.

Ideally, the bottle will be submerged into the stream to a depth of approximately half the total stream depth to collect the sample. At minimum, the sample bottle will be submerged to approximately 10cm below the water surface. If the stream is too shallow to submerge the bottle to 10cm below the surface, care will be taken to prevent surface debris or sediments from contaminating the sample. If necessary, a smaller bottle or an individually-packaged sterile plastic syringe provided by the contract laboratory can be used to transfer water to the larger sample bottles, provided that these are rinsed as required.

2.5.2 Lakes and Ponds

Surface samples from lakes and ponds should be collected using the same procedures as above. Subsequent samples should always be taken at the same location. Sample bottles should be submerged to a depth of approximately 10cm below the water surface.

Water quality samples collected at depth in lakes or ponds will be collected with a clean discrete water sampler (e.g., Niskin sampler, Go-Flo sampler), which is lowered to the required depth and triggered to trap a sample of water by releasing a messenger weight from the surface down the rope used to lower the sampler. The sampler is lowered to depth three times and rinsed with the water to be sampled before collecting the sample the fourth time it is lowered to depth.

2.5.3 Process Streams (Pipes, Valves and Auto Samplers)

Some sampling of process streams may be required by the water licence SNP, MDMER and for environmental management purposes. These may be grab samples taken from a valve or pipe discharge, or composite samples collected by combining multiple grab samples or by an automated sampling system. The same principles used in natural stream sampling should be applied when collecting grab samples. Valves should be open for at least one minute before taking the sample to help ensure that the water is representative of the process stream.

2.5.4 Soil Sampling

The location, number and depth of soil samples will depend on the purpose of the sampling program (i.e., characterization, delineation) and nature of the parameters of interest. All sampling equipment (e.g. trowel, scoop, augers) will be made of stainless steel or high density polyethylene, and will be cleaned prior to and between sample events. Powder-free nitrile gloves will be worn and gloves will be changed before each new sample is collected. Samples should be gathered from freshly exposed soil and preserved as soon as possible.

2.5.5 Ash Sampling

The monitoring, characterization and disposal of bottom ash generated through incinerating or open burning appropriate waste streams is a requirement of the water licences associated with the project. Ash is collected at intervals to be representative of all the ash and the analysis is used to determine suitability for landfill placement.

During each incinerator ash cleaning an ash sample is collected. These samples are combined at month end into a composite which is then subsampled for analysis.

Each time ash is cleaned out of the burn pan an ash sample is collected. These samples are combined at month end into a composite which is then subsampled and sent for analysis.

Bottom ash is analyzed for flash point, paint filter test, leachable metals, leachable mercury and leachable BTEX. Sub-samples are packed tightly into glass jars with no headspace and submitted to the contract laboratory for analysis.

2.5.6 Waste Oil Sampling

Feedstock oil to be burned in a waste oil burner must be analyzed to determine the content of metals and other substances known to exist in used oil from the lubrication of machinery components and internal combustion engines. This is a requirement of territorial guidelines, federal regulations and the water licences issued to Agnico Eagle by the NWB.

An annual supply of waste oil totes is identified and a representative sample is collected from each of the totes to create a composite which is then sent for analysis.

The samples are analyzed for glycol, PCBs, ash, flashpoint, metals, sulphur, total chlorine, heating value, viscosity, and water.

2.5.7 Environmental Surveillance Monitoring

Some of the monitoring required under the water licences does not involve collection of samples or laboratory analysis. This may include monitoring shoreline erosion or ground temperatures around infrastructure facilities. The timely acquisition and preservation of this data provides documentation for aspects relating to how the camp is affecting the local environment. For example, if runoff from the site is not properly controlled permafrost degradation may be observed and documented. On the same note, a warming trend in a temperature monitoring station could be an early indicator of permafrost degradation. Field notes and measurements are collected for these programs and are an important part of the site environmental management.

2.5.8 Flow Measurements

Seametric TX-115 Flow meters are used to measure piped water movements and discharge within the water management facilities. The calibration procedure for the Seametric TX-115 Flow meters includes testing of the flow measurement reading against a known flow to determine accuracy, adjusting the K- factor to ensure the flowmeters are within 10% and recording the information in a flowmeter calibration log. This calibration is conducted prior to deployment in the field for water management related activities.

2.5.9 Field Measurements

Water temperature, electrical conductivity, oxidation-reduction potential, salinity and pH are typically measured and recorded in the field when the sample is taken. The calibration of the meters must be verified against a known standard solution and recalibrated if necessary prior to each day's sampling activities. The calibration data is recorded in a calibration log. Additionally, the calibration of the meter should be checked against a known standard at the end of the days sampling. Any issues with the meter calibration, or discrepancies with the end of day calibration check should be noted in the field log book along with that days sampling data. Calibration check data will not be used to alter any reading taken during the day. Instead, these results may be used to help explain anomalous data.

Field measurements should be taken directly from the water body being sampled. Where this is impractical, perhaps due to high velocity of a sample stream, the measurements can be taken from a triple rinsed sample jug or pail. All field measurement equipment is to be cleaned between sampling stations and rinsed in the sample stream/water body being sampled. It is important that field meters are never introduced into sample bottles that are destined for laboratory analysis to prevent sample contamination.

3 Sample Handling

3.1 Sample Identification

Prior to beginning a sample event, the required sample bottles and preservatives should be gathered, prepared and organized into sample sets inside a plastic bag which should be supplied by the contract laboratory.

When sampling and sample preservation is completed, the bottles should be clearly marked with all information that the laboratory analyst will need to report the result. The following information should be included:

- Sample location (or SNP station number)
- Date of sampling
- Parameters to be analyzed
- Preservation method used
- Filtering method used
- Name or initials of sampler
- Temperature and pH (where applicable)
- Company name, and
- Property name

Prior to taking the bottles to the field, each bottle will be labelled with as many of the items above as possible using waterproof pre-printed labels. The sampling time, temperature and pH (where applicable) will be recorded on the label in the field using permanent waterproof ink.

In some cases, permanent markers can be used to identify sample bottles, however these markings can be erased with wear and may not be clearly legible. Whenever possible pre-printed waterproof labels can be used to mark the sample bottles.

3.2 Chain of Custody Forms

A Chain-of-Custody (CoC) form must be completed for each sample collected. Template CoC forms are saved on the Environment server. The completed form is to be filed on the server in the Laboratory Data folder. A copy of this form must also be printed, signed and sent accompanying the samples.

3.3 Sample Preservation

As samples cannot be delivered to the analytical laboratory within two hours of sampling, preservation may be required for some parameters to prevent chemical reactions that may affect the concentration of the parameter of interest. The samples must be preserved within two hours of sampling. Preservative must be analytical grade and must not be used after the expiry date.

Expired preservative is returned to the laboratory for proper disposal. The contracted laboratory can provide instruction for the preservative requirements for each analytical parameter and will provide appropriate preservatives for parameters to be analyzed.

Samples must be kept dark and cool (~4°C), but not frozen unless otherwise specified by the laboratory. Samples will be packed in a cooler with ice packs for transport and for shipment to the laboratory. Samples will be stored in a refrigerator if they will not be shipped to the laboratory immediately after sampling. Samples should be delivered to the analytical laboratory as soon as possible after collection.

The sample preservatives necessary for the different analyses required by the water licence SNPs are provided in Appendix B.

3.4 Transportation

Care should be taken when packing samples for shipment. To help prevent leakage and cross contamination, sample bottles should be packed standing upright in the cooler. Sample bottles laid on their side are much more likely to leak, especially if they have other samples on top of them. When possible, samples known or suspected to have elevated contaminate levels should not be shipped together with samples expected to be clean (i.e. sewage samples not shipped in same cooler as potable water samples).

The contracted laboratory can provide details on the storage or holding time for each parameter to be analyzed (i.e. can be as little as 24 hours). Where possible, sample dates will be scheduled so that a flight is available to transport the sample to the lab within the specified holding time. In all cases, samples will be shipped to the laboratory as quickly as possible and will be labelled as “Time Sensitive, Keep Cool” to ensure proper handling during shipment.

4 Quality Control Samples

There are six types of QC samples that can be collected and analyzed to verify the quality of the sample collection and analysis methods. These are described in the section below. These QC samples are analyzed for the same suite of analytical parameters as the SNP sampling station samples.

4.1 Travel Blanks

Travel blanks are used to check for contamination during the movement process of samples and are subjected to the same potential sources of contamination as the samples to be analyzed. The travel blanks are prepared by the analytical laboratory with de-ionized water and appropriate preservative. The travel blank bottles are shipped to site, transported to the field, carried through the sample collection and shipped back to the laboratory with the field samples. Travel blank bottles should not be opened at any time.

4.2 Equipment Blanks

Equipment blanks are collected after cleaning of field equipment and prior to sampling. De-ionized water provided by the contract laboratory is used to rinse the equipment. The field equipment is then filled with de-ionized water, and then collected and preserved in new sample bottles for the same analysis as the field samples (de-ionized water expires within six months of being produced by the laboratory; expired de-ionized water will not be used). The results from this blank sample assure adequate decontamination of the field equipment. The Niskin or other sampling equipment used to collect samples will be decontaminated prior to use.

4.3 Field Blanks

Field blanks are samples of laboratory-grade de-ionized water that are subjected to the same procedures as routine field samples. Any measurement of the parameter of interest, above method detection limits, will indicate an analytical error, impurities in the laboratory distilled water supply, contaminated sample preservatives or contamination of the sample during the handling process.

Combined with the results of other QC procedures, analysis of field blanks can help identify sources of contamination and error.

A set of field blanks should be made up once each month and taken into the field when the SNP stations are sampled. New sample bottles will be rinsed as directed by the contract laboratory and filled using de-ionized water provided by the contracted laboratory (de-ionized water expires within six months of being produced by the laboratory; expired de-ionized water will not be used). The samples will be poured directly from the bottles provided by the laboratory into the sample bottles to replicate grab sample methods. The field blank set should represent all the parameters routinely analyzed at that sample location. The bottles should be preserved using the same protocol as the regular samples and submitted to the laboratory identified as field blanks.

4.4 Replicate Samples

Replicate samples (sometimes referred to as duplicate samples) test precision and assure that sample results are reproducible. They are prepared by collecting two separate samples for each given analytical parameter at a given sample location. The replicate samples are collected, handled and analyzed using the same procedures applied to routine samples. The samples are also analyzed by the same analytical method in the laboratory. Replicate samples are usually used to identify sampling procedure errors.

Once per operating season, for each active SNP station, a set of duplicate samples will be taken representing as many of the routine analyses as possible. Where possible, this should be carried out in conjunction with audit sampling conducted by the designated Inspector. Replicate sampling should rotate between prescribed SNP stations.

4.5 Split Samples

Two or more representative sub-samples are removed from one collected sample and analyzed separately at the laboratory. This data is used as a check of the precision of the analytical procedure employed by the laboratory and is a normal part of the laboratory QA/QC program. These can also be collected in the field by dividing a composite sample into two sets of samples. If field split samples are collected, it is common to label each sample with a different station name, to provide a blind assessment of the laboratory's analytical program.

4.6 Method "Spiked" Samples and Certified Standards

The recovery of "known additions" from "spiked" samples is used as a check on the recovery of the parameter to be analyzed using a given analytical procedure. It is periodically carried out at the laboratories employed to analyze the samples and forms part of the laboratory's normal QA/QC program.

5 Laboratory Analysis

All environmental monitoring samples are submitted to an offsite analytical laboratory which is accredited by the Canadian Association for Laboratory Accreditation (CALA) or the Standards Council of Canada (SCC). Currently, Agnico Eagle uses ALS Environmental Laboratories (ALS), Bureau Veritas Canada Inc. (formally Maxxam Analytics) and Nautilus Environmental Inc. for analyses of all environmental samples. A cover letter from ALS confirming approval of the Plan for analyses to be performed under this Licence is provided in Appendix A of this plan. The quality control protocols used by ALS are provided in Appendix C of this plan. The CALA scope and Certificates for ALS can be found in Appendix D. The SCC Certificate and scope for Bureau Veritas Canada Inc. can be found in Appendix E. The CALA scope and Certificates for Nautilus Environmental Inc. can be found in Appendix F.

Agnico Eagle verifies with each laboratory that the analytical methods utilized for each parameter conform to industry best practices and those referenced in applicable guidance and regulatory documents.

6 Reporting

All analytical results are forwarded in electronic format to Agnico Eagle's Environmental Supervisor/Coordinator for filing. Agnico Eagle uses a MonitorPro electronic database to manage data and make data easily accessible. This database is maintained by the Environmental Supervisor/Coordinator.

After receipt, the results are screened for anomalies and/or trends, and are placed into the appropriate environmental files on the Environmental server. Results that appear to be anomalous are flagged and a review is conducted to identify potential sources of the anomaly. In some instances, the analysis is repeated. Analyses that indicate contamination or changes are subjected to further study and reported to the appropriate agencies. The environmental files are maintained on the server as a management tool for environmental risk assessment and in preparation of summary reports for the regulatory agencies and company officials. In compliance with the Surveillance Network Program, reports of analytical results for SNP samples are submitted electronically to the NWB and the Inspector within 30 days following the month in which the samples were taken. The NWB distributes the reports to other agencies and interested parties.

Results of samples collected under the Metal & Diamond Mining Effluent Regulations are reported to Environment and Climate Change Canada through the Single Window Information Manager online reporting system each calendar quarter not later than 45 days after the end of the quarter. An annual report of results of samples collected under the Metal & Diamond Mining effluent Regulations will be submitted by March 31 of each year.

7 References

Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites Volume I: Main Report. 1993, Canadian Council of Ministers of the Environment

Protocols Manual for Water Quality Sampling in Canada. 2011, Canadian Council of Ministers of the Environment

Standard Methods for the Examination of Water and Wastewater. 1999, American Public Health Association, American Water Works Association and Water Environment Federation

Quality Assurance (QA) and Quality Control (QC) Guidelines for use by Class “A” Licensees. 1996, Indian and Northern Affairs Canada Water Resources Division and Northwest Territories Water Board.

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QUALITY ASSURANCE AND QUALITY CONTROL PLAN

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Appendix A – ALS QA/QC Plan Review Confirmation Letter

ALS Canada Ltd.
8081 Lougheed Highway
Burnaby, BC
Canada V5A 1W9
T +1 604 253 4188 F +1 604 253 6700

March 4, 2022

Agnico Eagle Ltd.
Hope Bay, Nunavut

Re: APPROVAL CONFIRMATION FROM ALS ENVIRONMENTAL FOR ANALYSES PERFORMED UNDER THE Agnico Eagle QA/QC PLAN

ALS Burnaby - Environmental has reviewed the Quality Assurance and Quality Control Plan – Appendix B – Analytical Parameters, Sample Bottles and Required Preservatives, provided to ALS by Agnico Eagle Ltd.

ALS Burnaby has the capabilities to conduct all analyses listed in Appendix B of the above referenced QA/QC plan. In addition, ALS is accredited by the Canadian Association of Laboratory Accreditation (CALA) for all analyses listed in Appendix B.

Please feel free to contact myself or Amber Springer if you require any additional information.

Sincerely,

Katherine B. Thomas, B.Sc.	Amber Springer, B.Sc.
Director of Operations, Western Canada	Senior Project Manager, Burnaby

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Appendix B – Analytical Parameters, Sample Bottles and Required Preservatives

Analytical Parameters, Sample Bottles and Required Preservatives

SNP Monitoring Group Reference	Analytical Parameters	Measurement Units	Sample Bottle	Preservative
General (G)	pH	pH units	500 mL plastic	None
	TSS	mg/L		
Nutrients (N1)	Orthophosphate-P	mg/L		
	Nitrate-N	mg-N/L		
	Nitrite-N	mg-N/L		
Nutrients (N2)	Total Ammonia-N	mg-N/L	120 or 250 mL amber glass	1 mL of 1:3 H2SO4 or 1 mL of 1:1 H2SO4
	Total Phosphate-P	mg/L		
Total Metals - Unfiltered (MT)	T-Aluminum	mg/L	60 mL plastic	None
	T-Arsenic	mg/L		
	T-Copper	mg/L		
	T-Iron	mg/L		
	T-Nickel	mg/L		
	T-Lead	mg/L		
	T-Zinc	mg/L		
Dissolved Metals - Filtered (MT)	D-Iron	mg/L	60 mL plastic; field filtered	None
	D-Copper	mg/L		
	D-Arsenic	mg/L		
	D-Zinc	mg/L		
	D-Cadmium	mg/L		
	D-Nickel	mg/L		
Biological (B)	Biochemical Oxygen Demand	mg/L	500 mL plastic	None
	Fecal Coliforms *	CFU/100 mL (colony forming units)	Sterile 250 mL plastic	Sodium Thiosulfate (precharged)
Hydrocarbons (HC)	Total Oil & Grease	mg/L	2 X 250 mL or 2 X 500 mL amber glass	0.5 mL of 1:1 HCl or 1 mL of 1:1 HCl
	Benzene	mg/L	2 X 40 mL glass	Sodium Bisulphate (precharged)
	Toluene	mg/L		
	Ethyl Benzene	mg/L		
Discharge (D)	Flow	m3/day	None, field measured	N/A
	Volume	m3		
	Duration	Day		

*ALS methodological change. Fecal coliforms now in MPN/100mL (Most Probable Number).

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QUALITY ASSURANCE AND QUALITY CONTROL PLAN

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Appendix C – ALS Quality Control Protocols

ALS Canada Limited

Quality Control Protocols

02 January 2018

Quality control (QC) samples are introduced into batches of client samples at critical points of sample handling, preparation and analysis to demonstrate the processes are performing as expected. In general, quality control samples are considered either Instrument QC or Method QC. The following identifies the standard requirements for Quality Control at ALS, which are applicable to most tests. Many test methods use additional QC elements to monitor control over specific steps in testing processes.

Instrument QC:

Instrument QC samples demonstrate control for the instrumental portion of a method. Instrument QC requirements must be successfully met before the analysis of Method QC or samples may proceed.

- Verification of initial calibration - criteria varies with each test.
- 2nd source Calibration Verification Standard (CVS) – at minimum, with each initial calibration.
- Continuing Calibration Verification (CCV) – frequency varies by test.
- Instrument Blanks – usage and frequency varies by test.

Method QC:

Method QC samples encompass the entire method and are initiated at the earliest point of the method where appropriate. Refer to the QC Definitions below. One set of Method QC is included for each batch of up to 20 client samples. Each set includes:

- 1 Method Blank.
- 1 Sample Duplicate. *
- 1 Lab Control Sample.
- 1 Reference Material or Matrix Spike. **
- Surrogate Compounds.

* Duplicate analyses are not performed where sub-sampling is not possible – e.g. most tests for organics in water.
** Spikes and Reference Materials are unavailable for Microbiology tests. Microbiology tests utilize positive and negative controls daily in each incubator. The controls are specific to the tests performed.

Method QC must be successfully analyzed before sample results are approved. Method QC results are normally reported to ALS clients with data reports.

Data Quality Objectives (DQOs):

DQOs are established for each QC sample, based on a combination of reference method objectives, customer requirements and historical test method performance. Where applicable, prescriptive elements of reference methods or regulatory requirements take precedence over internal DQOs. Current DQOs are available upon request.

Detailed descriptions of how DQOs are evaluated for different types of Quality Control are described on the following pages.

Types of Quality Control – Definitions and Evaluation Protocols

Method Blank (MB) - A blank sample prepared to represent the sample matrix as closely as possible and analyzed exactly like the calibration standards, samples, and quality control (QC) samples. Results of Method Blanks provide an estimate of the within batch variability of the blank response and an indication of bias introduced by the analytical procedure.

Except in special cases (as outlined in ALS DQO summary documents) the ALS DQO for Method Blanks is for all results to lie below the Limit of Reporting (LOR).

Laboratory Sample Duplicate (DUP) - A second portion of sample taken from the same container as the sub-sample used for the primary analysis, that is analyzed independently through all steps of the laboratory's sampling and analytical procedures. Duplicate samples are used to assess variance of the total method including sampling and analysis.

Duplicate precision is normally measured as Relative Percent Difference (RPD), where RPD = |(Result2 - Result1) / Mean| * 100. Duplicate samples should normally agree to within the ALS Precision DQO for the test and parameter (expressed as RPD), or within ± 2 x the LOR (for low level results). Refer to the ALS DQOs for Precision for specific limits for any given test.

ALS does not establish DQOs for Field Sample Duplicates. However, it is generally understood and accepted that the variability of Field Sample Duplicates is significantly more than what is observed with Laboratory Sample Duplicates.[1]

Laboratory Control Sample (LCS) - A known matrix spiked with compound(s) representative of the target analytes. An LCS is used to verify the accuracy of the laboratory's performance of the test.

LCS accuracy is calculated as the measured amount divided by the target concentration, and is normally expressed as percent recovery. LCS recoveries should normally lie within the ALS Accuracy DQOs for the test and parameter. For a low level LCS, the result should normally lie within ± 1 x the LOR of the target concentration. Refer to the ALS Accuracy DQOs for specific limits for any given test.

Reference Material (RM) – A material or substance, one or more of whose property values are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. An RM is similar to an LCS, but encompasses a representative sample matrix. Similar to an LCS, an RM is used to verify the accuracy of the laboratory's performance of the test, but including the challenges of a complex sample matrix.

RM accuracy is calculated, expressed, and evaluated similarly to LCS accuracy. Refer to ALS Accuracy DQOs for specific limits for any given test.

Matrix Spike (MS) - A sample prepared by adding a known amount of a target analyte to a specified amount of a sample for which an independent estimate of the target analyte concentration is available. Spiked samples are used, for example, to determine the effect of the sample matrix on a method's recovery efficiency.

Matrix Spike results are calculated and expressed as percent recovery, by dividing the measured result (minus any analyte contribution from the unspiked sample) by the target analyte concentration. Matrix Spike results should normally lie within the ALS Accuracy DQOs for Matrix Spikes. Matrix Spike results cannot be accurately

[1] Depending on the type of Field Sample Duplicates being evaluated (e.g. Co-located versus Split Sample Duplicates), ALS recommends DQOs for Field Sample Duplicates that are between 1.5 – 2.0 times higher than our Laboratory Sample Duplicate DQOs. Co-located Sample Duplicates generally require higher DQOs than Split Sample Duplicates.

calculated or reported in cases where the background concentration of the test parameter in the sample is higher than the spike level.

Surrogate Compounds (SURR) – Surrogate Compounds are added to every sample where applicable (organics tests only). They are substances with properties that mimic the analyte of interest, and which are unlikely to be found in environmental samples. They are added at known concentrations to samples to establish that the analytical method has been properly performed.

Surrogate results are calculated and expressed as percent recovery, by dividing the measured result against the expected target concentration. Refer to ALS Accuracy DQOs for specific limits for any given test.

Automated Relational Checks

In addition to all our standard Quality Control checks, ALS also employs dozens of "Relational Checks", which are programmed into our Laboratory Information Systems (LIMS) to automatically highlight any situations where the expected relationships between different test parameters are violated, which can often point to errors. Such errors may originate with field sampling, or from laboratory processes, but should always be identified and pro-actively investigated.

Total versus Dissolved Metals ("D > T" Check) – One of the most important and common relational checks we do is a check for situations where Dissolved Metal concentrations significantly exceed Total Metal concentrations. By definition, this situation should not occur. However, there are a few reasons why this can occur:

i) Circumstances where Dissolved Metals slightly exceed Total Metals are expected in a small percentage of samples, simply due to normal random variability associated with sampling and testing protocols. In fact, when all metals in a test sample exist in the dissolved form, we expect that Dissolved Metals measurements will numerically exceed Total Metals measurements exactly half the time (by a small margin), simply due to random chance.

ii) Samples to be analyzed for Dissolved Metals must be filtered, which should be conducted in the field to ensure valid results. Unvalidated and uncontrolled filtration processes are a common source of low level metals contaminants. Contamination of a sample during field filtration is the most common source of significant D > T issues (ALS recommends syringe filtration in the field, using filters proven by ALS to be suitable for this task. If in-line filters are used, ALS recommends pre-rinsing with 1L of sample prior to use; smaller rinse volumes may be suitable but should be demonstrated in advance).

iii) ALS recommends the use of Field Filtration Blanks to monitor and control the filtration process, and to assist with the interpretation of any D > T issues.

iv) Field samples for Dissolved and Total Metals are normally collected independently, therefore field sampling variability is another common cause of D > T issues.

If none of the above causes can explain a situation where Dissolved Metals exceed Total Metals, then another type of error may be indicated, either with the collection of the sample in the field, or with sample containers or preservatives, or with the laboratory testing process.

ALS automatically highlights and investigates all circumstances where a Dissolved Metal result exceeds the Total Metal result by 30% RPD or more, but only if the absolute difference between the two results is greater than the sum of the Limits of Reporting (Detection Limits) of the two results.

In the case of field filtered samples where D > T, the following qualifier will be applied where no lab errors are identified upon review: *DTMF: Dissolved concentration exceeds total for field-filtered metals sample. Metallic contaminants were likely introduced to dissolved sample during field filtration*. The mechanism of this relational check is derived from the ALS Duplicate DQOs for Metals in Water (20% RPD), multiplied by 1.5 to account for variability attributed to field sampling, because the dissolved and total metals tests are conducted on independent samples.

All D > T relational checks that violate the rule above are flagged internally, and are investigated by ALS before sample results will be released to our clients. Anomalous results (except those consistent with low level contamination caused by field filtration) will be re-analyzed to confirm or correct the anomaly. If results are confirmed by re-analysis, the following data qualifier is applied: *DTC: Dissolved concentration exceeds total. Results were confirmed by re-analysis.*

Other Important Relational Checks Conducted by ALS

ALS employs dozens of other relational checks to highlight anomalous relationships between test parameters. Some of more common checks include the following:

- *Total Ammonia should not exceed Total Kjeldahl Nitrogen*
- *Weak Acid Dissociable Cyanide should not exceed Total Cyanide*
- *E. coli should not exceed Fecal Coliforms*
- *Nitrate + Nitrite should not exceed Total Nitrogen*
- *Hexavalent Chromium should not exceed Total Chromium*
- *True Colour should not exceed Apparent Colour*
- *Mineral Oil and Grease should not exceed Total Oil and Grease*
- *Reactive Phosphorus should not exceed Total Phosphorus*

ALS Canada Limited

Quality System Protocols

19 January 2018

ALS is a global diversified testing services organization with a presence on every continent, offering a broad range of services to leading global companies.

The following summarizes standard practices routinely employed by the ALS Environmental Division in Canada. Our practices exceed accreditation requirements and have been designed to meet or exceed the needs of our customers and to give them confidence in the reliability of our test data.

ALS Canada locations hold accreditations and certifications relevant to their work and area of operation. Participation in CALA, USA DOD, NELAP, various USA state and other regional and regulatory programs is location-specific. Refer to Accreditations in the Environmental Testing Downloads section at www.alsglobal.com for information relevant to each ALS location. Alternatively, current scopes and certificates are available from your Account Manager or by contacting our Quality Department.

Additional information is available on request. Customers are invited to audit or tour ALS facilities at their convenience.

Services to Customers:

ALS cooperates closely with our customers to ensure their testing needs are understood, and allows them reasonable access to relevant work areas of the laboratories to audit our management system or to witness test work undertaken on their behalf.

All client issues are logged into our tracking system to ensure each issue is addressed completely and appropriately. Local and national oversight and initiatives ensure that identified improvements are incorporated throughout our Canadian laboratory network so that customers receive the same level of service regardless of which location performs the testing.

Documentation and Document Control:

Test methods and support procedures are documented in detail to ensure consistency of application, repeatability of test results and traceability of analyses.

Test method requirements include but are not limited to sample handling, sample storage, minimizing interference, sample preparation, reagent and standard specifications, equipment, supplies, calibration requirements, instrumental measurement procedures, quality control requirements, data quality objectives and corrective actions, calculations, reporting requirements, reference information, and hazards and their preventive measures.

Administrative support procedures are also documented where needed to ensure quality system procedures and customer services are provided in a controlled, approved manner consistent with ALS policies and client needs.

All documents are authorized prior to use, ensuring adequate technical and quality oversight.

Distribution of documents is controlled to ensure only the most recent version is available for use. Authorized documents are reviewed periodically by the ALS signing authority to ensure they continue to meet both internal ALS requirements and our customers' needs.

Test methods and support procedures are available for client viewing on-site.

Internal Audits:

ALS Canada operates an extensive internal audit program. Audits are performed by qualified Quality Assurance and Technical staff for analytical procedures and Quality System elements. The ALS audit program ensures that procedures are implemented as intended, that test methods are scientifically defensible and technically sound, and that policies, procedures and records continue to meet the objectives of our Quality System.

Quality staff may periodically initiate unscheduled audits in response to proficiency testing program results, client feedback, requests from managers, or any other circumstance that warrants investigation.

Quality Control (QC):

ALS has established QC procedures for monitoring the validity of tests performed by our laboratories. Individual test methods specify quality control requirements, frequency of use, and Data Quality Objectives (DQOs).

The type of quality control elements used for process monitoring is dependent on the test performed, but typically includes (as appropriate): Calibration Verification Standards, Continuing Calibration Verifications, Instrument Blanks, Method Blanks, Laboratory Control Samples, Reference Materials, Matrix Spikes, Surrogate Spikes, and Internal Standards.

DQOs are established for each QC type, based on a combination of reference method objectives, customer requirements and historical test method performance. Where applicable, prescriptive elements of reference methods take precedence over internal DQOs.

Test results for selected QC samples are available on test reports. Please contact your Account Manager for more information.

Refer to the ALS Quality Control Protocol handout for details on ALS QC practices.

Control Charts:

Control charts are used to provide a graphical representation of QC results and test method performance over time. Control charts graphically display DQOs as well as the statistically derived mean and ± 2 and 3 standard deviations ("sigma") around the mean, calculated from recent historical QC results. ALS applies advanced trend monitoring algorithms to identify outliers and non-random data distributions (trends) that may indicate undesirable changes in test method performance, so the causes can be investigated and corrected.

Continuous Improvement:

ALS is committed to continuously improving our processes and services. The Quality System feeds into a continuous cycle of review, implementation, and monitoring so that improvements are actively sought and adopted where needed.

Test Data Validation and Record Retention:

ALS analytical data proceeds through several reviews prior to the release of final reports. The ALS data validation process includes test result validation, inter-parameter validation, and report validation. Test result validation involves a thorough analyst review followed by an independent peer review. Inter-parameter validation occurs when all department specific parameters for a sample are completed, and involves an overall review of test results within each sample for consistency among any related test parameters. Report validation occurs when all the requested test results for a work order are completed, and involves a review of the final report before it is sent to the customer.

ALS maintains laboratory records in a traceable manner for a minimum of five years.

Method Validation:

Customers rely on ALS to select test methods that are appropriate to meet their needs. Wherever possible, ALS references the latest versions of published standard methods developed by organizations such as American Public Health Association, United States Environmental Protection Agency, NIOSH, Environment Canada, and other international, regional or regulatory organizations or equipment manufacturers.

Method validations are conducted to confirm that our test methods are fit for their intended use. The validations are as extensive as necessary to meet the needs of the given application. The extent depends on the source of the method. Test methods are revalidated periodically to ensure continued suitability and fitness for purpose.

Method Detection Limits and Limits of Reporting:

ALS Limits of Reporting (LORs) are established using rigorous experimental and statistical procedures that begin with the determination of the Method Detection Limit (MDL) at 99% confidence. The MDL takes into account several factors, like long term Method Blanks, low level Sample Duplicates, and low level Spiked Samples. When detected at or above the MDL, ALS test results are considered to be qualitatively accurate, and a parameter can be reported with 99% confidence as being present in the sample.

$$\mathrm{MDL} = (s_0 \times t_{n\text{-}1}) + |\mathrm{MBlk}|$$

Where:
- s_0 = the standard deviation derived from the analysis of blank or low level samples, whichever gives a higher standard deviation,
- $t_{n\text{-}1}$ = the Student's t-distribution with n-1 degrees of freedom for the one-sided 99% confidence interval.
- $|\mathrm{MBlk}|$= the absolute value of the mean method blank.

ALS takes a conservative approach to detection limits. Our goal is to minimize false positives, because we recognize that any false positive results can be damaging for our clients. Where possible, we establish LORs at levels well-above the statistical MDL, and ideally at the LOQ_5. This improves the accuracy and precision of results near the detection limit, and reduces the chance of false positives due to sample-specific issues. At or above the LOQ_5, test results are considered to be quantitatively accurate. A reported parameter at the LOQ_5 is considered to be within 40% of the true value 95% of the time.

$$LOQ_5 = 5s_0 + |\mathrm{MBlk}|$$

Where:
s_0 = the standard deviation used in the MDL calculation,
$|\mathrm{MBlk}|$ = the absolute value of the mean method blank.

The D.L. column on ALS analytical reports contains the LOR (also known as Detection Limit). The LOR may be the MDL as calculated above, or a higher value. ALS does not report LORs that are less than the calculated MDL.

Measurement Uncertainty (MU):

ALS procedures for calculating measurement uncertainty are based on accepted practices of identifying components contributing to uncertainty, compiling data that represents or includes these components, evaluating the data using appropriate statistical calculations, and reporting in a manner that prevents misunderstanding of the result. ALS follows the Type A method of calculating measurement uncertainty, however additional factors are considered to ensure the best and most complete information is derived from our evaluation of test method performance.

The ALS model describes the dependency of uncertainty on three factors. The first is a constant contribution to uncertainty attributable to s_0, the standard deviation of the method for concentrations that approach zero. The second is a constant relative uncertainty associated with higher parameter concentrations. The third is a constant contribution to uncertainty attributable to the mean long-term method blank value where it is significant. The following is the ALS equation for measurement uncertainty, using an expansion factor of k=2:

Expanded 95% Uncertainty as a Function of Concentration

$$U(c) = 2 * [\sqrt{ \{ s_0^2 + (\theta c)^2 \} }] + |MBlk_{LT}|$$

Where:

U(c) = The expanded uncertainty at concentration c. The range c ± U(c) represents approximately the 95% confidence interval (two standard deviations).

c = Measured concentration of parameter in the sample.

s_0 = A constant contribution to standard uncertainty represented by the standard deviation at zero concentration, which is related to the method detection limit.

θ = Combined relative standard uncertainty, excluding MDL and Method Blank contributions. Theta has no units.

$|MBlk_{LT}|$ = Absolute value of the mean long-term Method Blank value, where significant (i.e. if > 1/5 s_0). [Note that the Method Blank term is not expanded because it represents a constant bias, not a variance.]

Uncertainty values obtained from this procedure must be regarded as estimates. Primarily, this is because all environmental samples are different, especially with regard to matrix effects and heterogeneity. It is our intent with this procedure to arrive at an estimate of a 95% confidence level uncertainty value that can be assumed to apply to 95% (or more) of the samples that a laboratory receives for a given test. It follows that for samples where undetected matrix effects or interferences occur, or for samples that are atypically heterogeneous, uncertainty estimates may be low.

Another aspect of reporting MU is the reporting of test method bias. Bias occurs in a small number of test methods that cannot recover 100% of a parameter from a sample. In these cases ALS reports bias along with the MU to aid with the interpretation of the test result.

Participation in Interlaboratory Proficiency Testing (PT) Programs:

ALS locations participate in an extensive variety of proficiency testing programs. Where available, formal programs operated by outside agencies are used. When not available, ALS utilizes less formal proficiency testing studies.

Root cause analysis is initiated and corrective action plans are developed when PT program results indicate a decline in test method performance.

Staff Training:

Formal training procedures are in place to ensure all staff are trained in ALS polices and analytical procedures prior to performing analyses. A staff orientation program communicates ALS polices to newly hired staff. Task specific training is performed, and analyst proficiency is demonstrated and documented before staff are authorized to work independently. On-going analyst proficiency is monitored using proficiency testing programs. Records are maintained in training logs issued to staff upon hiring.

As well, ALS Canada promotes continuing education and learning by offering advanced courses covering technical and quality functions.

Employee Agreements:

ALS protects our customers' confidential information and proprietary rights. We require all employees to review and sign a Code of Conduct policy that communicates the ALS confidentiality policy. It is ALS practice to never disclose information about a client's analysis to a third party without prior consent of the client, or unless compelled to by law. If we are obligated by law to disclose such information, we will inform the client prior to doing so.

ALS employees avoid involvement in activities that would diminish confidence in their competence, impartiality, judgment, or integrity by complying with the ALS Code of Conduct and Data Integrity Policy.

Sample Tracking:

Procedures are in place to track samples from receipt at the lab through to final reporting. A data management system (LIMS – Laboratory Information Management System) is used to generate a work order number for each sample submission, and a unique identification number is generated for each sample within the work order. The system is then used to assign specific analyses for the samples, to identify methods to be used, and to assign due dates for the results. The system is used to manage analytical workloads and track the status of all samples in-house. LIMS is a secure system that can only be accessed using login passwords. Controlling the level of access according to the needs of individual staff members provides additional security.

When requested by the client, legal sample protocols are implemented to ensure chain of custody defensibility in a court of law. Contact the lab for legal sampling and transportation instructions if this service is needed.

Equipment Calibration:

Measuring and testing equipment used by ALS laboratories that can have a significant effect on the accuracy or validity of test results is calibrated using established procedures. These procedures ensure traceability through an unbroken chain of calibrations or comparisons to national measurement standards. Where traceability of measurements to SI units is not possible and/or not relevant, traceability is provided by the use of certified reference materials and/or consensus standards.

Management Reviews (MR):

ALS management conducts a review at least annually to ensure our management system is effective, and continues to be suitable for our operations, and to identify necessary changes or improvements. Senior management is included in the review process for all locations.

QUALITY ASSURANCE AND QUALITY CONTROL PLAN

HOPE BAY, NUNAVUT

Appendix D – ALS CALA Certificates and Scopes

Canadian Association for Laboratory Accreditation Inc.

Certificate of Accreditation

ALS Environmental (Edmonton)
ALS Canada Ltd.
9450-17th Ave. NW
Edmonton, Alberta

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

Accreditation No.: A1352
Issued On: August 18, 2020
Accreditation Date: January 3, 2005
Expiry Date: February 16, 2023

President & CEO

This certificate is the property of the Canadian Association for Laboratory Accreditation Inc. and must be returned on request; reproduction must follow policy in place at date of issue.
For the specific tests to which this accreditation applies, please refer to the laboratory's scope of accreditation at www.cala.ca.

CALA Scope of Accreditation

Laboratory Name: ALS Environmental (Edmonton)
Parent Institution: ALS Canada Ltd.
Contact: Ms. Sarah Stilson
Phone: (780) 413-5226
Standard: Conforms with requirements of ISO/IEC 17025:2017
Revised On: 12/12/2021

Client ID: 1001352
Address: 9450-17th Ave. NW, Edmonton, Alberta, T6N 1M9
Email: alsed.quality@alsglobal.com; David.Gurdbaniuk@alsglobal.com
Fax: (780) 437-2311
Clients Served: All Interested Parties
Valid To: 09/18/2023

002 - Polychlorinated Biphenyls (PCB)

Field of Accreditation: Environmental
Matrix: Oil
Analytical Method: GC/ECD
Preparation Method: EXTRACTION
Lab Method ID(s): ED-TM-1104, ED-TM-1116

Method Reference	Modified From	Analytical Method	Preparation Method
ASTM D4059	True	True	False
EPA 8082	True	True	False

Parameter	Accredited
Aroclor 1016	Yes
Aroclor 1221	Yes
Aroclor 1232	Yes
Aroclor 1242	Yes
Aroclor 1248	Yes
Aroclor 1254	Yes
Aroclor 1260	Yes
Aroclor 1262	Yes
Aroclor 1268	Yes
Total PCB	Yes

004 - Alkalinity

Field of Accreditation: Environmental
Matrix: Water
Analytical Method: TITRIMETRIC
Preparation Method:
Lab Method ID(s): ED-TM-1026

Method Reference	Modified From	Analytical Method	Preparation Method
SM 2320 B	True	True	False

Parameter	Accredited
Alkalinity (pH 4.5)	Yes
Alkalinity (pH 8.3) (Phenolphthalein Alkalinity)	Yes

005 - Anions

Field of Accreditation: Environmental
Matrix: Water
Analytical Method: ION CHROMATOGRAPHY (IC)
Preparation Method:
Lab Method ID(s): NA-TM-1001

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 300.1	True	True	False

Parameter	Accredited
Bromide	Yes
Chloride	Yes
Fluoride	Yes
Nitrate	Yes
Nitrite	Yes
Sulfate	Yes

006 - Conductivity

Field of Accreditation: Environmental
Matrix: Water
Analytical Method: CONDUCTIVITY METER
Preparation Method:
Lab Method ID(s): ED-TM-1026

Method Reference	Modified From	Analytical Method	Preparation Method
SM 2510 B	True	True	False

Parameter	Accredited
Conductivity (25C)	Yes

007 - Dissolved Metals

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: ICP/MS

Preparation Method:

Lab Method ID(s): NA-TM-1002, NA-TP-2002

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 6020	True	True	False

Parameter	Accredited
Aluminum	Yes
Antimony	Yes
Arsenic	Yes
Barium	Yes
Beryllium	Yes
Bismuth	Yes
Boron	Yes
Cadmium	Yes
Calcium	Yes
Cesium	Yes
Chromium	Yes
Cobalt	Yes
Copper	Yes
Iron	Yes
Lead	Yes
Lithium	Yes
Magnesium	Yes
Manganese	Yes
Molybdenum	Yes
Nickel	Yes
Phosphorus	Yes
Potassium	Yes
Rubidium	Yes
Selenium	Yes
Silicon	Yes
Silver	Yes
Sodium	Yes
Strontium	Yes
Sulphur (Sulfur)	Yes
Tellurium	Yes
Thallium	Yes
Thorium	Yes
Tin	Yes
Titanium	Yes
Tungsten	Yes
Uranium	Yes
Vanadium	Yes
Zinc	Yes
Zirconium	Yes

011 - Phosphorus

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: COLORIMETRIC

Preparation Method: DIGESTION

Lab Method ID(s): ED-TM-1031

Method Reference	Modified From	Analytical Method	Preparation Method
SM 4500-P B	True	True	False
SM 4500-P E	True	True	False

Parameter	Accredited
Total Dissolved Phosphorus	Yes
Total Phosphorus	Yes

012 - Solids

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: GRAVIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1005, NA-TM-1004

Method Reference	Modified From	Analytical Method	Preparation Method
SM 2540 A	True	True	False
SM 2540 B	True	True	False

Method Reference	Modified From	Analytical Method	Preparation Method
SM 2540 C	True	True	False
SM 2540 D	True	True	False
SM 2540 E	True	True	False

Parameter	Accredited
Total Dissolved Solids	Yes
Total Suspended Solids	Yes

013 - Biochemical Oxygen Demand (BOD)

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: DISSOLVED OXYGEN METER (DO)

Preparation Method:

Lab Method ID(s): ED-TM-1007, ED-TM-1037

Method Reference	Modified From	Analytical Method	Preparation Method
SM 5210 B	True	True	False

Parameter	Accredited
BOD (5 day)	Yes
CBOD (5 day)	Yes
Ultimate Biochemical Oxygen Demand (BOD) (180 day)	Yes

015 - pH

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: PH METER

Preparation Method:

Lab Method ID(s): ED-TM-1026

Method Reference	Modified From	Analytical Method	Preparation Method
SM 4500-H+ A	True	True	False
SM 4500-H+ B	True	True	False

Parameter	Accredited
pH	Yes

016 - Metals

Field of Accreditation: Environmental

Matrix: Air [Filter]

Analytical Method: ICP/MS

Preparation Method: DIGESTION

Lab Method ID(s): ED-TP-2001, NA-TM-1002

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 6020A	True	True	False
NIOSH 7303	True	True	False

Parameter	Accredited
Aluminum	Yes
Antimony	Yes
Arsenic	Yes
Barium	Yes
Beryllium	Yes
Bismuth	Yes
Cadmium	Yes
Calcium	Yes
Chromium	Yes
Cobalt	Yes
Copper	Yes
Iron	Yes
Lead	Yes
Lithium	Yes
Magnesium	Yes
Manganese	Yes
Molybdenum	Yes
Nickel	Yes
Phosphorus	Yes
Potassium	Yes
Selenium	Yes
Silver	Yes
Sodium	Yes
Strontium	Yes
Sulphur (Sulfur)	Yes
Thallium	Yes
Tin	Yes
Tungsten	Yes
Uranium	Yes
Vanadium	Yes

Parameter	Accredited
Zinc	Yes
Zirconium	Yes

023 - Metals

Field of Accreditation: Environmental | **Matrix**: Solids [Soil]

Analytical Method: ICP/MS | **Preparation Method**: DIGESTION

Lab Method ID(s): NA-TM-1002, NA-TP-2004

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 200.2	True	True	False
EPA 6020	True	True	False

Parameter	Accredited
Aluminum	Yes
Antimony	Yes
Arsenic	Yes
Barium	Yes
Beryllium	Yes
Bismuth	Yes
Boron	Yes
Cadmium	Yes
Calcium	Yes
Chromium	Yes
Cobalt	Yes
Copper	Yes
Iron	Yes
Lead	Yes
Lithium	Yes
Magnesium	Yes
Manganese	Yes
Molybdenum	Yes
Nickel	Yes
Phosphorus	Yes
Potassium	Yes
Selenium	Yes
Silver	Yes
Sodium	Yes
Strontium	Yes
Sulphur (Sulfur)	Yes
Thallium	Yes
Tin	Yes
Titanium	Yes
Tungsten	Yes
Uranium	Yes
Vanadium	Yes
Zinc	Yes
Zirconium	Yes

028 - Grain Size

Field of Accreditation: Environmental | **Matrix**: Solids [Soil]

Analytical Method: GRAVIMETRIC | **Preparation Method**: SIEVE

Lab Method ID(s): ED-TM-1014

Method Reference	Modified From	Analytical Method	Preparation Method
ASTM D422-63	True	True	False

Parameter	Accredited
Particle Size (>75um)	Yes

029 - Oil and Grease

Field of Accreditation: Environmental | **Matrix**: Solids [Soil]

Analytical Method: GRAVIMETRIC | **Preparation Method**: EXTRACTION

Lab Method ID(s): ED-TM-1131

Method Reference	Modified From	Analytical Method	Preparation Method
SM 5520	True	True	False

Parameter	Accredited
Total Oil and Grease	Yes

035 - Hexavalent Chromium

Field of Accreditation: Environmental | **Matrix**: Water

Analytical Method: ION CHROMATOGRAPHY (IC) **Preparation Method**:

Lab Method ID(s): ED-TM-1023

Method Reference	Modified From	Analytical Method	Preparation Method
SM 3500-CR C	True	True	False

Parameter	Accredited
Hexavalent Chromium	Yes

051 - Chemical Oxygen Demand (COD)

Field of Accreditation: Environmental **Matrix**: Water

Analytical Method: COLORIMETRIC **Preparation Method**: DIGESTION

Lab Method ID(s): ED-TM-1009

Method Reference	Modified From	Analytical Method	Preparation Method
SM 5220 D	True	True	False

Parameter	Accredited
COD	Yes

055 - Flashpoint

Field of Accreditation: Environmental **Matrix**: Waste

Analytical Method: PENSKY-MARTENS CLOSED CUP **Preparation Method**:

Lab Method ID(s): ED-TM-1012

Method Reference	Modified From	Analytical Method	Preparation Method
ASTM 93-D	True	True	False

Parameter	Accredited
Flashpoint	Yes

075 - Petroleum Hydrocarbons (PHC)

Field of Accreditation: Environmental **Matrix**: Water

Analytical Method: GC/FID **Preparation Method**: EXTRACTION

Lab Method ID(s): NA-TM-1112

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 3511	True	True	False

Parameter	Accredited
F2: C10-C16	Yes
F3: C16-C34	Yes
F4: C34-C50	Yes
Total Extractable Hydrocarbons (TEH): C11-C30	Yes

077 - Phenols

Field of Accreditation: Environmental **Matrix**: Solids [Soil]

Analytical Method: GC/MS **Preparation Method**: EXTRACTION

Lab Method ID(s): ED-TM-1113

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 3540	True	True	False
EPA 8270	True	True	False

Parameter	Accredited
2,3,4,6-Tetrachlorophenol	Yes
2,4,6-Trichlorophenol	Suspended on 9/3/2021
2,4-Dichlorophenol + 2,5-Dichlorophenol	Yes
Pentachlorophenol	Yes

078 - Turbidity

Field of Accreditation: Environmental **Matrix**: Water

Analytical Method: TURBIDIMETRIC **Preparation Method**:

Lab Method ID(s): ED-TM-1011

Method Reference	Modified From	Analytical Method	Preparation Method
SM 2130 A	True	True	False
SM 2130 B	True	True	False

Parameter	Accredited
Turbidity	Yes

082 - Total Metals

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: ICP/MS

Preparation Method: DIGESTION

Lab Method ID(s): NA-TM-1002, NA-TP-2001

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 6020	True	True	False
SM 3030 E	True	True	False

Parameter	Accredited
Aluminum	Yes
Antimony	Yes
Arsenic	Yes
Barium	Yes
Beryllium	Yes
Bismuth	Yes
Boron	Yes
Cadmium	Yes
Calcium	Yes
Cesium	Yes
Chromium	Yes
Cobalt	Yes
Copper	Yes
Iron	Yes
Lead	Yes
Lithium	Yes
Magnesium	Yes
Manganese	Yes
Molybdenum	Yes
Nickel	Yes
Phosphorus	Yes
Potassium	Yes
Rubidium	Yes
Selenium	Yes
Silicon	Yes
Silver	Yes
Sodium	Yes
Strontium	Yes
Sulphur (Sulfur)	Yes
Tellurium	Yes
Thallium	Yes
Thorium	Yes
Tin	Yes
Titanium	Yes
Tungsten	Yes
Uranium	Yes
Vanadium	Yes
Zinc	Yes
Zirconium	Yes

084 - Phosphate

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: COLORIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1031

Method Reference	Modified From	Analytical Method	Preparation Method
SM 4500-P	True	True	False

Parameter	Accredited
Phosphate	Yes

097 - Polychlorinated Biphenyls (PCB)

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GC/ECD

Preparation Method: EXTRACTION

Lab Method ID(s): ED-TM-1102, ED-TM-1116

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 3550	True	True	False
EPA 8082	True	True	False

Parameter	Accredited
Aroclor 1016	Yes
Aroclor 1221	Yes
Aroclor 1232	Yes
Aroclor 1242	Yes

Parameter	Accredited
Aroclor 1248	Yes
Aroclor 1254	Yes
Aroclor 1260	Yes
Aroclor 1262	Yes
Aroclor 1268	Yes
Total PCB	Yes

099 - pH

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: METER

Preparation Method: SATURATED PASTE

Lab Method ID(s): ED-TM-1003, NA-TP-2008

Method Reference	Modified From	Analytical Method	Preparation Method
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.2.1	True	True	False
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER16.2	True	True	False

Parameter	Accredited
pH	Yes

100 - pH

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: PH METER

Preparation Method: EXTRACTION

Lab Method ID(s): ED-TM-1003

Method Reference	Modified From	Analytical Method	Preparation Method
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 16.2	True	True	False

Parameter	Accredited
pH (1:1) soil:water	Yes
pH (1:2) soil:water	Yes

110 - Particle Size Analysis (PSA)

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: PARTICLE SIZE

Preparation Method:

Lab Method ID(s): ED-TM-1010

Method Reference	Modified From	Analytical Method	Preparation Method
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 55.3	True	True	False

Parameter	Accredited
Percent Clay	Yes
Percent Sand	Yes
Percent Silt	Yes

119 - Phosphorus

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: COLORIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1031, ED-TP-2006

Method Reference	Modified From	Analytical Method	Preparation Method
SM 4500-P A	True	True	False
SM 4500-P B	True	True	False
SM 4500-P E	True	True	False

Parameter	Accredited
Inorganic Phosphorus	Yes

120 - Dustfall

Field of Accreditation: Environmental

Matrix: Air [Dustfall]

Analytical Method: GRAVIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1030

Method Reference	Modified From	Analytical Method	Preparation Method
ALBERTA ENVIRONMENT 32020	True	True	False

Parameter	Accredited
Fixed Dustfall	Yes
Total Dustfall	Yes

123 - Chlorine

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: COLORIMETRIC **Preparation Method**:

Lab Method ID(s): ED-TM-1036

Method Reference	Modified From	Analytical Method	Preparation Method
SM 4500-CL A	True	True	False
SM 4500-CL F	True	True	False
SM 4500-CL G	True	True	False

Parameter	Accredited
Free Chlorine	Yes
Total Chlorine	Yes

135 - BTEX

Field of Accreditation: Environmental **Matrix**: Waste

Analytical Method: GC/MS **Preparation Method**: TCLP

Lab Method ID(s): ED-TP-2005, NA-TM-1102

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 1311	True	False	True
EPA 8260B	True	True	False

Parameter	Accredited
Benzene	Yes
Ethylbenzene	Yes
m,p-Xylene	Yes
o-Xylene	Yes
Toluene	Yes

141 - Metals

Field of Accreditation: Environmental **Matrix**: Waste

Analytical Method: ICP/MS **Preparation Method**: TCLP

Lab Method ID(s): NA-TM-1002, NA-TM-1700, NA-TP-2001

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 1311	False	False	True
EPA 6020	True	True	False

Parameter	Accredited
Antimony	Yes
Arsenic	Yes
Barium	Yes
Beryllium	Yes
Boron	Yes
Cadmium	Yes
Chromium	Yes
Cobalt	Yes
Copper	Yes
Iron	Yes
Lead	Yes
Nickel	Yes
Selenium	Yes
Silver	Yes
Thallium	Yes
Uranium	Yes
Vanadium	Yes
Zinc	Yes
Zirconium	Yes

148 - Hexavalent Chromium

Field of Accreditation: Environmental **Matrix**: Solids [Soil]

Analytical Method: ION CHROMATOGRAPHY (IC) **Preparation Method**: DIGESTION

Lab Method ID(s): ED-TM-1023

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 3060A	True	True	False

Parameter	Accredited
Hexavalent Chromium	Yes

149 - Mercury

Field of Accreditation: Environmental **Matrix**: Water

Analytical Method: COLD VAPOUR ATOMIC ABSORPTION (CVAA) **Preparation Method**: COLD OXIDATION

Lab Method ID(s): NA-TM-1005

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 1631E	True	True	False
EPA 245.7	True	True	False

Parameter	Accredited
Mercury	Yes

152 - Colour

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: SPECTROPHOTOMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1038

Method Reference	Modified From	Analytical Method	Preparation Method
SM 2120 A	True	True	False
SM 2120 C	True	True	False

Parameter	Accredited
True Colour	Yes

154 - Petroleum Hydrocarbons (PHC)

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GC/MS-HEADSPACE

Preparation Method:

Lab Method ID(s): NA-TM-1102, NA-TP-2102

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 8260	False	True	False

Parameter	Accredited
Benzene	Yes
Ethylbenzene	Yes
m,p-Xylene	Yes
o-Xylene	Yes
Toluene	Yes

155 - Petroleum Hydrocarbons (PHC)

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GC/FID-HEADSPACE

Preparation Method:

Lab Method ID(s): NA-TM-1102, NA-TP-2102

Method Reference	Modified From	Analytical Method	Preparation Method
CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD	False	True	False
EPA 5021	False	True	False
EPA 8260	False	True	False

Parameter	Accredited
F1: C6-C10	Yes

156 - Conductivity

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: METER

Preparation Method: SATURATED PASTE

Lab Method ID(s): ED-TM-1004, NA-TP-2008

Method Reference	Modified From	Analytical Method	Preparation Method
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.2.1	True	True	False
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.3	True	True	False

Parameter	Accredited
Conductivity	Yes

158 - Petroleum Hydrocarbons (PHC)

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GC/FID

Preparation Method: TUMBLER EXTRACTION

Lab Method ID(s): NA-TM-1100, NA-TP-2100

Method Reference	Modified From	Analytical Method	Preparation Method
CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD	False	True	False

Parameter	Accredited
F2: C10-C16	Yes
F3: C16-C34	Yes
F4: C34-C50	Yes

159 - Oil and Grease

Field of Accreditation: Environmental | **Matrix**: Water

Analytical Method: INFRARED SPECTROSCOPY (IR) | **Preparation Method**:

Lab Method ID(s): NA-TM-1111

Method Reference	Modified From	Analytical Method	Preparation Method
SM 5520 C	True	True	False
SM 5520 F	True	True	False

Parameter	Accredited
Mineral Oil and Grease	Yes
Total Oil and Grease	Yes

160 - Salinity

Field of Accreditation: Environmental | **Matrix**: Solids [Soil]

Analytical Method: ICP | **Preparation Method**: SATURATED PASTE

Lab Method ID(s): ED-TM-1021, NA-TP-2008

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 200.7	True	True	False
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.2.1	True	True	False

Parameter	Accredited
Boron	Yes
Calcium	Yes
Magnesium	Yes
Potassium	Yes
Sodium	Yes
Sulphate	Yes
Sulphur (Sulfur)	Yes

161 - Microtox

Field of Accreditation: Environmental | **Matrix**: Waste [Liquid]

Analytical Method: BIOLUMINESCENCE | **Preparation Method**:

Lab Method ID(s): NA-TM-1400

Method Reference	Modified From	Analytical Method	Preparation Method
AER D50	True	True	False

Parameter	Accredited
Microtox IC50 (15 min)	Yes

162 - Mercury

Field of Accreditation: Environmental | **Matrix**: Waste

Analytical Method: COLD VAPOUR ATOMIC ABSORPTION (CVAA) | **Preparation Method**: DIGESTION, TCLP

Lab Method ID(s): NA-TM-1005, NA-TM-1700

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 1311	False	False	True
EPA 245.1	True	True	False
EPA 245.7	True	True	False

Parameter	Accredited
Mercury	Yes

163 - pH

Field of Accreditation: Environmental | **Matrix**: Solids [Soil]

Analytical Method: PH METER | **Preparation Method**: 1:2 CACL2 EXTRACTION

Lab Method ID(s): ED-TM-1015

Method Reference	Modified From	Analytical Method	Preparation Method
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 16.3	True	True	False

Parameter	Accredited
pH (1:2) soil:CaCl2	Yes

164 - Mercury

Field of Accreditation: Environmental | **Matrix**: Solids [Soil]

Analytical Method: COLD VAPOUR ATOMIC ABSORPTION (CVAA) | **Preparation Method**: DIGESTION

Lab Method ID(s): NA-TM-1005, NA-TP-2004

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 1631E	True	True	False
EPA 200.2	True	True	False

Parameter	Accredited
Mercury	Yes

165 - Petroleum Hydrocarbons (PHC)

Field of Accreditation: Environmental **Matrix**: Water

Analytical Method: GC/FID-HEADSPACE **Preparation Method**:

Lab Method ID(s): NA-TM-1102

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 5021	True	True	False
EPA 8260	True	True	False

Parameter	Accredited
F1: C6-C10	Yes

166 - Volatile Organic Compounds (VOC)

Field of Accreditation: Environmental **Matrix**: Water

Analytical Method: GC/MS-HEADSPACE **Preparation Method**:

Lab Method ID(s): NA-TM-1102

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 5021	True	True	False
EPA 8260	True	True	False

Parameter	Accredited
1,1,1,2-Tetrachloroethane	Yes
1,1,1-Trichloroethane	Yes
1,1,2,2-Tetrachloroethane	Yes
1,1,2-Trichloroethane	Yes
1,1-Dichloroethane	Yes
1,1-Dichloroethylene	Yes
1,1-Dichloropropene	Yes
1,2,3-Trichlorobenzene	Yes
1,2,3-Trichloropropane	Yes
1,2,4-Trichlorobenzene	Yes
1,2,4-Trimethylbenzene	Yes
1,2-Dibromo-3-chloropropane (DBCP)	Yes
1,2-Dichlorobenzene	Yes
1,2-Dichloroethane	Yes
1,2-Dichloropropane	Yes
1,3,5-Trimethylbenzene	Yes
1,3-Dichlorobenzene	Yes
1,3-Dichloropropane	Yes
1,4-Dichlorobenzene	Yes
2,2-Dichloropropane	Yes
2-Chlorotoluene	Yes
2-Hexanone (Methyl butyl ketone, MBK)	Yes
4-Chlorotoluene (p-Chlorotoluene)	Yes
4-Isopropyltoluene (p-Cymene)	Yes
Acetone (2-Propanone)	Yes
Acrylonitrile	Yes
Benzene	Yes
Bromobenzene	Yes
Bromochloromethane	Yes
Bromodichloromethane	Yes
Bromoform	Yes
Bromomethane	Yes
Butylbenzene (n-Butylbenzene)	Yes
Carbon disulfide	Yes
Carbon tetrachloride	Yes
Chlorobenzene	Yes
Chlorodibromomethane	Yes
Chloroethane (Ethyl chloride)	Yes
Chloroform	Yes
Chloromethane (Methyl chloride)	Yes
cis-1,2-Dichloroethylene	Yes
cis-1,3-Dichloropropene	Yes
cis-1,4-Dichloro-2-butene	Yes
Dibromomethane	Yes
Dichlorodifluoromethane (CFC-12, Freon 12)	Yes

Parameter	Accredited
Dichloromethane	Yes
Ethanol	Yes
Ethyl methacrylate (Ethyl-2-Methyl-2-Propenoate)	Yes
Ethylbenzene	Yes
Ethylene Dibromide	Yes
Hexachlorobutadiene (1,1,2,3,4,4-Hexachloro-1,3-butadiene)	Yes
Isopropylbenzene (Cumene)	Yes
m,p-Xylene	Yes
Methyl ethyl ketone	Yes
Methyl iodide	Yes
Methyl isobutyl ketone (MIBK)	Yes
Naphthalene	Yes
n-Propylbenzene	Yes
o-Xylene	Yes
sec-Butylbenzene ((1-Methylpropyl)benzene)	Yes
Styrene	Yes
tert-Butylbenzene	Yes
Tetrachloroethylene	Yes
Toluene	Yes
trans-1,2-Dichloroethylene	Yes
trans-1,3-Dichloropropene	Yes
trans-1,4-Dichloro-2-butene	Yes
Trichloroethylene	Yes
Trichlorofluoromethane	Yes
Vinyl chloride	Yes

167 - Volatile Organic Compounds (VOC)

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GC/MS-HEADSPACE

Preparation Method: EXTRACTION

Lab Method ID(s): NA-TM-1102, NA-TP-2102

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 5021	True	True	False
EPA 8260	True	True	False

Parameter	Accredited
1,1,1,2-Tetrachloroethane	Yes
1,1,1-Trichloroethane	Yes
1,1,2,2-Tetrachloroethane	Yes
1,1,2-Trichloroethane	Yes
1,1-Dichloroethane	Yes
1,1-Dichloroethylene	Yes
1,1-Dichloropropene	Yes
1,2,3-Trichlorobenzene	Yes
1,2,3-Trichloropropane	Yes
1,2,4-Trichlorobenzene	Yes
1,2,4-Trimethylbenzene	Yes
1,2-Dibromo-3-chloropropane (DBCP)	Yes
1,2-Dichlorobenzene	Yes
1,2-Dichloroethane	Yes
1,2-Dichloropropane	Yes
1,3,5-Trichlorobenzene	Yes
1,3,5-Trimethylbenzene	Yes
1,3-Dichlorobenzene	Yes
1,3-Dichloropropane	Yes
1,4-Dichlorobenzene	Yes
2,2-Dichloropropane	Yes
2-Chlorotoluene	Yes
2-Hexanone (Methyl butyl ketone, MBK)	Yes
4-Chlorotoluene (p-Chlorotoluene)	Yes
4-Isopropyltoluene (p-Cymene)	Yes
Acetone (2-Propanone)	Yes
Acrylonitrile	Yes
Benzene	Yes
Bromobenzene	Yes
Bromochloromethane	Yes
Bromodichloromethane	Yes
Bromoform	Yes
Bromomethane	Yes
Butylbenzene (n-Butylbenzene)	Yes
Carbon disulfide	Yes
Carbon tetrachloride	Yes
Chlorobenzene	Yes

Parameter	Accredited
Chlorodibromomethane	Yes
Chloroethane (Ethyl chloride)	Yes
Chloroethene (Vinyl chloride)	Yes
Chloroform	Yes
Chloromethane (Methyl chloride)	Yes
cis-1,2-Dichloroethylene	Yes
cis-1,3-Dichloropropene	Yes
cis-1,4-Dichloro-2-butene	Yes
Dibromomethane	Yes
Dichlorodifluoromethane (CFC-12, Freon 12)	Yes
Dichloromethane	Yes
Ethanol	Yes
Ethyl methacrylate (Ethyl-2-Methyl-2-Propenoate)	Yes
Ethylbenzene	Yes
Ethylene Dibromide	Yes
Hexachlorobutadiene (1,1,2,3,4,4-Hexachloro-1,3-butadiene)	Yes
Isopropylbenzene (Cumene)	Yes
m,p-Xylene	Yes
Methyl ethyl ketone	Yes
Methyl iodide	Yes
Methyl isobutyl ketone (MIBK)	Yes
Methyl t-butyl ether	Yes
n-Propylbenzene	Yes
o-Xylene	Yes
sec-Butylbenzene ((1-Methylpropyl)benzene)	Yes
Styrene	Yes
tert-Butylbenzene	Yes
Tetrachloroethylene	Yes
Toluene	Yes
trans-1,2-Dichloroethylene	Yes
trans-1,3-Dichloropropene	Yes
trans-1,4-Dichloro-2-butene	Yes
Trichloroethylene	Yes
Trichlorofluoromethane	Yes

168 - Chloride

Field of Accreditation: Environmental

Matrix: Solids [Saturated Paste, Soil]

Analytical Method: COLORIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1032, NA-TP-2008

Method Reference	Modified From	Analytical Method	Preparation Method
SM 4500-CL- E	True	True	False
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.2.1	True	True	False

Parameter	Accredited
Chloride	Yes

169 - Percent Saturation

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GRAVIMETRIC

Preparation Method:

Lab Method ID(s): NA-TP-2008

Method Reference	Modified From	Analytical Method	Preparation Method
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.2.1	True	True	False

Parameter	Accredited
Percent Saturation	Yes

170 - Density

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GRAVIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1025

Method Reference	Modified From	Analytical Method	Preparation Method
ASTM D5057	True	True	False

Parameter	Accredited
Density	Yes

171 - Petroleum Hydrocarbons (PHC)

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GRAVIMETRIC

Preparation Method: TUMBLER EXTRACTION

Lab Method ID(s): NA-TM-1100, NA-TP-2100

Method Reference	Modified From	Analytical Method	Preparation Method
CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD	False	True	False

Parameter	Accredited
F4: Gravimetric	Yes

172 - Barium

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: ICP

Preparation Method: FUSION

Lab Method ID(s): ED-TM-1021, ED-TM-1055

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 200.7	True	True	False
SSSA PART 3, 1996, PG 202	True	True	False

Parameter	Accredited
Barium	Yes

173 - Sulphate (Sulfate)

Field of Accreditation: Environmental

Matrix: Solids

Analytical Method: ION CHROMATOGRAPHY (IC)

Preparation Method: DIGESTION

Lab Method ID(s): ED-TM-1046, NA-TM-1001

Method Reference	Modified From	Analytical Method	Preparation Method
CSA A23.2	True	True	False

Parameter	Accredited
Sulphate (Sulfate)	Yes

174 - Specific Gravity

Field of Accreditation: Environmental

Matrix: Waste

Analytical Method: GRAVIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1025

Method Reference	Modified From	Analytical Method	Preparation Method
ASTM D5057	True	True	False

Parameter	Accredited
Specific Gravity	Yes

176 - Anions

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: ION CHROMATOGRAPHY (IC)

Preparation Method: SATURATED PASTE

Lab Method ID(s): NA-TM-1001, NA-TP-2008

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 300.1	True	True	False
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.2.1	True	True	False

Parameter	Accredited
Chloride	Yes
Nitrate-N	Yes
Nitrite (NO2)	Yes
Sulphate	Yes

179 - Percent Moisture

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GRAVIMETRIC

Preparation Method:

Lab Method ID(s): NA-TM-1200

Method Reference	Modified From	Analytical Method	Preparation Method
ASTM D2216-80	True	True	False

Parameter	Accredited
Percent Moisture	Yes

182 - Extractable Barium

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: ICP

Preparation Method: EXTRACTION

Lab Method ID(s): ED-TM-1021, ED-TM-1051

Method Reference	Modified From	Analytical Method	Preparation Method
BARITE WASTE GUIDELINES	True	True	False

Parameter	Accredited
Barium	Yes

183 - Phosphate

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: COLORIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1041

Method Reference	Modified From	Analytical Method	Preparation Method
SM 4500-P	True	True	False

Parameter	Accredited
Phosphate	Yes

184 - Phosphorus

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: COLORIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1041

Method Reference	Modified From	Analytical Method	Preparation Method
SM 4500-P B	True	True	False
SM 4500-P E	True	True	False

Parameter	Accredited
Total Dissolved Phosphorus	Yes
Total Phosphorus	Yes

188 - Fluoride

Field of Accreditation: Environmental

Matrix: Air

Analytical Method: ION SELECTIVE ELECTRODE (ISE)

Preparation Method:

Lab Method ID(s): ED-TM-1028

Method Reference	Modified From	Analytical Method	Preparation Method
ALBERTA ENVIRONMENT	True	True	False
SM 4500-F- C	True	True	False

Parameter	Accredited
Fluoride	Yes

190 - Mercury

Field of Accreditation: Environmental

Matrix: Air [Filter]

Analytical Method: COLD VAPOUR ATOMIC ABSORPTION (CVAA)

Preparation Method: DIGESTION

Lab Method ID(s): ED-TP-2001, NA-TM-1005

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 1631E	True	True	False
NIOSH 6009	True	True	False

Parameter	Accredited
Mercury	Yes

196 - Coliforms

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: QUANTI-TRAY (COLILERT)

Preparation Method:

Lab Method ID(s): NA-TM-1300

Method Reference	Modified From	Analytical Method	Preparation Method
SM 9223 B	True	True	False

Parameter	Accredited
Escherichia coli	Yes
Total Coliforms	Yes

197 - Fecal (Thermotolerant) Coliforms

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: QUANTI-TRAY (COLILERT)

Preparation Method:

Lab Method ID(s): NA-TM-1300

Method Reference	Modified From	Analytical Method	Preparation Method
SM 9223 B	True	True	False

Parameter	Accredited
Fecal (Thermotolerant) Coliforms	Yes

198 - Heterotrophic Plate Count (HPC)

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: QUANTI-TRAY (COLILERT)

Preparation Method:

Lab Method ID(s): NA-TM-1300

Method Reference	Modified From	Analytical Method	Preparation Method
SM 9215 E	True	True	False

Parameter	Accredited
Heterotrophic Plate Count (HPC)	Yes

201 - Metals

Field of Accreditation: Environmental

Matrix: Solids [Swab]

Analytical Method: ICP/MS

Preparation Method: EXTRACTION

Lab Method ID(s): ED-TP-2004, NA-TM-1002

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 200.2	True	True	False
EPA 6020	True	True	False

Parameter	Accredited
Aluminum	Yes
Antimony	Yes
Arsenic	Yes
Barium	Yes
Beryllium	Yes
Cadmium	Yes
Calcium	Yes
Chromium	Yes
Cobalt	Yes
Copper	Yes
Iron	Yes
Lead	Yes
Magnesium	Yes
Manganese	Yes
Molybdenum	Yes
Nickel	Yes
Potassium	Yes
Selenium	Yes
Silver	Yes
Sodium	Yes
Strontium	Yes
Tin	Yes
Vanadium	Yes
Zinc	Yes

202 - Polychlorinated Biphenyls (PCB)

Field of Accreditation: Environmental

Matrix: Solids [Swab]

Analytical Method: GC/ECD

Preparation Method: EXTRACTION

Lab Method ID(s): ED-TM-1102, ED-TM-1116

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 3550	True	True	False
EPA 8082	True	True	False

Parameter	Accredited
Aroclor 1016	Yes
Aroclor 1221	Yes
Aroclor 1232	Yes
Aroclor 1242	Yes
Aroclor 1248	Yes
Aroclor 1254	Yes
Aroclor 1260	Yes
Aroclor 1262	Yes
Aroclor 1268	Yes
Total PCBs (Total Polychlorinated Biphenyls)	Yes

205 - Total Solids

Field of Accreditation: Environmental
Matrix: Air [Impinger]

Analytical Method: GRAVIMETRIC
Preparation Method:

Lab Method ID(s): ED-TM-1157

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 5	True	True	False

Parameter	Accredited
Total Solids (TS)	Yes

211 - Mercury

Field of Accreditation: Environmental
Matrix: Solids [Swab]

Analytical Method: COLD VAPOUR ATOMIC ABSORPTION (CVAA)
Preparation Method: DIGESTION

Lab Method ID(s): ED-TP-2004, NA-TM-1005

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 1631E	True	True	False
EPA 3050B	True	True	False

Parameter	Accredited
Mercury	Yes

213 - Ammonia

Field of Accreditation: Environmental
Matrix: Water

Analytical Method: COLORIMETRIC
Preparation Method:

Lab Method ID(s): ED-TM-1024

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 350.1	True	True	False

Parameter	Accredited
Ammonia	Yes

216 - Volatile Organic Compounds (VOC)

Field of Accreditation: Environmental
Matrix: Air

Analytical Method: GC/FID
Preparation Method:

Lab Method ID(s): ED-TM-1142

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 018	True	True	False
EPA 25C	True	True	False

Parameter	Accredited
Benzene	Yes
Ethylbenzene	Yes
Non-methane Organic Carbons	Yes
Toluene	Yes
Xylenes	Yes

217 - Hydrocarbons

Field of Accreditation: Environmental
Matrix: Air

Analytical Method: GC/FID
Preparation Method:

Lab Method ID(s): ED-TM-1142, ED-TM-1144

Method Reference	Modified From	Analytical Method	Preparation Method
CSA Z180	False	True	False
EPA 18	True	True	False

Parameter	Accredited
Carbon dioxide (CO_2)	Yes
Carbon monoxide (CO)	Yes
Ethane	Yes
Methane	Yes
Total Volatile Hydrocarbons (TVH): C1-C16	Yes

218 - Gas

Field of Accreditation: Environmental
Matrix: Air [Compressed Breathing Air]

Analytical Method: GC/TCD
Preparation Method:

Lab Method ID(s): ED-TM-1144

Method Reference	Modified From	Analytical Method	Preparation Method
ASTM D1946	True	True	False

Method Reference	Modified From	Analytical Method	Preparation Method
CSA 180	False	True	False
EPA 3C	False	True	False

Parameter	Accredited
Nitrogen	Yes
Oxygen	Yes

219 - Fluoride

Field of Accreditation: Environmental

Matrix: Air [Filter]

Analytical Method: ION CHROMATOGRAPHY (IC)

Preparation Method:

Lab Method ID(s): ED-TM-1008, NA-TM-1001

Method Reference	Modified From	Analytical Method	Preparation Method
NIOSH 7906	True	True	False

Parameter	Accredited
Hydrogen Fluoride (as F)	Yes

221 - Formaldehyde

Field of Accreditation: Environmental

Matrix: Air

Analytical Method: HPLC/UV

Preparation Method: EXTRACTION

Lab Method ID(s): ED-TM-1151

Method Reference	Modified From	Analytical Method	Preparation Method
EPA TO-11A	True	True	False
NIOSH 2016	True	True	False

Parameter	Accredited
Formaldehyde	Yes

222 - Asbestos

Field of Accreditation: Environmental

Matrix: Solids [Bulk]

Analytical Method: POLARIZED LIGHT MICROSCOPY (PLM)

Preparation Method:

Lab Method ID(s): ED-TM-1152

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 600/R-93/116	True	True	False
NIOSH 9002	True	True	False

Parameter	Accredited
Bulk Asbestos	Yes

223 - Particulates

Field of Accreditation: Environmental

Matrix: Air [Particulate]

Analytical Method: GRAVIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1140

Method Reference	Modified From	Analytical Method	Preparation Method
NIOSH 0500	True	True	False
NIOSH 0600	True	True	False

Parameter	Accredited
Particulate Matter	Yes

224 - Phosphorus

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: COLORIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1041

Method Reference	Modified From	Analytical Method	Preparation Method
SM 4500-P	False	True	False

Parameter	Accredited
Inorganic Phosphorus	Yes

225 - Ammonia

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: COLORIMETRIC

Preparation Method: SATURATED PASTE

Lab Method ID(s): ED-TM-1024, NA-TP-2008

Method Reference	Modified From	Analytical Method	Preparation Method

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 350.1	True	True	False
SM 4500-NH3	True	True	False
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.2.1	True	True	False

Parameter	Accredited
Ammonia (NH3)	Yes

226 - Polyaromatic Hydrocarbons (PAH)

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: GC/MS

Preparation Method: MICROEXTRACTION

Lab Method ID(s): NA-TM-1112, NA-TP-2019

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 3511	True	True	False
EPA 8270D	True	True	False

Parameter	Accredited
1-Methylnaphthalene	Yes
2-Methylnaphthalene	Yes
Acenaphthene	Yes
Acenaphthylene	Yes
Acridine	Yes
Anthracene	Yes
Benzo(a)anthracene	Yes
Benzo(a)pyrene	Yes
Benzo(b,j)fluoranthene	Yes
Benzo(e)pyrene	Yes
Benzo(g,h,i)perylene	Yes
Benzo(k)fluoranthene	Yes
Chrysene	Yes
Dibenzo(a,h)anthracene	Yes
Fluoranthene	Yes
Fluorene	Yes
Indeno(1,2,3 - cd)pyrene	Yes
Naphthalene	Yes
Perylene	Yes
Phenanthrene	Yes
Pyrene	Yes
Quinoline	Yes

227 - Polycyclic Aromatic Hydrocarbons (PAH)

Field of Accreditation: Environmental

Matrix: Solids

Analytical Method: GC/MS

Preparation Method: EXTRACTION

Lab Method ID(s): NA-TM-1105, NA-TP-2103

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 3570	True	True	False
EPA 8270	True	True	False

Parameter	Accredited
1-Methylnaphthalene	Yes
2-Methylnaphthalene	Yes
Acenaphthene	Yes
Acenaphthylene	Yes
Anthracene	Yes
Benzo(a)anthracene	Yes
Benzo(a)pyrene	Yes
Benzo(b,j)fluoranthene	Yes
Benzo(g,h,i)perylene	Yes
Benzo(k)fluoranthene	Yes
Chrysene	Yes
Dibenzo(a,h)anthracene	Yes
Fluoranthene	Yes
Fluorene	Yes
Indeno(1,2,3 - cd)pyrene	Yes
Naphthalene	Yes
Perylene	Yes
Phenanthrene	Yes
Pyrene	Yes
Quinoline	Yes

228 - Phenols

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: COLORIMETRIC **Preparation Method**:

Lab Method ID(s): ED-TM-1057

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 9066	True	True	False

Parameter	Accredited
Total Phenolics	Yes

229 - Acidity

Field of Accreditation: Environmental **Matrix**: Water

Analytical Method: TITRIMETRIC **Preparation Method**:

Lab Method ID(s): ED-TM-1026

Method Reference	Modified From	Analytical Method	Preparation Method
SM 2310	True	True	False

Parameter	Accredited
Acidity	Yes

230 - UV Absorbance and Transmittance

Field of Accreditation: Environmental **Matrix**: Water

Analytical Method: SPECTROPHOTOMETRIC **Preparation Method**:

Lab Method ID(s): ED-TM-1058

Method Reference	Modified From	Analytical Method	Preparation Method
SM 5910 B	True	True	False

Parameter	Accredited
UV Absorbance	Yes
UV Transmittance	Yes

231 - Paint Filter

Field of Accreditation: Environmental **Matrix**: Solids [Paint, Soil]

Analytical Method: **Preparation Method**: FILTRATION

Lab Method ID(s): ED-TM-1042

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 9095A	False	True	False

Parameter	Accredited
Paint Filter (Free Liquid)	Yes

232 - Ammonia

Field of Accreditation: Environmental **Matrix**: Water

Analytical Method: FLUOROMETRIC **Preparation Method**:

Lab Method ID(s): ED-TM-1039

Method Reference	Modified From	Analytical Method	Preparation Method
JOURNAL OF ENVIRONMENTAL MONITORING (2005) SECTION 7, P. 37-42	True	True	False

Parameter	Accredited
Ammonia	Yes

233 - Total Kjeldahl Nitrogen (TKN)

Field of Accreditation: Environmental **Matrix**: Water

Analytical Method: FLUOROMETRIC **Preparation Method**:

Lab Method ID(s): ED-TM-1043, NA-TM-1006

Method Reference	Modified From	Analytical Method	Preparation Method
JOURNAL OF ENVIRONMENTAL MONITORING (2005) SECTION 7, P. 37-42	True	True	False
SM 4500-NORG B	True	True	False

Parameter	Accredited
Total Kjeldahl Nitrogen	Yes

234 - Naphthenic Acids

Field of Accreditation: Environmental **Matrix**: Water

Analytical Method: FTIR **Preparation Method**: EXTRACTION

Lab Method ID(s): ED-TM-1107

Method Reference	Modified From	Analytical Method	Preparation Method

Method Reference	Modified From	Analytical Method	Preparation Method
NAPHTHENIC ACIDS BY FTIR, SYNCRUDE, 1994	True	True	False

Parameter	Accredited
Naphthenic Acids	Yes

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Canadian Association for Laboratory Accreditation Inc.

Certificate of Accreditation

ALS Environmental (Vancouver)
ALS Canada Ltd.
8081 Lougheed Highway, Suite 100
Burnaby, British Columbia

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

Accreditation No.: A1719
Issued On: August 18, 2020
Accreditation Date: January 3, 2005
Expiry Date: February 16, 2023

President & CEO

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Laboratory Accreditation Inc.

CALA Directory of Laboratories

Membership Number: 1719
Laboratory Name: ALS Environmental (Vancouver)
Parent Institution: ALS Canada Ltd.
Address: 8081 Lougheed Highway Suite 100 Burnaby BC V5A 1W9
Contact: Ms. Helenita Franco
Phone: (604) 253-4188
Fax: (604) 253-6700
Email: quality.vancouver@alsglobal.com

Standard: Conforms with requirements of ISO/IEC 17025
Clients Served: All Interested Parties
Revised On: December 11, 2020
Valid To: February 16, 2023

Scope of Accreditation

Air (Inorganic)
Dustfall - Air [Dustfall] (227)
VA-TM-1039; ASTM D1739-98 and BC MOE LABORATORY MANUAL
GRAVIMETRIC
- Fixed Dustfall
- Total Dustfall
- Total Insoluble Dustfall
- Total Soluble Dustfall

Air (Inorganic)
Mercury - Air [Dustfall] (271)
NA-TM-1005, NA-TP-2012, VA-TP-2063; modified from BC MOE LABORATORY MANUAL and EPA 1631E
COLD VAPOUR ATOMIC ABSORPTION (CVAA) - DIGESTION
- Mercury

Air (Inorganic)
Metals - Air [Dustfall] (224)
NA-TM-1002, NA-TP-2007, VA-TP-2063; modified from BC MOE LABORATORY MANUAL and EPA 6020B
ICP/MS - DIGESTION
- Aluminum
- Antimony
- Arsenic
- Barium
- Beryllium
- Bismuth

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Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Potassium
Selenium
Silver
Sodium
Strontium
Thallium
Tin
Uranium
Vanadium
Zinc

Air (Inorganic)
Total Particulates - Air [Filter, Particulate] (035)
VA-TM-1041; modified from ASTM D2009-65 and BC WORKERS COMPENSATION BOARD STANDARDS (BCWCB) 1150
GRAVIMETRIC
Respirable Dust
Total Particulate Matter

Air (Organic)
Volatile Organic Compounds (VOC) - Air (206)
VA-TM-1109; modified from EPA TO-17
GC/MS
1,1-Dichloroethane
1,1-Dichloroethylene
1,1-Dichloropropene
1,1,1-Trichloroethane
1,1,1,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1,2-Trichlorotrifluoroethane
1,1,2,2-Tetrachloroethane
1,2-Dibromo-3-chloropropane (DBCP)
1,2-Dibromoethane (Ethylene dibromide)
1,2-Dichlorobenzene
1,2-Dichloroethane

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2

1,2-Dichloropropane
1,2,3-Trichlorobenzene
1,2,3-Trichloropropane
1,2,4-Trichlorobenzene
1,2,4-Trimethylbenzene
1,3-Butadiene
1,3-Dichlorobenzene
1,3-Dichloropropane
1,3,5-Trimethylbenzene
1,4-Dichlorobenzene
2-Butanone (Methyl ethyl ketone, MEK)
2-Chlorophenol
2-Chlorotoluene
2-Hexanone (Methyl butyl ketone, MBK)
2-Propanol (Isopropyl alcohol)
2,2-Dichloropropane
4-Chlorotoluene (p-Chlorotoluene)
4-isopropyltoluene (p-Cymene)
4-Methyl-2-pentanone (MIBK)
Acetone (2-Propanone)
Benzene
Biphenyl (1,1-Biphenyl)
Bromobenzene
Bromochloromethane
Bromodichloromethane
Bromoform
Bromomethane
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chloroethane (Ethyl Chloride)
Chloroethene (Vinyl chloride)
Chloroform
Chloromethane (Methyl chloride)
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
Cyclohexane
Decane
Dibromochloromethane
Dibromomethane
Dichlorodifluoromethane
Dichloromethane (Methylene Chloride)
Ethyl acetate
Ethylbenzene

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Hexachlorobutadiene
Isopropylbenzene (Cumene)
m,p-Xylene
Methyl tert-butyl ether (MTBE)
Methylcyclohexane
n-Butylbenzene
n-Heptane
n-Hexane
n-Octane
n-Propylbenzene
Naphthalene
o-Xylene
sec-Butylbenzene
Styrene
tert-Butylbenzene
Tetrachloroethylene
Toluene
trans-1,2-Dichloroethylene
trans-1,3-Dichloropropene
Trichloroethylene
Trichlorofluoromethane

Air (Organic)
Volatile Organic Compounds (VOC) - Air (207)
VA-TM-1109; modified from EPA TO-17
GC/FID
F1: C6-C10
F2: C10-C16
Total Volatile Organic Compounds (TVOC): >C10-C12
Total Volatile Organic Compounds (TVOC): >C12-C16
Total Volatile Organic Compounds (TVOC): >C6-C8
Total Volatile Organic Compounds (TVOC): >C8-C10
Volatile Hydrocarbons (VH): C6-C13

Dust (Inorganic)
Soluble Anions - Dustfall (255)
NA-TM-1001, VA-TM-1039; modified from BC MOE LABORATORY MANUAL and EPA 300.0 and SM 4110
ION CHROMATOGRAPHY (IC)
Chloride
Nitrate

Food
Arsenic Speciation - Food [Egg, Fresh Fruit, Meat, Processed Food, Vegetables] (236)
NA-TM-1002, NA-TP-2007, VA-TM-1082; modified from CFIA SOM-DAR-CHE-053-04 and EPA 6020A
HPLC/ICP/MS
Arsenate (As(V))
Arsenite (As(III))
Arsenobetaine (AsB)

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Dimethylarsinic acid (DMA)
Monomethyl arsenate (MMA)

Oil (Organic)
Total Polychlorinated Biphenyls (PCB) - Oil (080)
VA-TM-1118, VA-TP-2116; modified from EPA 3620C and EPA 3660B and EPA 3665A and EPA 600/4-81/045 and EPA 8082A
GC/ECD
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1260
Aroclor 1262
Aroclor 1268
Total PCB

Paint (Inorganic)
Lead - Paint (261)
NA-TM-1002, NA-TP-2004; modified from EPA 200.2 and EPA 6020B
ICP/MS - DIGESTION
Lead

Soil (Inorganic)
Acidity - Solids [Soil] (257)
VA-TM-1053, VA-TM-1074; modified from MEND REPORT 1.20.1 and SM 2320 B
TITRIMETRIC - SHAKEFLASK EXTRACTION
Acidity

Soil (Inorganic)
Alkalinity - Solids [Soil] (258)
VA-TM-1053, VA-TM-1074; modified from MEND REPORT 1.20.1 and SM 2320 B
TITRIMETRIC - SHAKEFLASK EXTRACTION
Alkalinity

Soil (Inorganic)
Anions - Solids [Leachate] (256)
NA-TM-1001, VA-TM-1078; modified from BC MOE LABORATORY MANUAL and EPA 300.0 and SM 4110
ION CHROMATOGRAPHY (IC) - FIXED RATIO EXTRACTION
Chloride
Chloride
Sulphate
Sulphate (Sulfate)

Soil (Inorganic)
Leachable Anions - Solids [Soil] (244)
NA-TM-1001, VM-TM-1074; modified from EPA 300.1 and MEND REPORT 1.20.1
ION CHROMATOGRAPHY (IC) - SHAKEFLASK EXTRACTION
Bromide
Chloride

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Fluoride
Nitrate as Nitrogen
Nitrite as Nitrogen
Sulphate (Sulfate)

Soil (Inorganic)
Leachable Metals - Solids [Soil] (247)
NA-TM-1002, NA-TP-2007, VA-TM-1074; modified from EPA 6020B and MEND REPORT 1.20.1
ICP/MS - SHAKEFLASK EXTRACTION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Selenium
Silicon
Silver
Sodium
Strontium
Thallium
Tin
Uranium
Vanadium
Zinc

Soil (Inorganic)
pH - Solids [Soil] (250)
VA-TM-1074; modified from MEND REPORT 1.20.1 and SM 4500-H
PH METER - SHAKE EXTRACTION
pH

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Soil (Microbiology)
Fecal (Thermotolerant) Coliforms - Solids [Soil] (245)
VA-TM-1200; modified from EPA 1680
MOST PROBABLE NUMBER (MPN)
Fecal (Thermotolerant) Coliforms

Solids (Inorganic)
Acid Volatile Sulphide (AVS) - Solids [Soil] (230)
VA-TM-1021; modified from EPA 821/R-91/100
COLORIMETRIC - EXTRACTION
Acid Volatile Sulfides

Solids (Inorganic)
Anions - Solids [Soil] (148)
NA-TM-1001, NA-TP-2008; modified from EPA 300.1 and SM 4110 B and SOIL SAMPLING & METHODS OF ANALYSIS CHAPTER 15
ION CHROMATOGRAPHY (IC) - SATURATED PASTE
Chloride
Fluoride
Nitrate-N
Nitrite
Sulphate

Solids (Inorganic)
Conductivity - Solids [Soil] (147)
NA-TP-2008, VA-TM-1053; modified from SM 2510 B and SOIL SAMPLING & METHODS OF ANALYSIS CHAPTER 15
METER - SATURATION EXTRACTION
Conductivity

Solids (Inorganic)
Cyanide - Solids [Soil] (213)
NA-TM-1003, VA-WI-3019; modified from BC MOE LABORATORY MANUAL and ISO 14403 and ON MOECC E3015 and SM 4500-CN- I
AUTOMATED COLORIMETRIC - DISTILLATION, EXTRACTION
Cyanide (SAD)
Cyanide (WAD)

Solids (Inorganic)
Cyanide - Solids [Soil] (214)
NA-TM-1003, VA-WI-3019; modified from ASTM 7237 and BC MOE LABORATORY MANUAL and ON MOECC E3015
COLORIMETRIC-GAS DIFFUSION - EXTRACTION
Cyanide, Free

Solids (Inorganic)
Flashpoint - Solids [Ash] (264)
VA-TM-1090; modified from ASTM D93-15
PENSKY-MARTENS CLOSED CUP
Flashpoint

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Solids (Inorganic)
Leachable Mercury - Solids [Soil] (270)
NA-TM-1005, NA-TP-2012, VA-TM-1074; modified from MEND REPORT 1.20.1
COLD VAPOUR ATOMIC ABSORPTION (CVAA) - EXTRACTION
Mercury

Solids (Inorganic)
Leachable Mercury - Solids [Waste] (267)
NA-TM-1005, NA-TP-2012, VA-TM-1071; modified from BC MOE ENVIRONMENTAL MANAGEMENT ACT HAZARDOUS WASTE REGULATION (EMA/HWR) and EPA 1631E
COLD VAPOUR ATOMIC ABSORPTION (CVAA) - EXTRACTION
Mercury

Solids (Inorganic)
Leachable Mercury - Solids [Waste] (268)
NA-TM-1005, NA-TM-1700, NA-TP-2012; modified from EPA 1311 (PREPARATION) and EPA 1631E (ANALYSIS)
COLD VAPOUR ATOMIC ABSORPTION (CVAA) - TCLP
Mercury

Solids (Inorganic)
Leachable Metals - Solids (121)
VA-TM-1066, VA-TM-1071, VA-TP-2072; modified from BC MOE ENVIRONMENTAL MANAGEMENT ACT HAZARDOUS WASTE REGULATION (EMA/HWR) and EPA 6010D
ICP/OES - MLEP EXTRACTION
Arsenic
Barium
Boron
Cadmium
Chromium
Copper
Lead
Selenium
Silver
Uranium
Zinc

Solids (Inorganic)
Leachable Metals - Solids (122)
NA-TM-1700, VA-TM-1066, VA-TP-2072; modified from EPA 1311 (PREPARATION) and EPA 6010D (ANALYSIS)
ICP/OES - TCLP
Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Calcium
Chromium
Cobalt

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Copper
Iron
Lead
Magnesium
Nickel
Selenium
Silver
Thallium
Vanadium
Zinc
Zirconium

Solids (Inorganic)
Leachable Metals - Solids [Soil] (235)
NA-TM-1002, NA-TM-1700, NA-TP-2007; modified from BC PROTOCOL 13 (ANALYSIS) and EPA 1311 (PREPARATION) and EPA 6020B (ANALYSIS)
ICP/MS - TCLP
Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Nickel
Selenium
Silver
Thallium
Uranium
Vanadium
Zinc
Zirconium

Solids (Inorganic)
Mercury - Solids [Soil] (269)
NA-TM-1005, NA-TP-2004, NA-TP-2012; modified from BC MOE LABORATORY MANUAL, SALM (PREPARATION) and EPA 1631E (ANALYSIS) and EPA 200.2 (ANALYSIS)
COLD VAPOUR ATOMIC ABSORPTION (CVAA) - DIGESTION
Mercury

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Solids (Inorganic)
Metals - Solids [Soil] (152)
NA-TM-1002, NA-TP-2004, NA-TP-2007; modified from BC MOE LABORATORY MANUAL, SALM (PREPARATION) and EPA 200.2 (ANALYSIS) and EPA 6020B (ANALYSIS)

ICP/MS - DIGESTION

Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Selenium
Silver
Sodium
Strontium
Sulphur (Sulfur)
Tellurium
Thallium
Thorium
Tin
Titanium
Tungsten
Uranium
Vanadium
Zinc
Zirconium

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Solids (Inorganic)
Metals - Solids [Soil] (153)
NA-TP-2008, VA-TM-1066, VA-TP-2072; modified from EPA 6010D and SOIL SAMPLING & METHODS OF ANALYSIS CHAPTER 15
ICP/OES - SATURATION EXTRACTION
Calcium
Magnesium
Potassium
Sodium

Solids (Inorganic)
Metals - Solids [Soil] (273)
NA-TM-1002, NA-TP-2007, VA-TM-1021; modified from EPA 6020B and EPA 821/R-91/100
ICP/MS - EXTRACTION
Arsenic
Cadmium
Copper
Lead
Nickel
Zinc

Solids (Inorganic)
Metals - Solids [Soil] (275)
NA-TM-1002, NA-TP-2007, NA-TP-2008; modified from EPA 6020B and SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15
ICP/MS - EXTRACTION
Calcium
Magnesium
Potassium
Sodium

Solids (Inorganic)
Methyl Mercury - Solids [Soil] (173)
VA-TM-1062; modified from EPA 1630
GC/CVAFS-PURGE AND TRAP - EXTRACTION
Methyl mercury

Solids (Inorganic)
Moisture - Solids [Soil] (089)
NA-TM-1200; CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD
GRAVIMETRIC
Percent Moisture

Solids (Inorganic)
Oil and Grease - Solids [Soil] (239)
VA-TM-1125; modified from BC MOE LABORATORY MANUAL
GRAVIMETRIC - EXTRACTION
Mineral Oil and Grease
Total Oil and Grease

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Solids (Inorganic)
Paint Filter - Solids [Paint] (262)
VA-TM-1055; modified from EPA 9095B
FILTRATION
Paint Filter (Free Liquid)

Solids (Inorganic)
Percent Saturation - Solids [Saturated Paste] (149)
NA-TP-2008; modified from SOIL SAMPLING & METHODS OF ANALYSIS CHAPTER 15
GRAVIMETRIC - SATURATED PASTE
Percent Saturation

Solids (Inorganic)
pH - Solids [Soil] (120)
NA-TP-2008, VA-TM-1078; modified from SM 4500-H+ B and SOIL SAMPLING & METHODS OF ANALYSIS CHAPTER 15
METER - SATURATION EXTRACTION
pH

Solids (Inorganic)
pH - Solids [Soil] (169)
VA-TM-1078; modified from BC MOE LABORATORY MANUAL and SM 4500-H+ B
METER - FIXED RATIO EXTRACTION
pH

Solids (Inorganic)
Simultaneously Extracted Metals (SEM) - Solids [Soil] (228)
NA-TM-1005, NA-TP-2012, VA-TM-1021; modified from EPA 1631E and EPA 821/R-91/100
COLD VAPOUR ATOMIC FLUORESCENCE SPECTROSCOPY (CVAFS) - SEM EXTRACTION
Mercury

Solids (Inorganic)
Simultaneously Extracted Metals (SEM) - Solids [Soil] (229)
VA-TM-1021, VA-TM-1066, VA-TP-2072; modified from EPA 6010D and EPA 821/R-91/100
ICP/OES - SEM EXTRACTION
Arsenic
Cadmium
Copper
Lead
Nickel
Zinc

Solids (Inorganic)
Waste Oil - Solids (123)
VA-TM-1111; BC MOE LABORATORY MANUAL
GRAVIMETRIC - EXTRACTION
Waste Oil Content

Solids (Organic)
Extractable Hydrocarbons - Solids [Soil] (184)
NA-TM-1100, NA-TP-2106; modified from BC MOE LABORATORY MANUAL and EPA 3570
GC/FID - COLD SHAKE EXTRACTION
EPH C10-C19 (sg)
EPH C19-C32 (sg)
Extractable Petroleum Hydrocarbons (EPH): C10-C19

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Extractable Petroleum Hydrocarbons (EPH): C19-C32

Solids (Organic)
Glycols - Solids [Soil] (156)
VA-TM-1113; modified from EPA 8015B
GC/FID - EXTRACTION
Diethylene glycol
Ethylene glycol
Propylene glycol
Triethylene glycol

Solids (Organic)
Petroleum Hydrocarbons (PHC) - Solids [Soil] (189)
NA-TM-1100, NA-TP-2100; modified from ALBERTA ENVIRONMENT INTERPRETATION, SEPT 2003 and CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD (DEC 2000 NO. 1310)
GC/FID - TUMBLER EXTRACTION
F2: C10-C16
F3: C16-C34
F4: C34-C50

Solids (Organic)
Petroleum Hydrocarbons (PHC) - Solids [Soil] (190)
NA-TM-1100; modified from ALBERTA ENVIRONMENT INTERPRETATION, SEPT 2003 and CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD (DEC 2000 NO. 1310)
GRAVIMETRIC - TUMBLER EXTRACTION
F4: Gravimetric
F4G-SG: Gravimetric Heavy Hydrocarbons - Silica

Solids (Organic)
Phenols - Solids [Soil] (071)
VA-TM-1122, VA-TP-2113; modified from EPA 3570 and EPA 8270D and KNAPP 1979
GC/MS - EXTRACTION
2-Chlorophenol
2-Methylphenol (o-Cresol)
2,3-Dichlorophenol
2,3,4-Trichlorophenol
2,3,4,5-Tetrachlorophenol
2,3,4,6-Tetrachlorophenol
2,3,5-Trichlorophenol
2,3,5,6-Tetrachlorophenol
2,3,6-Trichlorophenol
2,4-Dichlorophenol + 2,5-Dichlorophenol
2,4-Dimethylphenol
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,6-Dichlorophenol
3-Chlorophenol
3,4-Dichlorophenol
3,4,5-Trichlorophenol
3,5-Dichlorophenol

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4-Chloro-3-methylphenol
4-Chlorophenol
4-Methylphenol (p-Cresol)
m-Cresol
Pentachlorophenol
Phenol

Solids (Organic)
Polycyclic Aromatic Hydrocarbons (PAH) - Solids [Soil] (185)
NA-TM-1100, NA-TP-2107; modified from EPA 3570 and EPA 8270D
GC/MS - COLD SHAKE EXTRACTION
2-Methylnaphthalene
Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b,j)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Chrysene
Dibenzo(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3 - cd)pyrene
Naphthalene
Phenanthrene
Pyrene
Quinoline

Solids (Organic)
Total Polychlorinated Biphenyls (PCB) - Solids [Soil] (112)
VA-TM-1119, VA-TP-2116; modified from EPA 3570 and EPA 3620C and EPA 3660B and EPA 3665A and EPA 8082A
GC/ECD - EXTRACTION
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1260
Aroclor 1262
Aroclor 1268
Total PCB

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Solids (Organic)
Volatile Hydrocarbons (VH) - Solids [Soil] (202)
NA-TM-1102, NA-TP-2102; modified from BC MOE LABORATORY MANUAL and CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD and EPA 5021A
GC/FID-HEADSPACE

F1: C6-C10

VH: C6-C10

Solids (Organic)
Volatile Organic Compounds (VOC) - Solids (263)
NA-TM-1102, VA-TM-1126; modified from EPA 1311 (PREPARATION) and EPA 8260C (ANALYSIS)
GC/MS-HEADSPACE - TCLP

1,1-Dichloroethene
1,2-Dichlorobenzene
1,2-Dichloroethane
1,4-Dichlorobenzene
Benzene
Bromodichloromethane
Bromoform
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethene (Vinyl chloride)
Chloroform
Dichloromethane (Methylene Chloride)
Ethylbenzene
m,p-Xylene
Methyl ethyl ketone
o-Xylene
Tetrachloroethylene
Toluene
Trichloroethylene

Solids (Organic)
Volatile Organic Compounds (VOC) - Solids [Soil] (201)
NA-TM-1102, NA-TP-2102; modified from EPA 5021A and EPA 8260C
GC/MS-HEADSPACE

1,1-Dichloroethane
1,1-Dichloroethylene
1,1,1-Trichloroethane
1,1,1,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,2,4-Trimethylbenzene
1,3-Dichlorobenzene

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1,3,5-Trimethylbenzene
1,4-Dichlorobenzene
4-Isopropylbenzene
Benzene
Bromodichloromethane
Bromoform
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane (Ethyl Chloride)
Chloroethene (Vinyl chloride)
Chloroform
Chloromethane (Methyl chloride)
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
Dichloromethane
Ethylbenzene
Ethylene Dibromide
Isopropylbenzene (Cumene)
m,p-Xylene
Methyl t-butyl ether
n-Propylbenzene
Naphthalene
o-Xylene
Styrene
Tetrachloroethylene
Toluene
trans-1,2-Dichloroethylene
trans-1,3-Dichloropropene
Trichloroethylene
Trichlorofluoromethane

Tissue (Inorganic)
Ashfree - Tissue (259)
VM-TM-1051; modified from SM 10300
GRAVIMETRIC
Ash-free weight

Tissue (Inorganic)
Lipid Content - Tissue (241)
VA-TM-1112; modified from EPA 3570 and EPA 8290A
GRAVIMETRIC
Lipid Content

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Tissue (Inorganic)
Methyl Mercury - Tissue (172)
VA-TM-1062; modified from EPA 1630
GC/CVAFS-PURGE AND TRAP - DIGESTION
Methyl mercury

Tissue (Inorganic)
Moisture - Tissue (090)
VA-TM-1087; modified from PUGET SOUND PROTOCOLS
GRAVIMETRIC
Percent Moisture

Tissue (Inorganic)
Selenium Speciation - Tissue (253)
NA-TM-1002, NA-TP-2007, VA-TM-1085; CFIA METHOD SOM-DAR CHE-053-04
HPLC/ICP/MS
Selenium (IV)
Selenium (VI)
SelenoMethionine

Tissue (Inorganic)
Total Mercury - Tissue (266)
NA-TM-1005, NA-TP-2006, NA-TP-2012; modified from EPA 1631E and EPA 200.3
COLD VAPOUR ATOMIC ABSORPTION (CVAA)
Mercury

Tissue (Inorganic)
Total Metals - Tissue (100)
NA-TM-1002, NA-TP-2006, NA-TP-2007; modified from EPA 200.3 and EPA 6020A
ICP/MS - DIGESTION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Cesium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel

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Phosphorus
Potassium
Rubidium
Selenium
Silver
Sodium
Strontium
Sulphur (Sulfur)
Tellurium
Thallium
Tin
Titanium
Uranium
Vanadium
Zinc
Zirconium

Urine (Inorganic)
Creatinine - Biomaterials [Urine] (234)
VA-TM-1052; THERMO DRI CREATININE-DETECT SPECIMEN VALIDITY TEST
COLORIMETRIC
Creatinine

Urine (Organic)
Arsenic Speciation - Biomaterials [Urine] (233)
NA-TM-1002, NA-TP-2007, VA-TM-1081; modified from CDC METHOD ID ITU003B, 2004 and EPA 6020A
HPLC/ICP/MS
Arsenate (As(V))
Arsenite (As(III))
Arsenobetaine (AsB)
Dimethylarsinic acid (DMA)
Monomethyl arsenate (MMA)
Total Arsenic Species
Total Inorganic Arsenic
Total Inorganic Arsenic and Methylated Metabolites

Water (Inorganic)
Acidity - Water (219)
VA-TM-1053; modified from SM 2310
TITRIMETRIC
Acidity

Water (Inorganic)
Alkalinity - Water (001)
VA-TM-1053; modified from SM 2320 B
TITRIMETRIC
Alkalinity (pH 4.5)
Alkalinity-Bicarbonate
Alkalinity-Carbonate
Alkalinity-Hydroxide

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Phenolphthalein Alkalinity

Water (Inorganic)
Ammonia - Water (208)
VA-TM-1024; JOURNAL OF ENVIRONMENTAL MONITORING (2005) SECTION 7, P. 37-42
FLUOROMETRIC
Ammonia

Water (Inorganic)
Anions - Water (026)
NA-TM-1001; modified from EPA 300.1
ION CHROMATOGRAPHY (IC)
Bromide
Chloride
Fluoride
Nitrate
Nitrate plus Nitrite
Nitrite
Sulfate

Water (Inorganic)
Arsenic - Water (232)
NA-TM-1002, NA-TP-2007, VA-TM-1086; modified from USGS Water Resources Investigation Report 02-4144
HPLC/ICP/MS
Arsenate (AsV)
Arsenite (ASIII)
Arsenobetaine (AsB)
Dimethylarsinic acid (DMA)
Monomethyl arsenate (MMA)
Total Arsenic Species
Total Inorganic Arsenic
Total Inorganic Arsenic and Methylated Metabolites

Water (Inorganic)
Biochemical Oxygen Demand (BOD) - Water (027)
VA-TM-1032; modified from SM 5210 B
DISSOLVED OXYGEN METER (DO)
BOD (5 day)
CBOD (5 day)
Soluble Biological Oxygen Demand (SBOD)

Water (Inorganic)
Carbon - Water (091)
VA-TM-1037; modified from SM 5310 B
INFRARED SPECTROSCOPY (IR) - COMBUSTION
Inorganic Carbon
Organic Carbon
Total Carbon (TC)

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Water (Inorganic)
Chemical Oxygen Demand (COD) - Water (028)
VA-TM-1033; modified from SM 5220 D
COLORIMETRIC - DIGESTION
COD

Water (Inorganic)
Chlorophyll A - Water (220)
VA-TM-1038, VA-TP-2011; modified from EPA 445.0
FLUOROMETRIC
Chlorophyll a

Water (Inorganic)
Colour - Water (015)
VA-TM-1004; modified from BC MOE Laboratory Manual and SM 2120 C
COLORIMETRIC
Apparent Colour
True Colour

Water (Inorganic)
Conductivity - Water (004)
VA-TM-1053; modified from SM 2510 B
CONDUCTIVITY METER
Conductivity (25°C)

Water (Inorganic)
Cyanide - Water (209)
NA-TM-1003; modified from ISO 14403 and SM 4500-CN- I
AUTOMATED COLORIMETRIC - DISTILLATION
Cyanide (SAD)
Cyanide (WAD)

Water (Inorganic)
Cyanide - Water (210)
NA-TM-1003; modified from ASTM D7237
AUTOMATED COLORIMETRIC-GAS DIFFUSION
Cyanide, Free

Water (Inorganic)
Dissolved Ferrous Iron - Water (242)
VA-TM-1046, VA-TP-2009; modified from SM 3500-FE
COLORIMETRIC - FILTRATION
Ferrous Iron

Water (Inorganic)
Dissolved Metals - Water (032)
NA-TM-1002, NA-TP-2002, NA-TP-2007; modified from EPA 6020B and SM 3030 B
ICP/MS - FILTRATION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron

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Cadmium
Calcium
Cesium
Chromium
Cobalt
Copper
Gallium
Gold
Indium
Iron
Lanthanum
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Niobium
Phosphorus
Potassium
Rhenium
Rubidium
Selenium
Silicon
Silver
Sodium
Strontium
Sulphur (Sulfur)
Tantalum
Tellurium
Thallium
Thorium
Tin
Titanium
Tungsten
Uranium
Vanadium
Yttrium
Zinc
Zirconium

Water (Inorganic)
Dissolved Metals - Water (036)
NA-TP-2002, VA-TM-1066, VA-TP-2072; modified from EPA 6010D and SM 3030 B
ICP/OES
Aluminum

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Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Selenium
Silicon
Silver
Sodium
Strontium
Thallium
Tin
Titanium
Vanadium
Zinc

Water (Inorganic)
Hexavalent Chromium - Water (276)
NA-TM-1001, VA-TM-1056; modified from EPA 1620B and SM 3500-CR C
ION CHROMATOGRAPHY (IC)
Dissolved Hexavalent Chromium
Hexavalent Chromium

Water (Inorganic)
Mercury - Water (136)
NA-TM-1005, NA-TP-2002, VA-TP-2068; modified from EPA 1631E
COLD VAPOUR ATOMIC FLUORESCENCE SPECTROSCOPY (CVAFS) - DIGESTION
Mercury

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Water (Inorganic)
Mercury - Water (265)
NA-TM-1005, NA-TP-2002, NA-TP-2012; modified from EPA 1631E
COLD VAPOUR ATOMIC ABSORPTION (CVAA)
Mercury

Water (Inorganic)
Methyl Mercury - Water (192)
VA-TM-1062; modified from EPA 1630
GC/CVAFS-PURGE AND TRAP - DISTILLATION
Methyl mercury

Water (Inorganic)
Nitrogen - Water (217)
VA-TM-1047, VA-WI-3046; modified from SM 4500-P J
AUTOMATED COLORIMETRIC - DIGESTION
Total Dissolved Nitrogen
Total Nitrogen

Water (Inorganic)
Oil and Grease - Water (061)
NA-TM-1107; modified from EPA 1664
GRAVIMETRIC - EXTRACTION
Mineral Oil and Grease
Total Oil and Grease

Water (Inorganic)
pH - Water (018)
VA-TM-1053; modified from SM 4500-H+ B
pH METER
pH

Water (Inorganic)
Phosphorus - Water (179)
VA-TM-1025, VA-TP-2009, VA-WI-3046; modified from SM 4500-P B and SM 4500-P E
COLORIMETRIC - DIGESTION
Phosphate
Total Dissolved Phosphorus
Total Phosphorus

Water (Inorganic)
Reactive Silica - Water (008)
VA-TM-1018; modified from SM 4500-SIO2 D
COLORIMETRIC
Reactive Silica

Water (Inorganic)
Selenium Speciation - Water (252)
NA-TM-1002, NA-TP-2007, VA-TM-1084; Spectrochimica Acta Part B60 (2005) 633-641
HPLC/ICP/MS
Selenium (IV)
Selenium (VI)
SelenoMethionine

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Water (Inorganic)
Solids - Water (016)
NA-TM-1004, NA-TM-1008, VA-TM-1050; modified from SM 2540 B and SM 2540 C and SM 2540 D and SM 2540 E
GRAVIMETRIC
Fixed Suspended Solids
Total Dissolved Solids
Total Solids (TS)
Total Suspended Solids
Volatile Suspended Solids

Water (Inorganic)
Sulphide - Water (010)
VA-TM-1020; modified from SM 4500-S2- D
COLORIMETRIC
Sulphide

Water (Inorganic)
Sulphide - Water (277)
VA-TM-1057; modified from SM 4500 A and SM 4500 E and SM 4500 S2- D
COLORIMETRIC-CONTINUOUS FLOW (CFA)
Sulphide

Water (Inorganic)
Thiocyanate - Water (014)
VA-TM-1029; modified from SM 4500-CN- M
COLORIMETRIC
Thiocyanate

Water (Inorganic)
Total Kjeldahl Nitrogen (TKN) - Water (211)
NA-TM-1006, VA-TM-1044; modified from SM 4500-NORG D
FLUOROMETRIC - DIGESTION
Dissolved Kjeldahl Nitrogen
Total Kjeldahl Nitrogen

Water (Inorganic)
Total Metals - Water (031)
NA-TM-1002, NA-TP-2001, NA-TP-2007; modified from EPA 200.2 and EPA 6020B
ICP/MS - DIGESTION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Cesium
Chromium
Cobalt

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Copper
Gallium
Gold
Indium
Iron
Lanthanum
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Niobium
Phosphorus
Potassium
Rhenium
Rubidium
Selenium
Silicon
Silver
Sodium
Strontium
Sulphur (Sulfur)
Tantalum
Tellurium
Thallium
Thorium
Tin
Titanium
Tungsten
Uranium
Vanadium
Yttrium
Zinc
Zirconium

Water (Inorganic)
Total Metals - Water (041)
NA-TP-2001, VA-TM-1066, VA-TP-2072; modified from EPA 6010D and SM 3030 E
ICP/OES - DIGESTION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth

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Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Selenium
Selenium
Silicon
Silver
Sodium
Strontium
Thallium
Tin
Titanium
Vanadium
Zinc

Water (Inorganic)
Turbidity - Water (020)
VA-TM-1011; modified from SM 2130 B
TURBIDIMETRIC
Turbidity

Water (Inorganic)
UV Absorbance and Transmittance - Water (254)
VA-TM-1042, VA-TP-2011; modified from SM 5910 B
SPECTROPHOTOMETRIC
UV Absorbance
UV Transmittance

Water (Microbiology)
Coliforms - Water (145)
NA-TM-1300; modified from SM 9223 B
MOST PROBABLE NUMBER (MPN)
Escherichia coli
Fecal (Thermotolerant) Coliforms
Total Coliforms

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Water (Microbiology)
Enterococci - Water (186)
VA-TM-1203; modified from SM 9230 C
MEMBRANE FILTRATION (mENTEROCOCCUS)
Enterococci

Water (Microbiology)
Escherichia coli (E. coli) - Water (240)
VA-TM-1201; modified from SM 9222 G
MEMBRANE FILTRATION (mFC/NA-MUG)
Escherichia coli

Water (Microbiology)
Fecal (Thermotolerant) Coliforms - Water (029)
VA-TM-1200; modified from SM 9221 E
MOST PROBABLE NUMBER (MPN)
Fecal (Thermotolerant) Coliforms

Water (Microbiology)
Fecal (Thermotolerant) Coliforms - Water (030)
VA-TM-1201; modified from SM 9222 D
MEMBRANE FILTRATION (M-FC)
Fecal (Thermotolerant) Coliforms

Water (Microbiology)
Heterotrophic Plate Count (HPC) - Water (126)
NA-TM-1301; modified from SM 9215 B
POUR PLATE (PCA)
Heterotrophic Plate Count (HPC)

Water (Microbiology)
Pseudomonas aeruginosa - Water (187)
VA-TM-1204; modified from SM 9213 E
MEMBRANE FILTRATION (mPAC)
Pseudomonas aeruginosa

Water (Microbiology)
Total Coliforms - Water (142)
VA-TM-1200; modified from SM 9221 B
MOST PROBABLE NUMBER (MPN)
Total Coliforms

Water (Microbiology)
Total Coliforms - Water (143)
VA-TM-1201; modified from SM 9222 B
MEMBRANE FILTRATION (M-ENDO)
Total Coliforms

Water (Organic)
Extractable Petroleum Hydrocarbons (EPH) - Water (251)
NA-TM-1112, VA-TP-2127, VA-TP-2129; BC MOE LABORATORY MANUAL
GC/FID - EXTRACTION
EPH C10-C19 (sg)
EPH C19-C32 (sg)
Extractable Petroleum Hydrocarbons (EPH): C10-C19
Extractable Petroleum Hydrocarbons (EPH): C19-C32

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Total Extractable Hydrocarbons (TEH): C10-C30

Water (Organic)
Glycols - Water (155)
VA-TM-1113; modified from EPA 8015C
GC/FID - EXTRACTION
Diethylene glycol
Ethylene glycol
Propylene glycol
Triethylene glycol

Water (Organic)
Petroleum Hydrocarbons (PHC) - Water (238)
NA-TM-1112, NA-TP-2100; modified from CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD and EPA 3511
GC/FID - EXTRACTION
F2: C10-C16
F3: C16-C34
F4: C34-C50

Water (Organic)
Phenols - Water (059)
VA-TM-1101, VA-TP-2113; modified from BC MOE LABORATORY MANUAL and EPA 3510C and EPA 8270D
GC/MS - EXTRACTION
2-Chlorophenol
2-Methylphenol (o-Cresol)
2,3-Dichlorophenol
2,3,4-Trichlorophenol
2,3,4,5-Tetrachlorophenol
2,3,4,6-tetrachlorophenol
2,3,5-Trichlorophenol
2,3,5,6-Tetrachlorophenol
2,3,6-Trichlorophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
2,4,5-Trichlorophenol
2,4,6-trichlorophenol
2,6-Dichlorophenol
3-Chlorophenol
3,4-Dichlorophenol
3,4,5-Trichlorophenol
3,5-Dichlorophenol
4-Chloro-3-methylphenol
4-Chlorophenol
4-Methylphenol (p-Cresol)
m-Cresol
Pentachlorophenol
Phenol

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Water (Organic)
Polycyclic Aromatic Hydrocarbons (PAH) - Water (237)
NA-TM-1112, NA-TP-2109; modified from EPA 3511 and EPA 8270D
GC/MS - EXTRACTION
1-Methylnaphthalene
2-Methylnaphthalene
Acenaphthene
Acenaphthylene
Acridine
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b,j)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Chrysene
Dibenzo(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3 - cd)pyrene
Naphthalene
Phenanthrene
Pyrene
Quinoline

Water (Organic)
Resin and Fatty Acids - Water (212)
VA-TM-1105, VA-TP-2114; modified from EPA 3510C and EPA 8270D
GC/MS - LIQUID/LIQUID EXTRACTION (L/L)
12-Chlorodehydroabietic acid
14-Chlorodehydroabietic acid
Abietic acid
Arachidic acid
Behenic acid
Dehydroabietic acid
Dichlorodehydroabietic acid
Dodecanoic acid (Lauric acid)
Hexadecanoic acid (Palmitic acid)
Isopimaric acid + Palustric acid
Levopimaric acid
Lignoceric acid
Linoleic acid
Linolenic acid (Octadecadienoic acid)
Myristic acid (Tetradecanoic Acid)
Neoabietic acid
Oleic acid

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Pimaric acid

Sandaracopimaric acid

Stearic acid (Octadecanoic acid)

Water (Organic)
Total Polychlorinated Biphenyls (PCB) - Water (115)
VA-TM-1115, VA-TP-2116; modified from EPA 3510C and EPA 3620C and EPA 3660B and EPA 3665A and EPA 8082A

GC/ECD - EXTRACTION

Aroclor 1016

Aroclor 1221

Aroclor 1232

Aroclor 1242

Aroclor 1248

Aroclor 1254

Aroclor 1260

Aroclor 1262

Aroclor 1268

Total PCB

Water (Organic)
Volatile Hydrocarbons (VH) - Water (197)
NA-TM-1102; modified from BC MOE LABORATORY MANUAL and CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD and EPA 5021A

GC/FID-HEADSPACE

F1: C6-C10

Volatile Hydrocarbons (VH): C6-C10

Water (Organic)
Volatile Organic Compounds (VOC) - Water (196)
NA-TM-1102, NA-TP-2102; modified from EPA 5021A and EPA 8260C

GC/MS-HEADSPACE

1,1-Dichloroethane

1,1-Dichloroethylene

1,1,1-Trichloroethane

1,1,1,2-Tetrachloroethane

1,1,2-Trichloroethane

1,1,2,2-Tetrachloroethane

1,2-Dichlorobenzene

1,2-Dichloroethane

1,2-Dichloropropane

1,2,4-Trimethylbenzene

1,3-Dichlorobenzene

1,3,5-Trimethylbenzene

1,4-Dichlorobenzene

4-isopropyltoluene (p-Cymene)

Acetone (2-Propanone)

Benzene

Bromodichloromethane

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Bromoform
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane (Ethyl Chloride)
Chloroform
Chloromethane (Methyl chloride)
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
Dichloromethane
Ethylbenzene
Ethylene Dibromide
Isopropylbenzene (Cumene)
m,p-Xylene
Methyl ethyl ketone
Methyl isobutyl ketone (MIBK)
Methyl t-butyl ether
n-Propylbenzene
Naphthalene
o-Xylene
Styrene
Tetrachloroethylene
Toluene
trans-1,2-Dichloroethylene
trans-1,3-Dichloropropene
Trichloroethylene
Trichlorofluoromethane
Vinyl chloride

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AGNICO EAGLE
HOPE BAY

QUALITY ASSURANCE AND QUALITY CONTROL PLAN

HOPE BAY, NUNAVUT

Appendix E – Bureau Veritas Canada SCC Certificate and Scope

CERTIFICATE OF ACCREDITATION

Standards Council of Canada
Conseil canadien des normes

CERTIFICAT D'ACCRÉDITATION

Bureau Veritas Canada (2019) Inc.

Burnaby Laboratory
4606 Canada Way, Burnaby, British Columbia, V5G 1K5, Canada

having been assessed by the Standards Council of Canada (SCC) and found to conform with the requirements of ISO/IEC 17025:2005 and the conditions for accreditation established by SCC is hereby recognized as an

ACCREDITED TESTING LABORATORY

for the specific tests or types of tests listed in the scope of accreditation approved by SCC and found on the SCC website at www.scc.ca.

ayant fait l'objet d'une évaluation du Conseil canadien des normes (CCN), et ayant été trouvé conforme aux exigences énoncées dans ISO/IEC 17025:2005 et aux conditions d'accréditation établies par le CCN, est de ce fait reconnu comme étant un

LABORATOIRE D'ESSAIS ACCRÉDITÉ

pour les essais ou types d'essais énumérés dans la portée d'accréditation approuvée par le CCN et figurant dans le site Web du CCN au www.ccn.ca.

Accredited laboratory number: / Numéro de laboratoire accrédité : 117

SCC file number: / Dossier du CCN n° : 15188

Initial accreditation date: / Date de la première accréditation : 1993-06-08

Vice-President – Accreditation Services / Vice-président – Services d'accréditation
Issued on: / Délivré le : 2019-06-07

The validity of this certificate, including the date of last re-accreditation and its expiry can be confirmed by the accompanying Scope of Accreditation document in the Directory of Accredited Laboratories on the SCC website at www.scc.ca.

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. The accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF communiqué dated April 2017).

Pour vérifier la validité du présent certificat, y compris la date de la dernière réaccréditation et la date d'expiration du certificat, consulter la portée d'accréditation qui se trouve dans le répertoire des laboratoires accrédités dans le site Web du CCN au www.ccn.ca.

Ce laboratoire est accrédité conformément à la Norme internationale reconnue ISO/IEC 17025:2005. Cette accréditation démontre la compétence technique d'un organisme pour une portée définie et l'exploitation d'un système de management de la qualité de laboratoire (cf. communiqué conjoint ISO-ILAC-IAF date de avril 2017).

Canada

Standards Council of Canada
Conseil canadien des normes

TESTING AND CALIBRATION LABORATORY ACCREDITATION PROGRAM (LAP)

Scope of Accreditation

Accredited Laboratory No. 117

Legal Name of Accredited Laboratory: **Bureau Veritas Canada (2019) Inc., formerly known as Maxxam Analytics**

Location Name or Operating as (if applicable):

Contact Name: Alice Lu

Address: 4606 Canada Way, Burnaby, BC. V5G 1K5

Telephone: +1 604 734-7276

Fax: +1 604 731-2386

Website: www.bvlabs.com

Email: Alice.A.Lu@bvlabs.com

SCC File Number:	15188
Accreditation Standard(s):	ISO/IEC 17025:2005
Fields of Testing:	Biological Chemical/Physical Forensic
Program Specialty Area:	Agriculture Inputs, Food, Animal Health and Plant Protection (AFAP) Environmental Testing (ET) Forensic
Initial Accreditation:	1993-06-08
Most Recent Accreditation:	2020-10-05
Accreditation Valid to:	2021-06-08

Testing conducted at:

8577 Commerce Court,

Burnaby BC V5A 4N5

Forensics:

Forensic Equine Drug Testing (Drugs in Horse Hair, Urine and Blood)

ANIMAL AND PLANTS (AGRICULTURE)

Foods and Edible Products: (Human and Animal Consumption)

(Feed)

BBY4SOP-00105	Determination of 17-a-Methyltestosterone in Feed
BBY4SOP-00110	Determination of Avermectins in Feed

(Food Methods: Proximate Analysis)

BBY4SOP-00104	Determination Histamine in Fish

(Fruits and Vegetables, Processed Foods, Animal Tissue, Meat, Fish, Dairy, Honey, Eggs and Egg Products and Animal Derived Foods)

BBY4SOP-00048	Determination of Tetracyclines in Tissue and Animal Derived Foods
BBY4SOP-00052	Determination of Phenol in Honey
BBY4SOP-00058	Determination of Tetracyclines in Honey
BBY4SOP-00061	Determination of Halofuginone in Tissue and Animal Derived Foods
BBY4SOP-00066	Determination of Pesticides in Animal Derived Foods
BBY4SOP-00076	Determination of Sulfonamide Residues in Animal Derived Foods
BBY4SOP-00118	Determination of Herbicide in Food
BBY4SOP-00121	Fumonisins in Grains, Corn Products and Processed Foods
BBY7SOP-00011	Analysis of Metals in Meat, Fruit and Vegetables, Processed Foods and Animal Derived Foods by ICP-MS
BBY7SOP-00021	Digestion of Tissue, Vegetation for Analysis of Heavy Metals

(Microbiological)

AOAC 2014.05	Enumeration of Yeast and Moulds in Food using 3M™ Petrifilm™ Rapid Yeast And Mold Count (RYM) Plate

Assurance GDS® MPX	
Top 7 STEC Assay	BioControl Assurance GDS® MPX Top 7 STEC
COR1SOP-00019	Enumeration of Coliforms, Faecal Coliforms and *E.coli* in Foods by using the MPN Method(Modified MFHPB-19; option of standard 3tube and 10-tube MPN Method)
FDA BAM	BAM FDA Isolation and Identification of Salmonella in Food and Environment Samples
MFHPB-10	Isolation of *Escherichia coli* O157:H7/NM from foods and environmental surface samples
MFHPB-18	Determination of Aerobic Colony Count in Foods
MFHPB-19	Enumeration of Coliforms, Faecal Coliforms and *E. coli* in Foods by using the MPN Method
MFHPB-20	Isolation and Identification of *Salmonella* from Foods and Environmental Samples
MFHPB-21	Enumeration of *Staphylococcus aureus* in Foods
MFHPB-22	Enumeration of Yeasts and Molds in Foods
MFHPB-23	Enumeration of *Clostridium perfringens* in Foods
MFHPB-29	VIDAS Detection of Listeria spp. in Food, Environmental Samples
MFHPB-30	Isolation of *Listeria monocytogenes* and *Listeria spp.* from Foods and Environmental Samples
MFHPB-33	Enumeration of Total Aerobic Bacteria in food Products and Food Ingredients Using 3M™ Petrifilm™ Aerobic Count Plates
MFHPB-34	Enumeration of *E. coli* and Coliforms in Food Products and Food Ingredients using 3M™ Petrifilm™ *E. coli Count* Plates
MFHPB-35	Enumeration of Coliforms in Food Products and Food Ingredients using 3M™ Petrifilm™ Coliform Count Plates
MFLP-09	Enumeration of *Enterobacteriaceae* Species in Food and Environmental Samples Using 3M Petrifilm *Enterobacteriaceae* Count Plates
MFLP-16	Detection of *Escherichia coli* O157:H7 in Foods - Assurance GDS® for E. coli O157:H7 Gene Detection System
MFLP-21	Enumeration of *Staphylococcus aureus* in Foods and Environmental Samples Using 3M™ Petrifilm™ Staph Express Count (STX) Plates
MFLP-25	Isolation and Identification of *Shigella spp*. From Foods
MFLP-28	The Qualicon BAX ®System Method for the Detection of *Listeria monocytogenes* in a Variety of Food
MFLP-29	The Qualicon BAX® System for the Detection of *Salmonella* in Foods and Environmental Surface Samples
MFLP-30	Detection of E. coli O157:H7 in select foods using the BAX® system E.coli O157:H7 MP

MFLP-33	Detection of *Listeria monocytogenes* in Foods by the VIDAS LMO 2™ Method
MFLP-37	Part 1: Detection of Halophilic Vibrio Species in Seafood Part 2: Detection of *Vibrio cholerae*
MFLP-38	Detection of *Salmonella spp*. from All Foods and Selected Environmental Surfaces using IQ-Check™ Salmonella Real-time PCR Test Kit
MFLP-39	Detection of *Listeria* spp. from Environmental Surfaces and heat processed RTE Meat and Poultry Using iQ-CheckTM Listeria spp. Real-Time PCR Test Kit
MFLP-42	Isolation and Enumeration of *Bacillus cereus* Group in Foods
MFLP-46	Isolation of Thermophilic *Campylobacter* from Food
MFLP-49	Detection of Salmonella *spp* in Food Products and environmental surfaces by the VIDAS® UP Salmonella (SPT) Method
MFLP-54	Detection of *Listeria monocytogenes* from selected foods using iQCheck™ *Listeria monocytogenes* Real-Time PCR Test Kit
MFLP-59	Detection of *Listeria spp.* in food products and environmental surface samples with VIDAS® UP *Listeria* (LPT)
MFLP-74	Enumeration of *Listeria monocytogenes* in Food
MFLP-77	Detection of *Listeria* spp. in food products and environmental samples by the VIDAS® *Listeria* species Xpress (LSX) method
MFLP-79	Detection of *Listeria* spp. in Environmental Surface Samples Using the BAX® System Real-Time PCR Assay for *Listeria* Genus
MFLP-83	Detection of Verotoxins VT 1 And VT 2 from *E. coli* O157:H7/NM by The Merck Duopath® Verotoxin Kit
MLG4	FSIS Procedure for the Isolation and Identification of *Salmonella* from Meat, Poultry, Pasteurized egg and Siluriformes (Fish) products and Carcass and Environmental Sponge samples
MLG41	Isolation, Identification of Campylobacter jejuni/coli/lari from Poultry Rinse and Sponge and Raw Product Samples
COR1SOP-00089	USP: Enterobacterial Count in NHP by MPN Method
COR1SOP-00093	USP: Detection and Enumeration for *Pseudomonas aeruginosa* in NHP

(Natural Health Products)

BBY4SOP-00150	Determination of Pesticides in Natural Health Products
USP40-NF35 S1. Dietary Supplements Chapters: 2021	Microbial Enumeration Tests-Nutritional and Dietary Supplements Total Aerobic Microbial Count by Plate Method
USP40-NF35 S1. Dietary Supplements Chapters: 2021	Microbial Enumeration Tests-Nutritional and Dietary Supplements Total Combined Molds and Yeast Count by Plate Method

USP40-NF35 S1. Dietary Supplements Chapters: 2022	Microbiological Procedures for absence of specified microorganisms - Nutritional and Dietary Supplements Test for Absence of *Staphylococcus aureus*
USP40-NF35 S1. Dietary Supplements Chapters: 2022	Microbiological Procedures for absence of specified microorganisms - Nutritional and Dietary Supplements Test for Absence of *Salmonella species*
USP40-NF35 S1. Dietary Supplements Chapters: 2022	Microbiological Procedures for absence of specified microorganisms - Nutritional and Dietary Supplements Test for Absence of *Escherichia coli*

(Other)

BBY4SOP-00029	Determination of Free Residues of Beta-Agonists in Tissue and Animal Derived Foods
BBY4SOP-00032	Determination of Aminoglycocides in Tissue and Animal Derived Foods
BBY4SOP-00033	Determination of Dithiocarbamates (EBDC) in Fruits and Vegetables, Processed Foods and Animal Derived Foods by CS_2 Evolution
BBY4SOP-00035	Determination of Chlorinated Phenols in Tissue and Animal Derived Foods
BBY4SOP-00036	Determination of Fluoroquinolones and Quinolones in Tissue and Animal Derived Food
BBY4SOP-00037	Determination of Synthetic Pyrethrins in Tissue and Animal Derived Foods
BBY4SOP-00038	Determination of Carbamates in Tissue and Animal Derived Foods
BBY4SOP-00043	Determination of Ethylenebisdithiocarbamate (EBDC) in Fruits and Vegetables and Processed Foods
BBY4SOP-00044	Determination of Daminozide (ALAR) in Fruits and Vegetables, Processed Foods and Animal Derived Foods
BBY4SOP-00045	Determination of Ethylenethiourea in Fruits and Vegetables, Processed Foods and Animal Derived Foods
BBY4SOP-00046	Determination of Coccidiostats in Tissue and Animal Derived Foods
BBY4SOP-00047	Determination of Gestagens in Tissue and Dairy
BBY4SOP-00050	Determination of Sulfonamides in Tissue
BBY4SOP-00051	Determination of Amitraz and Metabolites in Fruits and Vegetables, Processed Foods and Animal Derived Foods
BBY4SOP-00054	Determination of Dipyrone Related Residues in Tissue and Animal Derived Foods
BBY4SOP-00055	Determination of Beta Agonists in Tissue and Animal Derived Foods
BBY4SOP-00056	Determination of Virginiamycin in Tissue and Animal Derived Foods
BBY4SOP-00059	Determination of Ceftiofur-Related Residues in Tissue and Animal Derived Foods

BBY4SOP-00060	Determination of Benzimidazoles in Tissue and Animal Derived Foods
BBY4SOP-00062	Determination of Endectocides in Tissue and Animal Derived Foods
BBY4SOP-00063	Determination of Phenylbutazone in Tissue and Animal Derived Foods
BBY4SOP-00064	Determination of Protein Bound Metabolites of Nitrofurans in Tissue and Animal Derived Foods
BBY4SOP-00067	Determination of Amphenicols in Fish
BBY4SOP-00068	Determination of Tranquilizers and Carazolol in Tissue and Animal Derived Foods
BBY4SOP-00069	Determination of Morantel and Pyrantel Drug Related Metabolites in Tissue and Animal Derived Foods
BBY4SOP-00070	Determination of Zeranol and Stilbenes in Tissue and Animal Derived Foods
BBY4SOP-00078	Determination of Emamectin, Ivermectin and Abamectin in Fish
BBY4SOP-00079	Determination of Volatile Pesticides in Tissue
BBY4SOP-00080	Detection of Thyreostats in Animal Tissue, Eggs and Dairy
BBY4SOP-00082	Determination of Triphenylmethane Dyes in Tissue
BBY4SOP-00083	Determination of Carbadox and Olaquindox-Related Metabolites in Tissue
BBY4SOP-00084	Determination of Amphenicols in Tissue and Animal Derived Foods
BBY4SOP-00085	Determination of Bacitracin A in Tissue and Animal Derived Foods
BBY4SOP-00086	Determination of Nitroimidazoles in Tissue and Animal Derived Foods
BBY4SOP-00087	Determination of Aflatoxin in Dairy
BBY4SOP-00089	Determination of Beta Lactams in Animal Tissue and Animal Derived Foods
BBY4SOP-00091	Determination of Non-Steroidal Anti-Inflammatory Drugs (NSAIDS), Hormones and Corticosteroids in Animal Tissue, Eggs and Dairy
BBY4SOP-00092	Determination of Melamine in Eggs, Dairy and Processed Foods
BBY4SOP-00093	Determination of Bisphenol A in Animal Derived Foods
BBY4SOP-00094	Determination of Ochratoxin A in Cereals and Processed Foods
BBY4SOP-00095	Determination of Deoxynivalenol (Vomitoxin) in Cereal and Cereal Products
BBY4SOP-00099	Determination of Macrolides in Tissue and Animal Derived Foods
BBY4SOP-00100	Determination of Trenbolone in Tissue and Animal Derived Foods
BBY4SOP-00111	Aflatoxins in Food and Animal Feed
BBY4SOP-00123	Determination of Pesticides in Grain Products by GCMSMS and LCMSMS
BBY4SOP-00128	Determination of Pesticides in FV Products and Honey by GC/LC
BBY4SOP-00129	Determination of Pesticides in Tissue by GCMSMS and LCMSMS
BBY4SOP-00130	Determination of Tiamulin in Tissue

BBY4SOP-00131	Determination of 3-monochloropropane-1,2-diol (3-MCPD) in Food and Food Ingredients
BBY4SOP-00132	Multi-Residue Determination of Multi-Class Drugs in Urine
BBY4SOP-00134	Determination of Ethyl Carbamate in Alcoholic Beverages
BBY4SOP-00135	Determination of Diquat and Paraquat in Fruit, Vegetables and Processed Foods
BBY4SOP-00136	Determination of Glyphosate and Metabolites in Fruit, Vegetables and Processed Foods
BBY4SOP-00137	Determination of Alternaria Mycotoxins in Beverages and Honey
BBY4SOP-00138	Multi-Residue Determination of Multi-Class Drugs in Animal Tissue and Animal Derived Foods
BBY4SOP-00139	Multi-Residue Determination of Multi-Class Antibiotics in Honey
BBY4SOP-00142	Determination of Steroids and Stilbenes in Fish
BBY4SOP-00145	Determination of 4-Methylimidazole in Processed Foods
BBY4SOP-00146	Determination of T-2 and HT2 Mycotoxins in Processed Foods
BBY4SOP-00147	Determination of Zearalenone and Related Mycotoxins in Processed Foods
BBY4SOP-00149	Multi-residue determination of Mycotoxins in Processed Foods
BBY7SOP-00014	Determination of Mercury in Tissue Digests
BBY4SOP-00151	Phthalates in Food by LC-MS/MS
BBY4SOP-00152	Determination of Polar Pesticides in Food

ENVIRONMENTAL AND OCCUPATIONAL HEALTH AND SAFETY

Environmental

(Microbiological)

BBY4SOP-00001	Total and Fecal Coliform and *E. coli* in Water by Membrane Filtration
BBY4SOP-00003	Heterotrophic Plate Count in Water
BBY4SOP-00005	*Pseudomonas aeruginosa* Count in Water by Membrane Filtration
BBY4SOP-00006	*Enterrococcus* Count in Water by Membrane Filtration
BBY4SOP-00143	Enumeration of Coliforms and E.coli by MF using Chromocult

(Biological Tissues)

BBY4SOP-00108	Determination of Polycyclic Aromatic Hydrocarbons in Tissue by GC/MS
BBY7SOP-00002	Determination of Metals in Environmental Samples Using CRC ICPMS

BBY7SOP-00012	Determination of Hg in Solids, Tissues and Miscellaneous Solids by CVAFS

(Air)

BBY5SOP-00005	Analysis of Total Suspended Particulates (TSP), PM2.5, and PM10 in Air [modified from BC Environmental Laboratory Manual Section G and EPA 600/R-94/038B] Particulate>2.5 microns (gravimetric)
BBY7SOP-00016	Preparation of Air Filters for Metals Analysis [modified from NIOSH 7303]
BBY7SOP-00002	Determination of Metals in Environmental Samples Using CRC ICPMS [modified from EPA 6020] Aluminum Antimony Arsenic Barium Beryllium Boron Cadmium Calcium Chromium Cobalt Copper Iron Lead Magnesium Manganese Molybdenum Nickel Phosphorus Potassium Selenium Sodium Strontium Sulphur (Sulfur) Tin Titanium Uranium Vanadium Zinc Zirconium
BBY7SOP-00018	Analysis of Various Sample Types by ICP-OES [EPA 6010]

	Aluminum
	Antimony
	Arsenic
	Barium
	Beryllium
	Boron
	Cadmium
	Calcium
	Chromium
	Cobalt
	Copper
	Iron
	Lead
Magnesium	Manganese
	Molybdenum
	Nickel
	Phosphorus
	Potassium
	Selenium
	Sodium
	Strontium Sulphur (Sulfur) Tin Titanium Vanadium Zinc Zirconium
BBY8SOP-00027	Determination of Polycyclic Aromatic Hydrocarbons in Air by GC/MS [modified from BC Environmental Laboratory Manual (Preparation) and EPA 8270 (Analysis)] Acenaphthene Acenaphthylene

	Anthracene Benzo (a) anthracene Benzo(a)pyrene Benzo(b,j)fluoranthene Benzo(e)pyrene Benzo(g,h,i)perylene Benzo(k)fluoranthene Chrysene Dibenzo (a,h) anthracene Fluoranthene Fluorene Indeno(1,2,3-cd)pyrene Naphthalene Perylene Phenanthrene Pyrene
BBY8SOP-00058	VOCs In Air/vapour Using TD Tubes with Analysis by GC/MS [modified from BC Environmental Laboratory Manual Section H] 1,1-Dichloroethane 1,1-Dichloroethene 1,1-Dichloropropene 1,1,1-Trichloroethane 1,1,1,2-Tetrachloroethane 1,1,2-Trichloroethane 1,1,2,2-Tetrachloroethane 1,2-Dibromo-3-chloropropane (DBCP) 1,2-Dibromoethane (Ethylene dibromide) 1,2-Dichlorobenzene 1,2-Dichloroethane 1,2-Dichloropropane 1,2,3-Trichlorobenzene 1,2,3-Trichloropropane 1,2,3-Trimethylbenzene 1,2,4-Trichlorobenzene 1,2,4-Trimethylbenzene 1,3-Butadiene 1,3-Dichlorobenzene 1,3-Dichloropropane 1,3,5-Trimethylbenzene 1,4-Dichlorobenzene 2-Butanone (Methyl ethyl ketone, MEK) 2-Chlorophenol

2-Chlorotoluene

2-Hexanone (Methyl butyl ketone, MBK)

2-Propanol (Isopropyl alcohol)

4-Chlorotoluene (p-Chlorotoluene)

4-isopropyltoluene (p-Cymene)

4-Methyl-2-pentanone (MIBK)

Acetone

Benzene

Bromobenzene

Bromodichloromethane

Bromoform

Bromomethane

Carbon Disulphide

Carbon tetrachloride

Chlorobenzene

Chloroethane (Ethyl Chloride)

Chloroethene (Vinyl chloride)

Chloroform

cis-1,2-Dichloroethylene cis-1,3-Dichloropropene
Dibromochloromethane

Dibromomethane

Dichlorodifluoromethane (Freon12)

Dichloromethane

Ethyl Acetate

Ethylbenzene

Hexachlorobutadiene

Isopropanol

Isopropylbenzene (Cumene)

m,p-Xylene

Methyl tert-butyl ether (MTBE)
Methylcyclohexane n-Butylbenzene n-Decane
n-Hexane

n-Propylbenzene Naphthalene
o-Xylene

sec-Butylbenzene

Styrene

tert-Butylbenzene

Tetrachloroethylene Toluene

trans-1,3-Dichloropropene Trichloroethene

Trichlorofluoromethane

Trichlorotrifluoroethane

Volatile Hydrocarbons (VH): C6-C13

(Soil/Solid/Water/Wastewater)

BBY6SOP-00010	Nitrite and Nitrite Plus Nitrate by Automated Colourimetric Method [modified from SM 4500-NO3- I] Nitrate + Nitrite Nitrogen Nitrite
BBY6SOP-00017	Determination of Sulfate by Konelab [modified from SM 4500-SO4 2-] Sulphate
BBY8SOP-00010	Determination of BTEX in Soil and Waters by Headspace-GC-MS [modified from EPA 5021 and EPA 5035 and EPA 8260] Benzene Ethylbenzene m,p-Xylene Methyl t-butyl ether o-Xylene Styrene Toluene
BBY8SOP-00011	VH Analysis in Soils and Waters by Headspace GC/FID [modified from BC Environmental Laboratory Manual Section D] VH: C6-C10 VPH: C6-C10 - BTEX
BBY8SOP-00029	Extractable Hydrocarbons (Water, Soils, Product, TPH) [modified from BC Environmental Laboratory Manual Section D] Extractable Petroleum Hydrocarbons (EPH): C10-C19

	Extractable Petroleum Hydrocarbons (EPH): C19-C32 Total Extractable Hydrocarbons (TEH): C10-C30
BBY8SOP-00030	Determination of CCME (F2-F4) in Water and Soil [CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD] F2: C10-C16 F3: C16-C34 F4: C34-C50
BBY8SOP-00012	F1 and LH Analysis for Soils and Waters by Headspace GC/FID [CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD] F1: C6-C10 F1-BTEX: C6-C10 - BTEX
BBY8SOP-00054	CP, NCP, HydroxyPhenol in water (MTBE extraction) and soil by GC/MS [modified from BC Environmental Laboratory Manual Section D] 2-Chlorophenol 2-Hydroxyphenol (Catechol) 2-Methyl-4,6-dinitrophenol (4,6-Dinitro-o-cresol, DNOC) 2-Methylphenol (o-Cresol) 2-Nitrophenol 2,3-Dichlorophenol 2,3,4-Trichlorophenol 2,3,4,5-Tetrachlorophenol 2,3,4,6-Tetrachlorophenol 2,3,5-Trichlorophenol 2,3,5,6-Tetrachlorophenol 2,3,6-Trichlorophenol 2,4 + 2,5-Dichlorophenol 2,4-Dimethylphenol 2,4-Dinitrophenol 2,4,5-Trichlorophenol 2,4,6-Trichlorophenol 2,6-Dichlorophenol 2,6-Dimethylphenol 3 + 4-Chlorophenol 3 + 4-Methylphenol 3-Hydroxyphenol (Resorcinol) 3,4-Dichlorophenol 3,4-Dimethylphenol 3,4,5-Trichlorophenol 3,5-Dichlorophenol 4-Chloro-3-methylphenol 4-Hydroxyphenol (Hydroquinone) 4-Nitrophenol Pentachlorophenol

	Phenol
BBY8SOP-00060	Determination of Tetraethyllead in Soil and Water by GC/MS [modified from BC Environmental Laboratory Manual Section D and EPA 8000, EPA 8270]
	Tetraethyl lead
BBY8SOP-00009	Analysis of VOC's in Solids and Waters by Static Headspace GC/MS [modified from EPA 5021 and EPA 8260]
	1,1-Dichloroethane
	1,1-dichloroethylene
	1,1-Dichloropropene
	1,1,1-Trichloroethane
	1,1,1,2-Tetrachloroethane
	1,1,2-Trichloroethane
	1,1,2-Trichloropropane
	1,1,2-Trichloro-1,2,2-Triflouroethane (Freon 113)
	1,1,2,2-Tetrachloroethane
	1,2-Dibromo-3-chloropropane (DBCP)
	1,2-Dibromoethane (Ethylene dibromide)
	1,2-dichlorobenzene
	1,2-dichloroethane
	1,2-Dichloropropane
	1,2,3-Trichlorobenzene
	1,2,3-Trichloropropane
	1,2,3-Trichloropropene
	1,2,3-Trimethylbenzene
	1,2,4-Trichlorobenzene
	1,2,4-Trimethylbenzene
	1,3-Butadiene
	1,3-Dichlorobenzene
	1,3-Dichloropropane
	1,3,5-Trichlorobenzene
	1,3,5-Trimethylbenzene
	1,4-dichlorobenzene
	2-Butanone
	2-Chlorotoluene
	4-Methyl-2Pentanone
	4-Chlorotoluene (p-Chlorotoluene)

4-isopropyltoluene (p-Cymene)

Acetone

Benzene

Bromobenzene

Bromodichloromethane

Bromoform

Bromomethane

Carbon tetrachloride

Chlorobenzene

Chlorodibromomethane

Chloroethane (Ethyl Chloride)

Chloroethene (Vinyl Chloride)

Chloroform

Chloromethane (Methyl chloride) cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene

Dibromomethane

Dichlorodifluoromethane

Dichloromethane

Ethylbenzene

Ethylene Dibromide

Hexachlorobutadiene

Hexane

Isopropylbenzene (Cumene) m,p-Xylene

Methyl t-butyl ether Methylcyclohexane
n-Butylbenzene n-Decane

n-Propylbenzene

Naphthalene

o-Xylene

	Pentachloroethane sec-Butylbenzene Styrene tert-Butylbenzene Tetrachloroethylene
	Toluene trans-1,2-Dichloroethylene trans-1,3-Dichloropropene Trichloroethylene Trichlorofluoromethane
BBY8SOP-00040	VOC Extra Compounds in Soil and Water by Headspace-GC-MS [BC Environmental Laboratory Manual Section D] 1-Butanol (n-Butanol) 1-Chlorobutane 1,4-Dioxane (p-dioxane) 2-Hexanone (Methyl butyl ketone, MBK) 2-Propanol (Isopropyl alcohol) Acrolein (Propenal) Acrylonitrile Allyl chloride (3-chloropropene) Alpha-Diisobutylene Beta-Diisobutylene Butylated hydroxytoluene (BHT) Carbon disulfide Chloroprene (2-Chloro-1,3-butadiene) Cyclohexanone Cyclohexene Dicyclopentadiene Ethyl acrylate Ethyl ether Hexachloroethane Isobutanol (2-Methyl-1-propanol) Methyl methacrylate Methylacrylonitrile Tetrabromomethane Tetrahydrofuran (THF) Vinyl acetate

(Soil/Solid/Waste)

BBY6SOP-00042	Determination of Flash Point by SetaFlash Closed Tester [modified from ASTM D3828] Flashpoint
BBY6SOP-00043	Determination of Free Liquid [modified from EPA 9095] Free Liquid

BBY7SOP-00004	Digestion of Soil, Sediment and Sludge for Total Recoverable Metals [modified from BC Environmental Laboratory Manual Section C]
BBY7SOP-00012	Determination of Hg in Solids, Tissues and Miscellaneous Solids by CVAFS [modified from EPA 245.7 and BC Environmental Laboratory Manual Section C] Mercury
BBY7SOP-00018	Analysis of Various Sample Types by ICP-OES [modified from EPA 6010 and BC Environmental Laboratory Manual Section B] Aluminum Antimony Arsenic Barium Beryllium Bismuth Boron Cadmium Calcium Chromium Cobalt Copper Iron Lead Lithium Magnesium Manganese Molybdenum Nickel Phosphorus Potassium Selenium Silver Sodium Strontium Tin Titanium Vanadium Zinc Zirconium
BBY8SOP-00003	Gravimetric Heavy Hydrocarbon-CCME F4G in Soils by AME [CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD] F4: Gravimetric

BBY8SOP-00006	Total Oil and Grease in Soils by Sonification Extraction-Dichloromethane [modified from BC Environmental Laboratory Manual Section D] Total Oil and Grease
BBY8SOP-00007	Mineral Oil and Grease in Solid Samples by Sonification Extraction [modified from BC Environmental Laboratory Manual Section D] Mineral Oil and Grease
BBY8SOP-00008	Waste Oil Quantification in Solids, Liquids by Petroleum Ether Extraction [BC Environmental Laboratory Manual Section D] Waste Oil Content
BBY8SOP-00017	Determination of Moisture Content in Solid Samples [modified from BC Environment Laboratory Manual] Percent Moisture
BBY8SOP-00022	Determination of Polycyclic Aromatic Hydrocarbons in Soil by GC/MS [modified from BC Environmental Laboratory Manual Section D] 1-Methylnaphthalene 2-Chloronaphthalene 2-Methylnaphthalene 3-Methylcholanthrene 4-Nitropyrene 7,12-Dimethylbenz(a)anthracene 9,10-Anthraquinone Acenaphthene Acenaphthylene Acridine Anthracene Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(c)phenanthrene Benzo(e)pyrene Benzo(g,h,i)perylene Benzo(j)fluoranthene Benzo(k)fluoranthene Chrysene Dibenzo(a,e)pyrene Dibenzo(a,h)anthracene Fluoranthene Fluorene Indeno(1,2,3 - cd)pyrene N-Methylaniline Naphthalene Perylene Phenanthrene

	Pyrene Quinoline
BBY8SOP-00050	Determination of Tributyltin in Soil and Sediment by GC-MS [modified from RESTEK CORP APPLICATION NOTE# 59550] Tributyltin Dibutyltin

(Water/Wastewater/Soil Extract/Soil Leachate)

BBY0SOP-00003	Determination of pH in Waters, Leachates and Extracts by pH Meter [modified from SM 4500-H+ B] pH
BBY0SOP-00006	Determination of Conductivity in Waters, Leachates and Extracts by Meter [modified from SM 2510 B] Conductivity (25˚C)
AB SOP-00007	Ammonia-Nitrogen by Automated Phenate Colorimetric method [modified from EPA 350.1] Ammonia
BBY6SOP-00011	Determination of Chloride by Konelab [modified from SM 4500-CL-E and BC Environmental Laboratory Manual Section B] Chloride
BBY6SOP-00013	Ortho-, Total Dissolved, and Total Phosphate by Automated Method [modified from SM 4500-P E] Phosphate Total Dissolved Phosphorus Total Phosphorus
BBY6SOP-00016	Determination of Total and Total Dissolved Nitrogen by Automated Method [modified from SM 4500-N C] Total Dissolved Nitrogen Total Nitrogen
BBY6SOP-00021	Determination of Apparent Colour in Water Samples [modified from SM 2120 B] Apparent Colour
BBY6SOP-00024	Chemical Oxygen Demand (COD) by Closed Reflux, Colorimetric Method [modified from SM 5220 D] COD
BBY6SOP-00025	Determination of pH in Saturated Paste Extract [modified from SM 4500-H+ B] pH
BBY6SOP-00026	pH, Conductivity, Salinity, Alkalinity (Total, Phenolphthalein) in Water [modified from SM 2320 B, SM 2510 B, SM 4500-H+ B] Alkalinity (pH 4.5)

	Conductivity (25˚C) pH
BBY6SOP-00027	Determination of Turbidity in Water Samples [modified from SM 2130 B] Turbidity
BBY6SOP-00028	Determination of pH in Soil Leachate [modified from BC Environmental Laboratory Manual Section B] pH
BBY6SOP-00029	Specific Conductance in Satpaste and 1:5 DI Leach by Conductivity Cell [modified from SM 2510 B] Conductivity
BBY6SOP-00030	Satpaste Extract Preparation for Saturation Percent, Salinity Analyses [modified from BC Environmental Laboratory Manual Section B] Percent Saturation Saturated Paste
BBY6SOP-00033	Determination of Total Dissolved Solids in Waters and Wastewaters [modified from SM 2540 C] Total Dissolved Solids
BBY6SOP-00034	Determination of Total Suspended Solids in Waters and Wastewaters [modified from SM 2540 D] Total Suspended Solids
BBY6SOP-00035	Determination of Total Solids and Total Solids Fixed in Waters [modified from SM 2540 A] Fixed Solids Total Solids (TS)
BBY6SOP-00037	Determination of Total Acidity pH 8.3, Acidity to pH 4.5, in Waters [modified from SM 2310 B] Acidity
BBY6SOP-00045	Total and Carbonaceous BOD, DO, and pH Analysis [modified from SM 5210 B] BOD (5 day) CBOD (5 day)
BBY6SOP-00048	Determination of Fluoride in Waters, Soil Extracts, Leachates by ISE [modified from BC MOE ENVIRONMENTAL MANAGEMENT ACT HAZARDOUS WASTE REGULATION (EMA/HWR) SCHEDULE 4, PART 2 (Preparation) and SM 4500-F- C (Analysis)] Fluoride
BBY6SOP-00057	Determination of True Colour in Water Samples by Konelab [modified from SM 2120 C] True Colour
BBY7SOP-00001	Determination of Metals in Solids by ICPMS [modified from EPA 6020] Antimony

	Arsenic Barium Beryllium Boron Cadmium Calcium Chromium Cobalt Copper Iron Lead Manganese Mercury Molybdenum Nickel Selenium Silver Thallium Tin Vanadium Uranium Zinc Zirconium
BBY7SOP-00005	Procedure for the Preparation of Solids and Soil using TCLP [EPA 1311]
BBY7SOP-00009	Procedure for the Preparation of Leachates Using BC MLEP [modified from BC MOE ENVIRONMENTAL MANAGEMENT ACT HAZARDOUS WASTE REGULATION (EMA/HWR) SCHEDULE 4, PART 2]
BBY8SOP-00021	Determination of Polycyclic Aromatic Hydrocarbons in Waters by GC/MS [modified from BC Environmental Laboratory Manual Section D] 1-Methylnaphthalene 2-Chloronaphthalene 2-Methylnaphthalene 3-Methylcholanthrene 4-Nitropyrene 7,12-Dimethylbenz(a)anthracene 9,10-Anthraquinone Acenaphthene Acenaphthylene Acridine Anthracene Benzo(a)anthracene

	Benzo(a)pyrene Benzo(b,j)fluoranthene Benzo(c)phenanthrene Benzo(e)pyrene Benzo(g,h,i)perylene Benzo(k)fluoranthene Chrysene Dibenzo(a,e)pyrene Dibenzo(a,h)anthracene Fluoranthene Fluorene Indeno(1,2,3-cd)pyrene N-Methylaniline Naphthalene Perylene Phenanthrene Pyrene Quinoline
BBY7SOP-00018	Analysis of Various Sample Types by ICP-OES [modified from EPA 6010] Aluminum Antimony Arsenic Barium Beryllium Bismuth Boron Cadmium Calcium Chromium Cobalt Copper Iron Lead Lithium Magnesium Manganese Molybdenum Nickel

	Phosphorus
	Potassium
	Selenium
	Silicon
	Silver
	Sodium
	Strontium
	Sulphur (Sulfur)
	Tin
	Titanium
	Vanadium
	Zinc
	Zirconium
BBY7SOP-00002	Determination of Metals in Environmental Samples Using CRC
	ICPMS [modified from EPA 6020 and BC Environmental Laboratory Manual Section C]
	Aluminum
	Antimony
	Arsenic
	Barium
	Beryllium
	Bismuth
	Boron
	Cadmium
	Calcium
	Cesium
	Chromium
	Cobalt
	Copper

	Gold
	Iron
	Lanthanum
	Lead
	Lithium
	Magnesium
	Manganese
	Mercury
	Molybdenum
	Nickel Palladium Phosphorus Platinum Potassium Rubidium Selenium Silicon Silver Sodium Strontium Sulphur (Sulfur) Tellurium Thallium Thorium Tin Titanium Tungsten Uranium Vanadium Zinc Zirconium
BBY7SOP-00003	Digestion of Aqueous Samples for Metals by ICPMS or ICP-OES [modified from EPA 6020 and BC Environmental Laboratory Manual Section C]
AB SOP-00084	Mercury in Water, Leachates and Liquids by Bromination and Cold Vapour [modified from BC Environmental Laboratory Manual Section C) Mercury

BBY7SOP-00022	Determination of Ultra-Low Level Mercury in Water by CVAFS [modified from EPA 1631] Mercury
BBY8SOP-00004	Oil and Grease in Water Samples by Hexane Extraction and Gravimetry [modified from BC Environmental Laboratory Manual Section D] Mineral Oil and Grease Total Oil and Grease
BBY8SOP-00059	Determination of Tributyltin in Water by GC-MS [modified from RESTEK CORP LIT. CAT#59550] Dibutyltin Tributyltin
BBY8SOP-00025	Chlorinated Phenols in Water (DCM extraction) by GC/MS [modified from BC Environmental Laboratory Manual Section D] 2-Chlorophenol 2,3-Dichlorophenol 2,3,4-Trichlorophenol 2,3,4,5-Tetrachlorophenol 2,3,4,6-tetrachlorophenol 2,3,5-Trichlorophenol 2,3,5,6-Tetrachlorophenol 2,3,6-Trichlorophenol 2,4 + 2,5-Dichlorophenol 2,4,5-Trichlorophenol 2,4,6-trichlorophenol 2,6-Dichlorophenol 3 + 4-Chlorophenol 3,4-Dichlorophenol 3,4,5-Trichlorophenol 3,5-Dichlorophenol 4-Chloro-3-Methylphenol Pentachlorophenol

(Seawater)

BBY7SOP-00002	Determination of Metals in Environmental Samples Using CRC ICPMS [modified from EPA 6020] Aluminum Antimony Arsenic Barium Beryllium Bismuth Boron Cadmium

Calcium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Selenium
Silicon
Silver
Sodium
Strontium
Sulphur (Sulfur)
Tellurium
Tin
Thallium
Titanium
Uranium
Vanadium

Zinc

Zirconium

(Soil / Solid – Toxicology)

BBY2SOP-00010	Chironomids dilutus 10-Day Survival and Growth Test [EPS 1/RM/32] Chironomids (10d)
BBY2SOP-00011	Hyalella azteca 14-Day Survival and Growth Test [EPS 1/RM/33] Hyalella azteca (14d)
BBY2SOP-00012	Marine or Estuarine Amphipod 10 Day Survival and Reburial Test [EPS 1/RM/26 and EPS 1/RM/35] Marine Amphipods (10d)
BBY2SOP-00014	Microtox - Acute Solid Phase Analysis [EPS 1/RM/42] Microtox IC50
BBY2SOP-00030	Neanthes arenaceodentata Survival and Growth Test Neanthes (20d)
BBY2SOP-00032	Bivalve Larval Development Sediment Test [PUGET SOUND ESTUARY PROGRAM 1995 B] Bivalves (48hr)
BBY2SOP-00062	Echinoderm Embryo / Larval Development Test [EPS 1/RM/58] Echinoid Larval Development (48hr)

(Water – Toxicology)

BBY2SOP-00001	Ceriodaphnia dubia Chronic Survival and Reproduction Test [EPS 1/RM/21] Ceriodaphnia dubia (7d)
BBY2SOP-00002	Fathead Minnow 7 Day Survival and Growth Test [EPS 1/RM/22] Fathead Minnow (7d)
BBY2SOP-00004	Rainbow Trout Acute Survival Test (Environment Canada) [EPS 1/RM/13 and EPS 1/RM/9] Single Concentration (96hr) Trout LC50 (96hr)
BBY2SOP-00006	Pseudokirchneriella Subcapitata 72H Growth Inhibition Test [EPS 1/RM/25] Pseudokirchneriella subcapitata (72hr)
BBY2SOP-00007	Daphnia magna 48 Hour Acute Test [EPS 1/RM/11 and EPS 1/RM/14] Daphnia LC50 (48hr) Daphnia Single Concentration (48hr)
BBY2SOP-00009	Echinoid 20 Minute Fertilization Test [EPS 1/RM/27] Echinoderm Fertilization (20 min)
BBY2SOP-00053	Lemna minor 7 Day Growth Inhibition Test [EPS 1/RM/37] Lemna minor (7d)
BBY2SOP-00061	Rainbow Trout Acute Survival Test with pH Stabilization [EPS 1/RM/50] Single Concentration (96hr) - pH Stabilization Trout LC50 (96hr) - pH Stabilization

This document forms part of the Certificate of Accreditation issued by the Standards Council of Canada (SCC). The original version is available in the Directory of Accredited Laboratories on the SCC website at www.scc.ca.

Elias Rafoul

Vice President, Accreditation Services

Publication on: 2020-10-19

AGNICO EAGLE
HOPE BAY

QUALITY ASSURANCE AND QUALITY CONTROL PLAN

HOPE BAY, NUNAVUT

Appendix F – Nautilus CALA Certificate and Scope

Canadian Association for Laboratory Accreditation Inc.

CALA

Certificate of Accreditation

Nautilus Environmental Inc.
8664 Commerce Court
Burnaby, British Columbia

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

CANADIAN ASSOCIATION FOR LABORATORY ACCREDITATION INC. CALA

Accreditation No.: A3525
Issued On: September 10, 2019
Accreditation Date: March 6, 2007
Expiry Date: March 10, 2022

Andrew M. Adams
President & CEO

CALA

CALA
Canadian Association for
Laboratory Accreditation Inc.

CALA Directory of Laboratories

Membership Number: 3525
Laboratory Name: Nautilus Environmental Inc.
Parent Institution:
Address: 8664 Commerce Court Burnaby BC V5A 4N7
Contact: Ms. Julianna Kalocai
Phone: (604) 420-8773; (778) 829-6359
Fax: (604) 357-1361
Email: julianna@nautilusenvironmental.ca

Standard: Conforms with requirements of ISO/IEC 17025
Clients Served: All Interested Parties
Revised On: September 10, 2019
Valid To: March 10, 2022

Scope of Accreditation

Sediment (Toxicology)
Chironomous dilutus - Sediment (011)
401; EPS 1/RM/32
SURVIVAL AND GROWTH INHIBITION
Survival and Growth (10d)

Sediment (Toxicology)
Hyalella azteca - Sediment (012)
400; EPS 1/RM/33
SURVIVAL AND GROWTH INHIBITION
Survival and Growth (14d)

Water (Toxicology)
Ceriodaphnia dubia - Water (003)
209; EPS 1/RM/21
SURVIVAL AND REPRODUCTION
Cerodaphnia dubia (7d)

Water (Toxicology)
Daphnia magna - Water (002)
205; EPS 1/RM/11 and EPS 1/RM/14
ACUTE LETHALITY (SURVIVAL)
Daphnia LC50 (48 h)

Water (Toxicology)
Fathead minnow - Water (010)
220; EPS 1/RM/22
SURVIVAL AND GROWTH INHIBITION
Survival and Growth (7d)

† "OSDWA" indicates the appendix is used for the analysis of Ontario drinking water samples, which is subject to the rules and related regulations under the Ontario "Safe Drinking Water Act" (2002).

The list of tests and measurement capabilities for which a laboratory is accredited can change at any time due to circumstances such as scope extensions, voluntary withdrawal of tests by the laboratory and suspension. Scopes are published by the CALA via the Internet at http://www.cala.ca/cala_directories.html

Water (Toxicology)
Hyalella azteca - Water (013)
400; EPS 1/RM/33
SURVIVAL AND GROWTH INHIBITION
Survival and Growth (14d)

Water (Toxicology)
Lemna minor - Water (005)
215; EPS 1/RM/37
GROWTH INHIBITION
Lemna minor (7d)

Water (Toxicology)
Pseudokirchneriella subcapitata - Water (008)
213; EPS 1/RM/25
GROWTH INHIBITION
Pseudokirchneriella subcapitata (72h)

Water (Toxicology)
Rainbow Trout - Water (001)
201; EPS 1/RM/13 and EPS 1/RM/9
ACUTE LETHALITY (SURVIVAL)
Trout LC50 (96 h)

Water (Toxicology)
Rainbow Trout [pH Stabilization] - Water (009)
204; EPS 1/RM/50
pH STABILIZATION
Survival

Water (Toxicology)
Salmonid - Water (004)
203; EPS 1/RM/28
EARLY LIFE STAGE
Salmonid Embryo (7d)

† "OSDWA" indicates the appendix is used for the analysis of Ontario drinking water samples, which is subject to the rules and related regulations under the Ontario "Safe Drinking Water Act" (2002).

The list of tests and measurement capabilities for which a laboratory is accredited can change at any time due to circumstances such as scope extensions, voluntary withdrawal of tests by the laboratory and suspension. Scopes are published by the CALA via the Internet at http://www.cala.ca/cala_directories.html

QUALITY ASSURANCE AND QUALITY CONTROL PLAN

HOPE BAY, NUNAVUT

Module A: 2AM-DOH1335

Conformity Table

Licence	Part	Item	Topic	Report Section
2AM-DOH1335	B	13	The Licensee shall, for all plans submitted under this Licence, implement the plan as approved by the Board in writing. Any changes to the plans deemed significant shall be considered as an amendment to the plan(s) or as a modification and must be submitted to the Board for approval in writing. The Board has approved under this Amended Water Licence 2AM-DOH1335, the following plans for implementation under the relevant sections in the Amended Licence: *q. Quality Assurance and Quality Control Plan (January 2017)*	This plan
	I	3	The Licensee shall undertake the Monitoring Program provided in the Tables 1, 2, and 3 of Schedule I. The Licensee shall, in consultation with an Inspector, establish the locations and GPS coordinates for all Monitoring Program Stations.	Table A1 and Figure A1
		15	The Licensee shall annually review the approved Quality Assurance and Quality Control Plan and modify the Plan as necessary. Proposed changes shall be submitted to an Accredited Laboratory for approval.	Section 1.4
		16	All analyses shall be conducted as described in the most recent edition of “Standard Methods for the Examination of Water and Wastewater” or by other such methods approved by an Analyst.	Sections 2 and 3
		17	All compliance analyses shall be performed in an accredited laboratory according to ISO/IEC Standard 17025. The accreditation shall be current and in good standing.	Section 5

A1 Introduction

The Type A Water Licence No. 2AM-DOH1335 issued to Agnico Eagle by the Nunavut Water Board (NWB) details the sampling and analysis requirements for the SNP program.

A2 SNP Sampling Stations

Table A1 summarizes the sampling stations, sampling frequency and monitoring parameters required as part of the Surveillance Network Program for water licence 2AM-DOH1335. The location of each sampling point is illustrated in Figure A1 through Figure A3 below.

Table A1. 2AM-DOH1335 Sample Stations, Sample Frequency and Analytical Parameters

SNP Station	Description	Phase	Monitoring Parameters	Frequency during Operations and Anytime after Initial Deposit of Tailings to the TIA
ST-1	Doris Sedimentation Pond	Construction, Operation, Care and Maintenance, Closure	G, N1, MT and Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, and Total Metals by ICP-MS	Annually
ST-2	Doris Contact Water Pond	Construction, Operation, Care and Maintenance, Closure	G, N1, MT and Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, and Total Metals by ICP-MS	Annually
ST-3	Discharge from Non-hazardous Landfill Contact Water control sump	Construction, Care and Maintenance, Operation, Closure	G, MT and Total Ammonia-N, Total Sulphate, Total and Free CN, Total Oil and Grease	Annually. Once prior to every discharge onto the tundra
			D	Daily during periods of discharge
ST-4	Discharge from Landfarm sump	Construction, Operation, Care and Maintenance, Closure	G, HC, total Ammonium, total Lead	Annually. Once prior to every discharge onto the tundra
			D	Daily during periods of discharge
ST-5	Discharge from Doris Plant Site Fuel Storage and Containment Area Sump	Construction, Operation, Care and Maintenance, Closure	G, HC, Total Pb	Annually. Once prior to every discharge onto the tundra
			D	Daily during periods of discharge
ST-6a and ST-6b	Discharge from the Roberts Bay Fuel Storage and Containment Area Sumps	Construction, Operation, Care and Maintenance, Closure	G, HC, Total Pb	Annually. Once prior to every discharge onto the tundra
			D	Daily during periods of discharge
ST-7	Freshwater pumped from Doris Lake	Construction, Operation, Care and Maintenance, and Closure	G, N1, N2, MT and Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, T-Tl, and Total Oil and Grease, Cl	Monthly during periods of pumping
			D	Monthly during periods of pumping

SNP Station	Description	Phase	Monitoring Parameters	Frequency during Operations and Anytime after Initial Deposit of Tailings to the TIA
			Cl-a	Annually
ST-7a	Freshwater pumped from the Windy Lake freshwater intake	Construction, Operation, Care and Maintenance, Closure	G, N1, N2, MT, Cl and, T-Ag, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, T-Tl, T-Ca, and Total Oil and Grease, Free CN, Total CN	Monthly during periods of pumping
			B	
			D	
ST-8	Discharge from Doris Sewage Treatment Plant bio-membrane	Construction, Operation, Care and Maintenance, Closure	G, B, and Total Oil and Grease	Monthly when discharge to the Tundra, Annually when discharge to the TIA
			Location of discharge	Monthly during periods of discharge
			D	Daily during periods of discharge
ST-9	Runoff from Doris Sewage Treatment Plant discharge - downstream of wastewater treatment plant discharge point and just prior to flow entering Doris Lake	Construction, Operation, Care and Maintenance, Closure	G, B, and Total Oil and Grease	Monthly when ST-8 is discharged to the tundra
ST-10	Doris Site Runoff from Sediment Controls	Construction, Operations, Closure	TSS or Turbidity (following development and approval of a site-specific TSS-Turbidity)	Daily during periods of discharge
ST-11	Reagent and Cyanide Doris Storage Facility Sumps	Construction, Operation, Care and Maintenance, Closure	G, HC , MT, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, T-Tl Total Ammonia, Total and Free Cyanide, and D	Annually
ST-12	Doris Lake	Operation, Closure	Water Level	Monthly
			Ice Thickness	Annually in April
ST-13	Doris Contact Water Pond associated to Pad U	Construction, Operation, Care and Maintenance, Closure	G, N1, MT and Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, and Total Metals by ICP-MS	Annually
			D	Daily during periods of discharge
TL-1	TIA at the Reclaim Pipeline	Operation, Care and Maintenance, Closure, Post-Closure	G, N1, N2, MT and TDS, Cl, Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-K, T-Mo, T-Mg, T-Na, T-Se, T-Tl, HC, Fecal Coliforms	Monthly during Operations, Closure and Post-Closure Annually during Care and Maintenance
			Dissolved Oxygen, Redox Potential, BOD	Annually
			Acute Lethality	Annually during Post-Closure
			D	Daily during periods of discharge

SNP Station	Description	Phase	Monitoring Parameters	Frequency during Operations and Anytime after Initial Deposit of Tailings to the TIA
TL-2	Doris Outflow Creek - upstream (at the flow monitoring station adjacent to the bridge)	Closure, Post-Closure	G, N1, N2, MT and TDS, Cl, Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-K, T-Mo, T-Mg, T-Na, T-Se, T-Tl, Oil and Grease	Annually during Care and Maintenance Annually for 2 years prior to Post-Closure, and during Post-Closure, Increase to three times per year (under ice, freshet, and pre-freeze up), two years prior to breach of the North Dam.
		Operation	D	Daily upon commencement of mining in or beneath the Doris Lake Talik.
TL-3	Doris Outflow Creek (~80m downstream of the base of the waterfall)	Care and Maintenance, prior to any deposit of tailings to the TIA	G, N1, N2, MT and TDS, Cl, Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-K, T-Mo, T-Mg, T-Na, T-Se, T-Tl, Total Oil and Grease D	Inactive
TL-4	TIA Discharge End-of-Pipe	Care and Maintenance, prior to any deposit of tailings to the TIA	G, N1, N2, MT, and TDS, Cl, Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-K, T-Mo, T-Mg, T-Na, T-Se, T-Tl, T-Radium 226 Acute Lethality B D	Inactive
TL-5	Effluent from Doris Process Plant (tailings slurry/water)	Operations	G, N1, MT, and Free CN, Total CN, WAD CN, Sulphate, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, and Total Metals by ICP-MS	Monthly
			Cyanate and Thiocyanate	Quarterly
TL-6	Tailings Discharged into TIA (Solid Component) taken from a valve in the mill at the discharge end of the mill tailings pumps	Operations	Tonnage of dry tailings solids	Monthly during periods of discharge
			MT and T-Cd, T-Cr, T-Hg, T-Mo, T-Se, Total Inorganic Carbon and Total Metals by ICP-MS (must include Sulphur)	Sampled on a weekly basis with analyses carried out monthly on a composite sample of the TL-6 weekly samples
TL-7a	Detoxified tailings solids sent underground as backfill	Operations	Dry tonnage of detoxified tailings sent underground; Moisture content of backfill trucked underground	Monthly
TL-7b	Filtrate from TL-7a (Detoxified tailings sent underground as backfill)	Operations	Cyanate and Thiocyanate, WAD CN, Total Inorganic Carbon, Total Metals by ICP-MS (including Sulphur)	Monthly
TL-8	Reclaim water pumped from TIA to Mill Process water tank taken from	Operations	G, N1, N2, MT and Free CN, Total CN, T-Ag, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, T-Tl	Inactive

SNP Station	Description	Phase	Monitoring Parameters	Frequency during Operations and Anytime after Initial Deposit of Tailings to the TIA
	a valve at the discharge end of the reclaim water pump		D	Daily during periods of pumping
TL-9	Detox tailings reactor tank (650-TK-565)	Monitoring and reporting is captured within the Water Management Plan		Monitoring and reporting is captured within the Water Management Plan
TL-10	Water Column in deepest portion of Tail Lake and at a location away from the TIA Reclaim water floating pump house, sampled at surface, mid- depth and near bottom	Inactive		Inactive
TL-11	Seepage from Doris underground backfilled stopes	Operations	Visual inspection for seepage. If seepage present parameters to be monitored include N1 and pH, EC, Trace metals by ICP-MS, Alkalinity, Acidity, Sulphate, Total, Free and WAD CN	Survey Twice annually
TL-12	Doris Mine Water Discharge Point	Operations during continuous pumping	Chloride, TDS and nitrate	Weekly
			Total Ammonia, Nitrate, Nitrite, pH, EC, Total Metals by ICPMS, alkalinity, bromide, fluoride, sulphate, TSS, and Total and WAD Cyanide	Monthly
			D	Daily during periods of discharge
MMS-1	Madrid North Contact Water Pond	Construction, Operations, Care and Maintenance	G, N1, MT and Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, and Total Metals by ICP-MS	Sampled twice annually, Weekly water levels
MMS-2	Madrid South Primary Contact Water Pond	Construction, Operations, Care and Maintenance, Closure	G, N1, MT and Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, and Total Metals by ICP-MS	Sampled twice annually, Weekly water levels
MMS-3	Madrid South Secondary Contact Water Pond	Construction, Operations, Care and Maintenance, Closure	G, N1, MT and Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, and Total Metals by ICP-MS	Sampled twice annually, Weekly water levels
MMS-4a	Freshwater Intake at Windy Lake North	Construction, Operations, Care and Maintenance, Closure	G, N1, N2, MT and Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, T-Tl, and Total Oil and Grease, Cl, D	Sampled monthly during active pumping periods
MMS-4b	Freshwater Intake at Windy Lake South (Windy Camp)	Construction, Operations, Care and Maintenance, Closure	G, N1, N2, MT and Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, T-Tl, and Total Oil and Grease, Cl, D	Sampled monthly during active pumping periods

SNP Station	Description	Phase	Monitoring Parameters	Frequency during Operations and Anytime after Initial Deposit of Tailings to the TIA
MMS-5	Discharge from Madrid South Fuel Storage facility	Construction, Operations, Care and Maintenance, Closure	G, HC, Total Pb	Annually. Once prior to every discharge to tundra
MMS-6	Brine Mixing Facility	Operations during continuous pumping	G, N1, Chloride, Fluoride, Bromide, Sulphate, TDS, EC, Total Metals ICP-MS, alkalinity, Total and WAD Cyanide	Sampled monthly during active pumping periods
MMS-7	Effluent from Madrid North Concentrator to TIA	Operations	G, N1, MT, and Free CN, Total CN, WAD CN, Sulphate, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, and Total Metals by ICP-MS	Sampled quarterly during active pumping periods
MMS-8	Discharge from Madrid North Fuel Storage Facility	Construction, Operations, Care and Maintenance, Closure	G, HC, Total Pb	Annually. Once prior to every discharge to tundra
MMS-9	Site runoff from sediment controls during construction	Construction	TSS or Turbidity	Sampled daily during periods of discharge
MMS-10	Mine Water Discharge Point	Operations during continuous pumping	Chloride, TDS and nitrate Total Ammonia, Nitrate, Nitrite, pH, EC, Total Metals ICP-MS, alkalinity, Fluoride, Bromide, Sulphate, TSS, and Total and WAD Cyanide	Weekly Monthly

Figure A.1 2AM-DOH1335 Sample Station Locations

Figure A.2 2AM-DOH1335 Sample Station Locations

Figure A.3 2AM-DOH1335 Sample Station Locations

QUALITY ASSURANCE AND QUALITY CONTROL PLAN

HOPE BAY, NUNAVUT

Module B: 2BE-HOP1222

Conformity Table

Licence	Part	Item	Topic	Report Section
2BE-HOP1222	J	14	The Licensee shall implement the Hope Bay Mining Limited, Quality Assurance and Quality Control Plan R5, for the Windy Lake Camp and the Patch Lake Fuel Farm Area, dated December 31, 2010, prepared in accordance with the INAC document "Quality Assurance (QA) and Quality Control (QC) Guidelines for use by Class "B" Licensees in Collecting Representative Water Samples in the Field, 1996" approved by an Analyst on July 4, 2011.	
		15	The Licensee shall annually review the approved Quality Assurance/Quality Control plan and modify it as necessary. Proposed modifications shall be submitted to an Analyst for approval.	Section 1.4
		16	The approved Quality Assurance/Quality Control Plan shall be submitted to the Board for review and implemented as approved by an Analyst.	This plan
		17	All sampling, sample preservation and analyses shall be conducted in accordance with methods prescribed in the current edition of Standard Methods for the Examination of Water and Wastewater, or by such other methods approved by the Board.	Sections 2 and 3
		18	All analyses shall be performed in a laboratory accredited according to ISO/IEC Standard 17025. The accreditation shall be current and in good standing.	Section 5

B1 Introduction

The Type B Water Licence No. 2BE-HOP1222 issued to Agnico Eagle by the Nunavut Water Board (NWB) details the sampling and analysis requirements for the SNP program. Windy Camp and the Patch Lake Laydown facility are no longer in use; therefore, sampling stations associated with camp operations and fuel storage facility are not being used or monitored. There are currently no active sampling stations at Windy Camp or Patch Lake. Water drawn from Windy Lake for domestic use at Doris Camp is monitored under the 2AM-DOH1323 Licence SNP Station ST-7A.

B2 SNP Sampling Stations

Table B1. 2BE-HOP1222 Sample Stations, Sample Frequency and Analytical Parameters

SNP Station	Description	Monitoring Parameters	Frequency
HOP-1	Raw water supply intake at Windy Lake	B, G, Oil and Grease	Monthly (when in use for Doris)
		D	Daily during periods of pumping
HOP-2*	WWTF effluent discharge at the surge tank prior to being pumped over the ridge east of the Windy Camp Facilities	G, B, Oil and Grease	Monthly
HOP-3*	WWTF effluent at a point of entry into Windy lake	G, B, Oil and Grease	Monthly
		Acute Lethality	Annually
		D	Daily during periods of discharge
HOP-4*	Effluent from the Landfarm Treatment Facility pumped to the WWTF surge tank. Has been decomissionned.	No monitoring requirements	N/A
HOP-5*	Effluent from the Bulk Fuel Storage Facility located at the Windy Camp, prior to release	MT, Oil and Grease, BTEX, TPH, PAH,T-Hg, T-Cd, T-Cr Nitrate, Nitrite, Total Phenols, Total Hardness, Total Alkalinity, Calcium, Potassium, Sulphate, Sodium, Magnesium	Once before any discharge, monthly when discharging onto the tundra
		D	Daily during periods of discharge
HOP-6*	Effluent from the Bulk Fuel Storage Facility located at the Patch Lake location, prior to release to a location approved by an Inspector	MT, Oil and Grease, BTEX, TPH, PAH,T-Hg, T-Cd, T-Cr Nitrate, Nitrite, Total Phenols, Total Hardness, Total Alkalinity, Calcium, Potassium, Sulphate, Sodium, Magnesium	Once before any discharge, monthly when discharging onto the tundra
		D	Daily during periods of discharge
HOP-7A, B, and D	Discharge from Quarries A, B, and D respectively	pH, T-Ammonia, Nitrate, ICP metals, Total Sulphate, Alkalinity, Oil and Grease, Electrical Conductivity and Reduction potential (Eh)	Once before any discharge, monthly when discharging onto the tundra
		D	Daily during periods of discharge

SNP Station	Description	Monitoring Parameters	Frequency
HOP-8*	Effluent from the Bulk Fuel Storage Facility located at the new Windy Camp location, prior to release to a location approved by an Inspector	MT, Oil and Grease, BTEX, TPH, PAH,T-Hg, T-Cd, T-Cr Nitrate, Nitrite, Total Phenols, Total Hardness, Total Alkalinity, Calcium, Potassium, Sulphate, Sodium, Magnesium	Once before any discharge, monthly when discharging onto the tundra
		D	Daily during periods of discharge
Drill Sites	Under-ice sampling before and after drilling	G, ICP total trace metals, Trace Arsenic, Trace Mercury, Electrical Conductivity	Before and after on-ice drilling
	Water intake from all sources	D	Daily during periods of operation

Figure B1. 2BE-HOP1222 Sample Stations Locations

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QUALITY ASSURANCE AND QUALITY CONTROL PLAN

HOPE BAY, NUNAVUT

Module C: 2BB-BOS1727

Conformity Table

Licence	Part	Item	Topic	Report Section
2BB-1727	J	16	The Board has accepted the Plan entitled "Quality Assurance and Quality Control Plan, Hope Bay, Nunavut, Module C: 2BB-BOS1217 Boston" dated January 2017, submitted as additional information with the Application. The Licensee shall submit with the Annual Report an addendum to the Plan; the addendum is to include an updated Table of Contents.	
		17	The Licensee shall annually review the Quality Assurance/Quality Control plan of Part J, Item 16 and modify it as necessary. Proposed modifications shall be submitted to an Analyst for approval.	Section 1.4
		18	All sampling, sample preservation and analyses shall be conducted in accordance with methods prescribed in the current edition of Standard Methods for the Examination of Water and Wastewater, or by such other methods approved by the Board.	Sections 2 and 3
		19	All analyses shall be performed in a laboratory accredited according to ISO/IEC Standard 17025. The accreditation shall be current and in good standing.	Section 5

C1 Introduction

The Type B Water Licence No. 2BB-BOS1727 issued to Agnico Eagle by the Nunavut Water Board (NWB) details the sampling and analysis requirements for the SNP program.

C2 SNP Sampling Stations

Table C1 summarizes the sampling stations, sampling frequency and monitoring parameters required as part of the Surveillance Network Program for water licence 2BB-BOS1727. The location of each sampling point is illustrated in Figure C1 below.

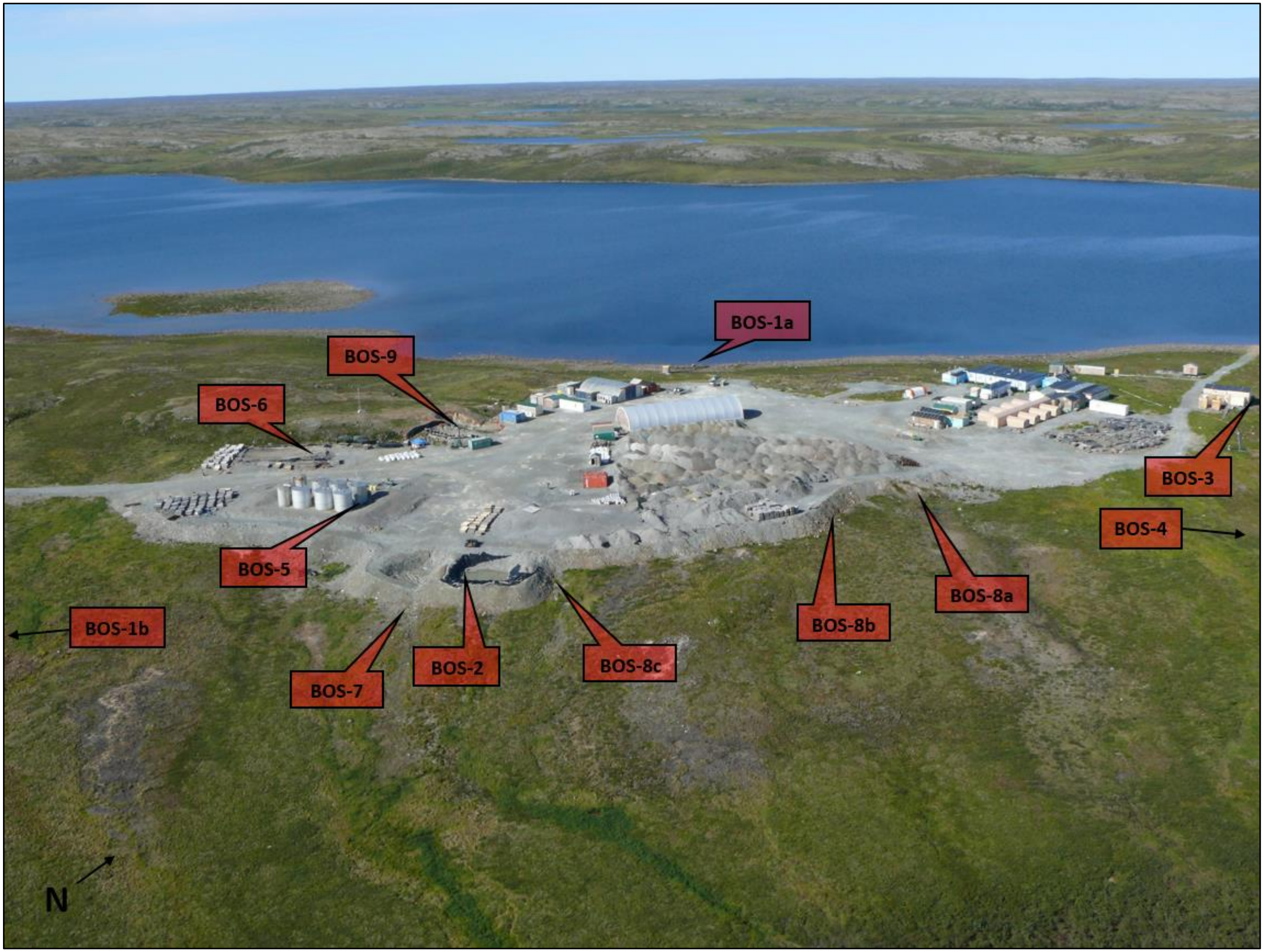
Table C1. 2BB-BOS1727 Sample Stations, Sample Frequency and Analytical Parameters

SNP Station	Description	Monitoring Parameters	Frequency
BOS-1a*	Raw water supply intake at Aimaokatalok (Spyder) Lake	D	Daily during periods of pumping
BOS-1b*	Raw water supply intake at Stickleback Lake	D	Daily during periods of pumping
BOS-2	Containment Pond discharge	pH, Nitrate as NO3-, Oil and Grease, Total Suspended Solids Total As, Cu, Pb, Ni and Zn.	Prior to discharge, weekly during periods of discharge
		TPH, PAH, BTEX, pH, Electrical Conductivity, Nitrate, Nitrite, Oil and Grease, Total Phenols, Total Alkalinity, Total Hardness, Total Suspended Solids, Calcium, Magnesium, Potassium, Sodium, Sulphate & Chloride, Total As, Cd, Cu, Cr, Fe, Pb, Hg, Ni, Se and Zn.	Prior to discharge, monthly during periods of discharge
		D	Daily during periods of discharge
BOS-3*	Sewage Disposal Facility treated effluent discharge	BOD_5, TSS, Oil and Grease (visual), Fecal Coliforms, pH	Once prior to discharge and monthly during periods of discharge
		D	Daily during periods of discharge
BOS-4*	Treated sewage effluent point prior to entry into Aimaokatalok (Spyder) Lake	BOD_5, TSS, Oil and Grease (visual), Fecal Coliforms, pH	Monthly during periods of discharge
		D	Daily during periods of discharge
BOS-5	Effluent from the Bulk Fuel Storage Facility prior to release to a location approved by an Inspector	TPH, PAH, BTEX, pH, Electrical Conductivity, Nitrate-Nitrite, Oil and Grease, Total Phenols, Total Alkalinity, Total Hardness, Calcium, Magnesium, Potassium, Sodium, Sulphate & Chloride, Total As, Cd, Cu, Cr, Fe, Pb, Hg, Ni, Se, and Zn.	Once before any discharge, monthly when discharging onto the tundra

SNP Station	Description	Monitoring Parameters	Frequency
		D	Daily during periods of discharge
BOS-6*	Effluent from the Landfarm Treatment Facility prior to release	TPH, PAH, BTEX, pH, TSS, Electrical Conductivity, Nitrate-Nitrite, Oil and Grease, Total Phenols, Total Alkalinity, Total Hardness, Calcium, Magnesium, Potassium, Sodium, Sulphate & Chloride, Total As, Cd, Cu, Cr, Fe, Pb, Hg, Ni and Se.	Once before any discharge, monthly when discharging onto the tundra
		D	Daily during periods of discharge
BOS-7*	Runoff from the temporary storage of hydrocarbon contaminated soils prior to discharge onto the tundra	TPH, PAH, BTEX, pH, TSS, Electrical Conductivity, Nitrate-Nitrite, Oil and Grease, Total Phenols, Total Alkalinity, Total Hardness, Calcium, Magnesium, Potassium, Sodium, Sulphate & Chloride, Total As, Cd, Cu, Cr, Fe, Pb, Hg, Ni, Se and Zn.	Once before any discharge, monthly when discharging onto the tundra
		D	Daily during periods of discharge
BOS-8	Seepage/runoff from the ore stockpiles and camp pad, monitored on the tundra to the east of the ore stockpiles	pH, Sulphate & Chloride, Electrical Conductivity, TSS, Total Ammonia, Total As, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo, Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Initially during spring thaw and monthly during periods of observed flow
BOS-9	Portal decline, surface water runoff discharged to onto the tundra West of Portal	pH, Sulphate & Chloride, Electrical Conductivity, TSS, Total Ammonia, Total As, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo, Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Once before any discharge
BOS-10*	Underground Mine Water Sumps pumped from Underground	pH, Sulphate & Chloride, Electrical Conductivity, TSS, Total Ammonia, Total As, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo, Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Three times a year, during periods of water inflow
		D	Daily during periods of discharge

SNP Station	Description	Monitoring Parameters	Frequency
Drill Sites	Under-ice sampling before and after drilling	pH, TSS, Electrical Conductivity, Total Trace Metals for a minimum of the following elements: As, Al, Sb, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Li, Mn, Mo, Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Before and after on-ice drilling
	Water intake from all sources	D	Daily during periods of discharge

Figure C1. 2BB-BOS1727 Sample Stations Locations



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QUALITY ASSURANCE AND QUALITY CONTROL PLAN

HOPE BAY, NUNAVUT

Module D: 2BB-MAE1727

Conformity Table

Licence	Part	Item	Topic	Report Section
2BB-MAE1727	J	14	The Licensee shall submit to the Board for review within 60 (sixty) days prior any major monitoring takes place, a Quality Assurance and Quality Control Plan, prepared in consultation with the accredited laboratory conducting the analysis. The Plan shall include a cover letter from the accredited laboratory confirming approval of the Plan for analysis to be performed under this Licence. The Plan shall be developed in accordance with current Standard Methods and the 1996 Quality Assurance and Quality Control Guidelines for Use by Class “A” Licensees (INAC).	
		15	The Licensee shall annually review the approved Quality Assurance/Quality Control plan and modify it as necessary. Proposed modifications shall be submitted to an accredited laboratory for approval.	
		16	All sampling, sample preservation and analyses shall be conducted in accordance with methods prescribed in the current edition of Standard Methods for the Examination of Water and Wastewater, or by such other methods approved by the Board in writing.	
		17	All analyses shall be performed in a laboratory accredited according to ISO/IEC Standard 17025. The accreditation shall be current and in good standing.	

D1 Introduction

The Type B Water Licence No. 2BB-MAE1727 issued to Agnico Eagle by the Nunavut Water Board (NWB) details the sampling and analysis requirements for the SNP program.

D2 SNP Sampling Stations

Table D1 summarizes the sampling stations, sampling frequency and monitoring parameters required as part of the Surveillance Network Program for water licence 2BB-MAE1727. The locations of these monitoring stations have not yet been established as work at Madrid under this licence. Work at the Madrid North site is monitored under water licence 2AM-DOH1335. Locations of these monitoring stations as approved by the Inspector will be provided with the next version of this plan. Proposed locations for monitoring stations MAE-14, MAE-15 and MAE-16 are illustrated in Figure D1 below.

Table D1. 2BB-MAE1727 Sample Stations, Sample Frequency and Analytical Parameters

SNP Station	Description	Monitoring Parameters	Frequency
MAE-01*	Madrid North, Freshwater intake at Windy Lake	D	Daily during periods of pumping
MAE-02*	Madrid South, Freshwater intake at Patch Lake	D	Daily during periods of pumping
MAE-03*	Freshwater intake at other Lakes	D	Daily during periods of pumping
MAE-04*	Madrid North Pollution Control Pond (PCP) Water at the point of discharge	pH, TSS, Electrical Conductivity, Oil and Grease, Total Ammonia, Nitrate-Nitrite, Total Phenols, Total Alkalinity, Total Hardness, Chloride, Sulphate, Magnesium, Sodium, Calcium, Potassium, Total As, Cd, Cu, Cr, Fe, Pb, Hg, and Ni	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge
MAE-05*	Madrid South Pollution Control Pond No.1 Water at the point of discharge	pH, TSS, Electrical Conductivity, Oil and Grease, Total Ammonia, Nitrate-Nitrite, Total Phenols, Total Alkalinity, Total Hardness, Chloride, Sulphate, Magnesium, Sodium, Calcium, Potassium, Total As, Cd, Cu, Cr, Fe, Pb, Hg, and Ni	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge

SNP Station	Description	Monitoring Parameters	Frequency
MAE-06*	Madrid South Pollution Control Pond No.2 Water at the point of discharge	pH, TSS, Electrical Conductivity, Oil and Grease, Total Ammonia, Nitrate-Nitrite, Total Phenols, Total Alkalinity, Total Hardness, Chloride, Sulphate, Magnesium, Sodium, Calcium, Potassium, Total As, Cd, Cu, Cr, Fe, Pb, Hg, and Ni	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge
MAE-07*	Madrid North Fuel Storage Area Water Sump	pH, TSS, Sulphate, Chloride, Electrical Conductivity, Oil and Grease, Total Ammonia, BTEX, Total Arsenic, Total Lead, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge
MAE-08*	Madrid North Fuel Transfer Station Water Sump	pH, TSS, Sulphate, Chloride, Electrical Conductivity, Oil and Grease, Total Ammonia, BTEX, Total Arsenic, Total Lead, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge
MAE-09*	Madrid South Fuel Storage Area Water Sump	pH, TSS, Sulphate, Chloride, Electrical Conductivity, Oil and Grease, Total Ammonia, BTEX, Total Arsenic, Total Lead, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge

SNP Station	Description	Monitoring Parameters	Frequency
MAE-10*	Madrid South Fuel Transfer Station Water Sump	pH, TSS, Sulphate, Chloride, Electrical Conductivity, Oil and Grease, Total Ammonia, BTEX, Total Arsenic, Total Lead, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge
MAE-11*	Quarry G Contact Water Sump	pH, TSS, Sulphate, Chloride, Electrical Conductivity, Total Ammonia, Total Arsenic, Total Nickel, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge
MAE-12*	Quarry H Contact Water Sump	pH, TSS, Sulphate, Chloride, Electrical Conductivity, Total Ammonia, Total Arsenic, Total Nickel, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge
MAE-13*	Quarry I Contact Water Sump	pH, TSS, Sulphate, Chloride, Electrical Conductivity, Total Ammonia, Total Arsenic, Total Nickel, Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Once, prior to every discharge onto the tundra
		D	Daily during periods of discharge
MAE-14*	Windy Lake immediately downgradient of the Pollution Control Pond Discharge	Chloride, Electrical Conductivity, Total Dissolved Solids (TDS)	Once prior to each discharge; and a maximum of two weeks post discharge
MAE-15*	Patch Lake immediately downgradient of the Pollution Control Pond Discharge	Chloride, Electrical Conductivity, Total Dissolved Solids (TDS)	Once prior to each discharge; and a maximum of two weeks post discharge

SNP Station	Description	Monitoring Parameters	Frequency
MAE-16*	Wolverine Lake immediately downgradient of the Pollution Control Pond Discharge	Chloride, Electrical Conductivity, Total Dissolved Solids (TDS)	Once prior to each discharge; and a maximum of two weeks post discharge
Drill Sites	Under-ice sampling before and after drilling	pH, TSS, Electrical Conductivity, Trace Arsenic, Trace Mercury Total Trace Metals for a minimum of the following elements: Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo, Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Before and after on-ice drilling
	Water intake from all sources	D	Daily during periods of pumping
Mine Sumps*	Water from Madrid South Underground Mine Water Sumps	Total Dissolved Solids, pH, Electrical Conductivity, Chloride, Total Ammonia and Nitrate, Alkalinity, Sulfate, Trace Metals for a minimum of the following elements: As, Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo, Ni, Se, Sn, Sr, Tl, Ti, U, V, Zn	Three times per year during periods of Water inflow

Figure D1. 2BB-MAE1727 Sample Stations Locations

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QUALITY ASSURANCE AND QUALITY CONTROL PLAN

HOPE BAY, NUNAVUT

Module E: 2AM-BOS1835

Conformity Table

Licence	Part	Item	Topic	Report Section
2AM-BOS1835	B	13	The Licensee shall, for all plans submitted under this Licence, implement the plan as approved by the Board in writing. Any changes to the plans deemed significant shall be considered as an amendment to the plan(s) or as a modification and must be submitted to the Board for approval in writing. The Board has approved under this Water Licence 2AM-BOS1835, the following plans for implementation under the relevant sections in the Licence: *q. Quality Assurance and Quality Control Plan (January 2017)*	
	I	3	The Licensee shall undertake the Monitoring Program provided in the Tables 1 and 2 of Schedule I. The Licensee shall, in consultation with an Inspector, establish the locations and GPS coordinates for all Monitoring Program stations.	Table E1
		14	The Licensee shall annually review the approved Quality Assurance and Quality Control Plan and modify the Plan as necessary. Proposed changes shall be submitted to an Accredited Laboratory for approval.	Section 1.4
		15	All analyses shall be conducted as described in the most recent edition of “Standard Methods for the Examination of Water and Wastewater” or by other such methods approved by an Analyst.	Sections 2 and 3
		16	All compliance analyses shall be performed in an accredited laboratory according to ISO/IEC Standard 17025. The accreditation shall be current and in good standing.	Section 5

E1 Introduction

The Type A Water Licence No. 2AM-BOS1835 issued to Agnico Eagle by the Nunavut Water Board (NWB) details the sampling and analysis requirements for the SNP program.

E2 SNP Sampling Stations

Table E1 summarizes the sampling stations, sampling frequency and monitoring parameters required as part of the Surveillance Network Program for water licence 2AM-BOS1835. The locations of these monitoring stations have not yet been established as work at Boston under this licence has not yet commenced. Locations of these monitoring stations as approved by the Inspector will be provided with the next version of this plan.

Table E1. 2AM-BOS1835 Sample Stations, Sample Frequency and Analytical Parameters

SNP Station	Description	Phase	Monitoring Parameters	Frequency during Operations and any time after initial deposit of Tailings to the TMA
BMS-1	Contact Water Pond #1 and #2	Construction, Operations, Care and Maintenance	G, N1, MT and Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, and Total metals by ICP-MS, D	Sampled twice annually; Weekly water levels
BMS-2	Surge pond at intake to Contact Water Treatment Plant	Construction, Operations, Care and Maintenance, Closure	G, N1, N2, MT, and TDS, Cl, Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-K, T-Mo, T-Mg, T-Na, T-Se, T-Tl, T-Radium 226, HC, D	Sampled monthly during discharge periods; Weekly water levels
BMS-3	Discharge from Contact Water Treatment Plant	Construction (upon Effluent release), Operations, Care and Maintenance, Closure	G, N1, N2, MT, and TDS, Cl, Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-K, T-Mo, T-Mg, T-Na, T-Se, T-Tl, T-Radium 226, D, AT	Sampled weekly during discharge periods and prior to discharge
BMS-4	Reclaim line from TMA Contact Water Pond	Construction, Operations, Care and Maintenance, Closure	G, N1, N2, MT, and TDS, Cl, Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-K, T-Mo, T-Mg, T-Na, T-Se, T-Tl, HC, D, Fecal coliform	Sampled monthly during reclaim periods; Weekly water levels
BMS-5	Non-contact Water Pond	Construction, Operations, Care and Maintenance	G, N1, MT and Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, and Total metals by ICP-MS, D	Sampled annually; Water levels after large inflow events
BMS-6	Fresh Water intake at Aimaokatalok Lake	Construction, Operations, Care and Maintenance, Closure	G, N1, N2, MT, and Free CN, Total CN, T-Ag, T-Ca, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, T-Tl, and Total Oil and Grease, Cl, D	Sampled monthly during active pumping periods

SNP Station	Description	Phase	Monitoring Parameters	Frequency during Operations and any time after initial deposit of Tailings to the TMA
BMS-7	Landfill Sump	Construction, Operations, Care and Maintenance, Closure	G, MT and Total Ammonia-N, Total Sulphate, Total and Free CN, Total Oil and Grease, D	Annually. Once prior to every discharge onto the tundra
BMS-8	Discharge of treated Sewage	Construction, Operations, Care and Maintenance, Closure	G, B, and Total Oil and Grease, D	Sampled monthly during active pumping periods
BMS-9	Landfarm Sump	Construction, Operations, Care and Maintenance, Closure	G, HC, Total Ammonium, Total Lead, D	Annually. Once prior to every discharge onto the tundra
BOS-10	Site runoff from sediment controls during construction	Construction	TSS or Turbidity	Daily during periods of discharge
BMS-11	Discharge from the Boston Fuel storage and containment sumps	Construction, Operations, Care and Maintenance, Closure	G, HC, Total Pb	Annually. Once prior to every discharge onto the tundra
			D	Daily during periods of pumping

HOPE BAY PROJECT QUARRY MANAGEMENT PLAN

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HOPE BAY, NUNAVUT

MARCH 2022

Hope Bay Project Quarry Management Plan

Plain Language Overview:

This Plan describes the management and monitoring requirements for quarries at the Hope Bay Project. Construction of many of the facilities at the Hope Bay Project site require rock for fill material. This rock is to be sourced from various approved quarry sites. Quarry material that will be used for construction is considered to have a low potential for acid rock drainage and metal leaching. Any quarry rock that is unsuitable for use as construction material will be placed as backfill in an underground mine. After waste rock has been exhausted as a source of mine backfill, quarry rock will be required for structural support underground and will be used as a source of mine backfill. The quarrying, infrastructure and road construction activities consist of drilling, blasting, mucking crushing, haulage to usage locations (e.g., the advancing road limit), end dump and levelling. Each activity is to be conducted in accordance with this Plan and the various water licenses for the specific sites.

Hope Bay, Nunavut

Publication Date: March 2022

Hope Bay Project
c/o #18 Yellowknife Airport
100 McMillan Drive
Yellowknife, NT X1A 3T2
Phone: 867-873-4767
Fax: 867-766-8667

Revisions

Revision #	Date	Section	Changes Summary	Author	Approver
1	April 2010	Throughout		SRK	HBML
2	December 2014	Throughout	Inclusion of Quarries 2, 3 and 4. Update to license requirements. TMAC as current licensee for the Hope Bay region.	SRK	TMAC
3	February 2017	Throughout	Changes to document structure for operational suitability and efficiency	TMAC with contributions from SRK	TMAC
4	November 2017	Throughout	Transfer to new template. Inclusion of Phase 2 quarries, quarry rock use as mine backfill and identification of quarries not suitable for use as construction (and to be used as mine backfill at Madrid North or Boston).	TMAC with contributions from SRK	
5	March 2022	Throughout	Transferred to AEM template, updated Roles and Responsibilities and inclusion of wildlife and noise monitoring during blasts.	AEM	AEM

Contents

Tables

Attachments

Glossary

Term	Definition
Agnico	Agnico Eagle Mines Limited
AN	ammonium nitrate
ANFO	ammonium nitrate + fuel oil
ARD	acid rock drainage
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
ESR	Environmental and Social Responsibility
ICP-MS	Inductively coupled plasma mass spectrometry
KIA	Kitikmeot Inuit Association
ML	metal leaching
NIRB	Nunavut Impact Review Board
NP/AP	Neutralizing potential to acid generating potential
NWB	Nunavut Water Board
PAG	Potentially acid generating
QA/QC	Quality Assurance and Quality Control
SNP	Surveillance network program
TDS	Total dissolved solids
TIA	Tailings Impoundment Area
TMAC	TMAC Resources Inc
WSCC	Workers Safety and Compensation Committee

1 Introduction

The Hope Bay Project (the Project) is a gold mining and milling undertaking of Agnico Eagle Mines Limited (Agnico). The Project is located 705 km northeast of Yellowknife and 153 km southwest of Cambridge Bay in Nunavut Territory, and is situated east of Bathurst Inlet. The Project comprises of three distinct areas of known mineralization plus extensive exploration potential and targets. The three areas that host mineral resources are Doris, Madrid, and Boston.

The Project consists of two phases: Phase 1 (Doris project), which is currently being carried out under an existing Water Licence, and Phase 2 (Madrid-Boston Project) which is in the environmental assessment and water licencing stage. Phase 1 includes mining and infrastructure at Doris only, while Phase 2 includes mining and infrastructure associated with Madrid and Boston located approximately 10 and 60 km due south from Doris, respectively.

This Hope Bay Project Quarry Management Plan (the Plan) has been prepared by Agnico as part of the water licencing stage of Phase 2 of the Project and in accordance with various existing water licences and the Kitikmeot Inuit Association (KIA) Framework Agreement held by Agnico associated with developments throughout the Hope Bay region.

The Plan is intended primarily for use by Agnico and its contractors to ensure that best practices are followed for minimizing potential environmental impacts and environmental liabilities with respect to *quarry rock*, and that the conditions of water licences and KIA agreement are met.

This Plan is structured in a manner such that one document pertaining to *quarries* is approved and implemented across all Agnico's Hope Bay Project sites, while still addressing site and licence-specific needs. The main document outlines Agnico's approach to *quarr*ies as it pertains to all of Agnico's Hope Bay developments. Subsequent updates will be included if new quarries are proposed with specific management requirements. This is intended for consistency and efficiency across operations and compliance management.

1.1 Objectives

Quarry rock for the Hope Bay Project will be used for the construction of infrastructure and roads, and also as structural backfill in selected underground mines. The scope of this Plan includes 35 quarries, of which 11 are approved quarry sites and 24 are proposed quarries as part of Madrid-Boston Project.

The construction of many of the facilities at the Hope Bay Project site require rock for fill material. Material from quarries considered to have a low potential for acid rock drainage (ARD) generation and low sulphur content is suitable to be used as construction material. Quarries will also be developed for use as as structural backfill at Madrid North and Boston once all mine rock has been exhausted. Quarry rock that is unsuitable for use as construction material will only be used as mine backfill.

The quarrying, infrastructure and road construction activities consist of drilling, blasting, mucking crushing, haulage to usage locations (e.g., the advancing road limit, to the waste rock stockpile), end dump and levelling. The objective of this Plan is to outline how these activities will be managed and monitored. Furthermore, this Plan documents if rock from each quarry is geochemically suitable for use as construction material or as mine backfill. Management and material handling of quarry rock to be used as backfill is described in the Madrid-Boston Project, Waste Rock, Ore and Mine Backfill Management Plan. In brief, quarry rock that will be placed as backfill will be placed on the waste rock stockpile pad before being transferred underground. The monitoring of all quarry rock used as mine backfill is docmented in this Plan.

1.2 Quarry Locations

The quarries currently approved for use as construction material are listed and briefly described in Table 1.1. Table 1.2 lists the proposed Madrid-Boston Project quarries and summarizes the geochemical suitability of each location for construction. Maps presenting all quarry locations are presented in Attachment 1. Approved quarry locations are outlined in Figures A-1 to A-6 in solid blue line.

Table 1.2 also notes which quarries require additional test work prior to development (discussed further in Section 2.1.1).

Table 1.1: Location and Status of Approved Hope Bay Quarries[1]

Quarry	Description
1	Located on the eastern side of the Roberts Bay waste management facility. Site is currently used for the Fuel Tank Farm.
2	Located west of the Doris Camp.
3	Located east of Tail Lake. Material will be required for construction of the South Dam.
4	Doris Camp is located on the former quarry site.
5	Located at the south apron of the Doris North Airstrip Expansion.
A	Located at the northern end of the Doris Windy Road. Site is currently used for storage of explosives.
B	Located on the Doris Windy Road. Site has been proposed for storage of explosives.
D	Located on the Doris-Windy Road. Site has been approved for construction of a new camp.
G	Located on the proposed Madrid South All-weather Road.
H	Located on the proposed Madrid South All-weather Road at the Madrid South Portal.
I	Located at Proposed Doris Central Vent Raise.

Table 1.1.2: Location and Status of Proposed Madrid-Boston Project Quarries (SRK 2017b)

Quarry ID	Quarry Rock Suitable for Construction?	Confirmatory Test Work Required Prior to Use as Construction Material	Description
s	✓		Located east of Patch Lake
L	✓		Along Madrid-Boston all-weather road
M	✓		Along Madrid-Boston all-weather road
N	✓		Along Madrid-Boston all-weather road
O	✓	✓	Along Madrid-Boston all-weather road
P	✓		Along Madrid-Boston all-weather road
Q	✓	✓	Along Madrid-Boston all-weather road
R	✓		Along Madrid-Boston all-weather road
S	✓	✓	Along Madrid-Boston all-weather road
T	✓	✓	Along Madrid-Boston all-weather road
U	✓	✓	Along Madrid-Boston all-weather road
V	✓	✓	Along Madrid-Boston all-weather road
W	Suitable as mine backfill. Silicate mineralogical characterization recommended to assess suitability for construction.*	✓	Along Madrid-Boston all-weather road
X	✓	✓	Along Madrid-Boston all-weather road
Z	Possible*	✓	Along Madrid-Boston all-weather road
AA	✓	✓	Along Madrid-Boston all-weather road
AB	✓	✓	Along Madrid-Boston all-weather road
AD	Suitable as mine backfill only		Located on the proposed Boston processing plant pad
AE	✓	✓	Located on the proposed Roberts Bay cargo dock
AF	✓	✓	Located on the proposed Roberts Bay tank farm
AG	✓	✓	Along all-weather road between Madrid and Tailings Impoundment Area (TIA) South Dam
AH	✓	✓	Located on the proposed Madrid North portal
AI	✓	✓	Located on the proposed Madrid North vent raise
AJ	✓	✓	Along Madrid-Boston all-weather road

Notes:
(1) ✓ confirms column heading.
(2) *Additional geochemical testwork required to demonstrate suitability as construction rock

1.3 Relevant Legislation and Guidance

Worker health and safety, and operational components of the Plan are part of Agnico's mine plan and come under the jurisdiction of the Nunavut Mines Inspector. Environmental elements of the Plan come under the jurisdiction of the Nunavut Water Board (NWB), the Nunavut Impact Review Board (NIRB) and other regulatory agencies.

Implementation of the Plan in part should be considered alongside the relevant legislation listed in Table 1.3.

Table 1.3: List of federal and territorial regulations governing the Hope Bay Project Quarry Management Plan

Regulation	Year	Governing Body	Relevance
Workers Safety and Compensation Commission (WSCC) Chief Mines Inspector as per Mine Health and Safety Act, and its associated Regulations	1995	Government of Nunavut	Includes underground disposal management

1.4 Related Documents

Table 1.4: List of documents related to the Hope Bay Project Quarry Management Plan

Document Title	Year	Relevance
Hope Bay Project Groundwater Management Plan (SRK 2016)	2016a	Includes underground disposal management
Hope Bay Project Waste Rock, Ore and Mine Backfill Management Plan (AEM 2022a)	2022	Includes monitoring of waste rock, ore and mine backfill, including quarry rock backfill management. Geochemical characterization program for using waste rock for construction is outlined.
Quality Assurance and Quality Control Plan (AEM 2022b)	2022	Detailed QA/QC procedures
Hope Bay Project Doris-Madrid Interim Closure and Reclamation Plan, November 2017 (SRK 2017a) Hope Bay Project Boston Conceptual Closure and Reclamation Plan, November 2017 (SRK 2017b)	2017	Includes closure activities

1.5 Plan Management

Revisions to the Plan can be triggered by activities such as changes in the mine plan, operational performance, personnel, or organizational structure, mine ownership, regulatory or social considerations, and life cycle or design philosophy. The Plan is reviewed annually and is revised or updated as necessary in accordance with changing circumstances.

Overall responsibility for the Plan implementation lies with the Maintenance Superintendent. The functional site-based lead for assigning and applying appropriate resources to execute the Plan rests with the Surface Superintendent. The Environmental Manager and Coordinator are responsible for day-to-day execution of activities associated with the Plan.

1.6 Roles and Responsibilities

Table 1.5 shows the roles and responsibilities for the Hope Bay Project Quarry Management Plan.

Table 1.5: Roles and Responsibilities

Role	Responsibilities
Mine General Manager	• Responsible for the management and operations of the quarries and for providing the necessary resources to manage the quarries.
Maintenance Superintendent	• Implementing the Plan; • Providing onsite resources to operate the quarries; • Conducting and documenting regular inspections; • Ensuring that water treatment and discharge activities take place as requested by Environment and Social Responsibility (ESR) and logs of discharge quantities and locations are provided to ESR; and • .
Mining Engineering Superintendent	• Providing the drill and blast designs • Providing input on the modifications in the design and the operation of the quarries
Environmental Manager	• Updating the Plan; • Providing the necessary resources for completing the water sampling programs; • Liaise with Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) inspector prior to allow water discharge; • Coordinate: - - Construction Monitoring Report; - Waste Rock and Quarry Monitoring Report; - Construction Summary Report; - Monthly Monitoring Report; and - Annual Geotechnical Inspection Report
Environmental Coordinator	• Ensuring water sampling programs are completed as needed; • Ensuring internal records are kept of the quantities of rock excavated from the quarries; • Weekly visual inspections of active quarries; • Conduct or facilitate seep and operational quarry sampling programs; • Keeping records of onsite analysis, observations, photographs, water discharge activities and laboratory analysis; and • Conducting monthly and annual regulatory reporting as required
Geologist	• Weekly visual inspections of the quarry face; and keeping records of inspection data sheets and photographs. • Providing onsite resources to conduct geological/geochemical inspections; • Conduct quarry sampling programs

2 Management Issues

2.1 Pre-Development

2.1.1 Quarry Material Characterization

Geochemical characterization studies of all approved quarry sites for the Hope Bay Project (Table 1.1) have been presented in AMEC (2005), and SRK (2007, 2008, 2010, 2011, 2014 and 2017c). Based on these geochemical characterization programs, the material from the approved quarries (Table 1.1) is considered to have a low potential for ARD generation based on NP/AP ratios and low sulphur content. Accordingly, material from these quarries is suitable to be used as construction material.

The geochemical assessment of the proposed Madrid-Boston Project quarries (Table 1.2) was based on results of the 2011 quarry geochemical characterization program and/or a comparison to the existing quarry rock data set in the context of regional belt-wide geology. The results of the assessment are presented in Table 1.2 and are summarized as follows:

- Six quarries (Quarry J, L, M, N, P, and R) are considered to have a low potential for ARD generation based on NP/AP ratios and low sulphur content. Accordingly, material from these quarries is suitable to be used as construction material. In Attachment 1, the boundaries of these quarries are presented as green dashed lines.
- Fifteen quarries (Quarry O, Q, S, T, U, V, X, AA, AB, AE, AF, AG, AH, AI, and AJ) are considered to have a low potential for ARD based on the regional geology of the quarry rock in comparison to the belt-wide quarry rock geochemical database. These quarries are suitable for use as construction rock but a confirmatory sampling program is required prior to development. The boundaries of these quarries are presented as purple dashed lines in Attachment 1.
- Based on the existing data, two quarries (Quarry W and Z) are currently suitable as mine backfill material only, however additional test work may demonstrate that the quarry rock is suitable for construction. The boundaries of these quarries are presented as pink dashed lines in Attachment 1.
- Quarry AD (denoted by red dashed lines in Attachment 1) contains material that is not suitable for construction due to high risk of ARD and has been designated for use as mine backfill only. The management of quarry rock not suitable for use as construction material is discussed in Section 2.2.1.

2.1.2 Archaeology Survey

Archaeological surveys of the quarries and the all-weather road routes were conducted. Based on the results of the survey, buffers were established to ensure that the development of quarries and all-weather roads do not impact any archaeological sites.

Management Action

Agnico provides training on “chance-find” procedures to relevant field staff to ensure that any archaeological sites that were not identified during pre-development surveys are recognized and treated in an appropriate manner i.e., in accordance with the Heritage Resources Protection Plan (TMAC 2016).

2.1.3 Setback Distance Requirements

Shock waves from blasting in close proximity to fish bearing water have the potential to cause detrimental shock wave effects on fish. Guidelines for the use of explosives in or near Canadian fisheries waters (Wright and Hopky 1998) provide specific methods for calculating the setback distance required to stay below this threshold based on different amounts of explosive and the type of substrate.

Management Action

To ensure that there are no detrimental effects on fish from quarry activities, these guidelines will be used to establish final setback distances for each of the quarries.

2.2 Operations

2.2.1 Quarries Classified as High Risk for ARD

The construction of mine infrastructure may necessitate the development of quarries with quarry rock that is unsuitable for use as construction material. Table 2-1 lists all quarries that are currently designated as not geochemically suitable as construction material. Material from quarries listed in Table 2.1 is to be managed as mine backfill, which entails placing the rock on the designated waste rock stockpile at either Madrid North or Boston. For Quarry W and Z, these quarries can potentially be used for construction, subject to further geochemical characterizaiton as outlined in SRK (2017c). Monitoring of quarry rock that would be used as structural backfill is outlined in Section 3.1 and is support of the objectives of the mine backfill monitoring program (AEM 2022a).

Table 2.1: Quarries designated for use as mine backfill

Quarry	Description	Potential for Use as Construction Material
AD	In proposed location of the Boston processing plant; located in mineralized area	None
W	Along Madrid-Boston all-weather road	Could potentially be used as construction material, subject to additional characterization. Silicate mineralogical characterization recommended.
Z	Along Madrid-Boston all-weather road	Could potentially be used as construction material, subject to additional characterization.

2.2.2 Residual Explosives

The majority of the rock fill will be blasted using an Ammonium Nitrate (AN) and fuel oil mixture blasting product (ANFO).

The potential for wet-holes in the quarries is considered to be low due to the land-based nature of the quarry sites and the presence of permafrost below the outcrops. The potential for wet holes will be assessed at the time of drilling and again at the time of loading each blast hole.

Management Action

The blaster responsible for loading and firing the drilled pattern begins the loading process by walking the entire pattern and checking the actual drilled depth of each hole versus the plan and noting any conditions such as water in each hole. This information is recorded on the blast pattern record sheet required by regulation to determine the amount and type of explosive and delay detonators required in each hole.

The presence of water in any drill hole requires one of several approaches to be taken to ensure proper and complete explosive detonation. ANFO designed for proper detonation in wet holes is available and can be used. Alternatively, dewatering the hole using a down hole dewatering pump and truck so that a poly borehole liner can be lowered into the hole and ANFO poured inside the bag is another approach which can be implemented.

In the event that an incomplete detonation of the product occurs, it is likely that an orange colour smoke plume would be observed rising from the affected area. The blaster is required by the regulations to inspect the blasted area, make note of blast holes that may have experienced incomplete detonation and mark those locations with flagging.

Information from the blaster's inspection will be noted in the blast pattern log and the daily operations shift log communicated to all field supervision personnel. The flagged off area will remain until the excavation equipment advances to within half the hole spacing distance at which time the suspect material would be more closely inspected for the presence of ANFO.

2.2.3 Blast Management

The quarry sites have been deemed suitable for use provided that the archaeological site buffer zone is kept intact; therefore, due care will be taken in order to maintain the integrity of these sites.

Management Action

The blasts will be designed to shoot away from the potentially impacted archaeological sites. Prior to any blast, the rock face will be cleaned to minimize the potential of fly rock.

Single hole delays will also be used for maximum shot placement away from any identified archaeological sites and row timing will be increased to prevent back break and ensure all rock is moving in a forward motion away from the archaeological sites.

As an additional precaution, the blast limits will be set 60 m from the recommended 30 m buffers zones located in the quarries. This extra buffer will offer further protection from any possible disturbance to archaeological sites.

2.2.4 Precipitation/ Snow Melt Water Management

The development of each quarry will proceed in a manner that, to the extent possible, ensures that all water entering the quarry as a result of precipitation or snow melt is retained within the quarry boundaries. Generally, this will be accomplished by ensuring that the quarry floors are sloped toward a natural low area of the quarry and, if required, the creation of a quarry sump to collect the waters and settle out suspended solids.

In the event that the quarry sump requires pumping, a sample of the ponded water will be collected, preserved in the appropriate manner, and submitted to an accredited laboratory for the analysis of specified parameters. These parameters are outlined in the relevant Water Licences. Table 2-2 presents the quarry effluent quality limits as stated in Part D Item 18 of Water Licence 2BE-HOP1222. In addition to the parameters listed in Table 2-2, the following parameters shall be analyzed as per Part J Item 6b of Water Licence 2BE-HOP1222; Total Sulphate, Nitrate, Alkalinity, ICP Metals analysis and Reduction potential (Eh).

Additionally, notification will be provided to the Inspector, at least ten (10) days prior to the planned pumping (as per Part D, Item 16 of 2BE-HOP1222). The notification will include the volume proposed for discharge and the discharge location.

Management Action

Following receipt of the laboratory results, water meeting the discharge requirements (Table 2-2) will be discharged. Section 5.1.5 describes the management action if water does not meet the discharge limits.

Care will be taken not to disturb settled solids in the bottom of the sump and pumping of the sump will only take place when conditions are suitable. Care will also be taken to ensure that discharged water does not enter fish bearing waters and that the pump discharge is positioned in a manner that minimizes erosion and siltation of the area downstream of the discharge.

Table 2.2: Quarry Effluent Quality Limits (Part D Item 18 of Water Licence 2BE-HOP1222)

Parameter	Maximum Average Concentration	Maximum Concentration in Any Grab Sample
pH	6.0 to 9.0	9.0
Electrical Conductivity	500 µS/cm	500 µS/cm
Total Ammonia	2 mg/L	4 mg/L
Total Suspended Solids	15 mg/L	30 mg/L
Oil and Grease	5 mg/L and no visible sheen	10 mg/L and no visible sheen
Total Aluminum	1.0 mg/L	2.0 mg/L
Total Arsenic	0.05 mg/L	0.10 mg/L
Total Copper	0.02 mg/L	0.04 mg/L
Total Iron	0.30 mg/L	0.60 mg/L
Total Lead	0.01 mg/L	0.02 mg/L
Total Nickel	0.05 mg/L	0.10 mg/L
Total Zinc	0.01 mg/L	0.02 mg/L

2.2.5 Dust Management

The major source of dust generation during the operations of the quarries will be in the vicinity of the crusher while it is operating.

Management Action

Dust suppression, where required, will consist of using water as permitted by the relevant Water Licence. A record of the volume of water used for this purpose will be maintained.

2.2.6 Equipment Re-fuelling

Re-fuelling of equipment operating in one of the active quarries will be conducted in a manner that will ensure that any spill of fuel or lubricants is effectively contained within the quarry area and clean-up is easily accomplished. During this activity, all re-fuelling equipment will be equipped with a Spill Kit suitable for the materials being handled and a functioning fire extinguisher suitable for the materials being transferred.

Management Action

In the unlikely event that a spill does occur during re-fuelling activities, clean-up of the spilled material will be initiated immediately and all activities within the quarry suspended until the clean-up is complete. The material will be disposed of in an appropriate manner as per the requirements specified in the Hope Bay Project Spill Contingency Plan (AEM, 2022b).

2.3 Quarry Closure

The quarries will be decommissioned at mine closure upon full utilization of the available materials, when the quarry is deemed no longer required or re-purposed for a different land use by Agnico The quarries will be decommissioned and reclaimed. All vertical faces in the quarries will be scaled. Safety berms will be left in place. The area of each quarry will be inspected by a qualified inspector, to ensure no loaded holes are remaining

Details of the closure activities are available in the relevant Closure and Reclamation Plans.

3 Monitoring and Evaluation

The monitoring and evaluation programs outlined below applies to all quarries and quarry rock regardless of intended use or geochemical characteristics, and includes quarry rock used for construction or mine backfill. The rationale for monitoring of quarry rock that will be used as backfill is presented in the Hope Bay Project, Waste Rock, Ore and Mine Backfill Management Plan (AEM, 2022a).

3.1 Quarry Operations

3.1.1 Quarry Visual Inspection

During quarrying operations, a visual inspection of the quarry face to verify the geological characteristics of the rock will be conducted by a qualified field geologist or geochemist at least once per week. The purpose of the inspection will be to confirm the presence of the expected rock types and that disseminated sulphides only (e.g., not veins) are being exposed and therefore used in construction. A secondary objective of the inspection will be to confirm the absence of any fibrous forms of actinolite in the quarry material.

Prior to the inspection, site personnel will ensure that it is safe to work within the quarry and will inform any vehicle operators as to the location and timing of the inspection work.

The inspector will walk from one side of the quarry around to the other side examining both the surface and the exposed bedding material along the side of the quarry for any anomalous rock types or significant amounts of sulphide. If present, these materials will be examined, described, and located on a map. In addition, at regular 100 metre intervals, the inspector will stop and complete a close inspection of the rocks, breaking open several rock clasts and describing what they see. The results of each inspection will be recorded on data sheets, and reported in the Construction Monitoring Report submitted by March 31 of the year following construction.

3.1.2 Quarry Material Tracking

For each quarry, volumes of material and the intended purpose (construction or backfill) will be recorded. If the quarry rock is used as backfill, the waste rock stockpile on which it was placed will also be recorded.

3.1.3 Quarry Rock Sampling

During quarrying activities, blast material from each active quarry will be collected at two different stages of quarry development per year. During each collection event, a whole rock sample and a sample of the same material sieved to pass a less than 2 mm screen will be submitted to an accredited external lab for sulphur analysis. This sampling method and frequency will result in up to four samples from each active quarry per year. The sample locations will be pre-determined to ensure that they reflect a random selection of the rock fill material used in road construction. In the event that the results return a sulphur value of greater than (>) 0.1 % sulphur, the samples will be subjected to ABA[1] and other confirmatory test work including shake flask extraction tests[2] on a representative subset of sieved samples (-2 mm).

The objective of this program will be to confirm previous rock characterization results and to assess the ARD potential of the fine fraction, which tends to concentrate sulphide minerals. In the case of quarries that will be developed as mine backfill material, a secondary objective is to confirm the geochemical characteristics of the mine backfill.

The results of the analysis will be reported in the Waste Rock and Quarry Monitoring Report (which is referenced in the Construction Monitoring Report) and submitted by March 31 of the year following construction. The report will include a discussion and interpretation of the geochemical data collected.

3.1.4 Quarry Sump Monitoring

After significant precipitation events, the quarry area will be inspected and the water level in the quarry sump assessed. In the event that the quarry sump requires pumping, the procedures or contingencies outlined in Sections 2.2.4 and 5.1.5 of this plan will be followed.

3.1.5 Blast Vibration Monitoring

Guidelines for the use of explosives in or near Canadian fisheries waters (Wright and Hopky 1998) indicate that "*no explosive shall be detonated in or near fish habitat that produces, or is likely to produce, an instantaneous pressure change (i.e., overpressure) greater than 100 kPa (14.5 psi) in the swimbladder of a fish*". Blast vibration monitoring will be undertaken to avoid potential effects when detonation distances approach the recommended setbacks to ensure appropriate vibration thresholds that are protective of fish and vulnerable life stages of fish are maintained.

[1] Paste pH, sulphate by HCl leach, total inorganic carbon, Modified NP and elemental content by aqua regia digestion followed by ICP finish.
[2] MEND (2009) method. Leachate analysis to include pH, EC, SO_4, acidity, alkalinity, chloride, ammonia, and low level dissolved metals.

3.1.6 Wildlife Monitoring

Prior to all blasts, a visual inspection of the quarry and of the surrounding tundra will be carried out by trained environmental personnel to verify that no caribou or muskox are within line of sight, up to 2.8 km, of the quarry high point, as per the Hope Bay Project, Wildlife Mitigation and Monitoring Plan (AEM, 2021a).

If a caribou or muskox is found within the limits established by Agnico, the blast shall be postponed until the caribou or muskox has moved to a distance that is greater than 2.8 km from the quarry or out of the line of sight from the quarry high point.

Should caribou be observed at a distance that is greater than 2.8 km from the blast site, the environment personnel shall conduct behaviour monitoring of the animal during the blast to evaluate how the caribou responds to the blast. Any behaviour monitoring conducted will be reported in the annual Wildlife Mitigation and Monitoring Plan Report, submitted by March 31 of the following year.

The inspector shall inform the blast lead of the all-clear prior to the blast. If the all clear is not given by the environmental personnel, the blast shall be postponed.

3.1.7 Noise Monitoring

During quarry blasts, noise monitoring measurements will be carried out by the environment department or other qualified personnel following methods of the Quarry Blasting Noise Monitoring Standard Operating Procedure (AEM, 2021b). Monitoring will initially be conducted at a distance of 2.8 km and 4 km from the blast site. The aim of these tests being to confirm model prediction and that an overpressure value of 96 L_{peak} dBZ will not be exceeded at 2.8 km from the blast site This monitoring will end once the validity of the model has been confirmed, in consultation with regulators.

3.2 Construction

3.2.1 Infrastructure and All-Weather Roads

Visual Inspections

During all construction activities, a visual inspection by environment personnel will be conducted of the quarries, equipment storage and re-fuelling areas, construction areas and the advancing area of road construction activity at least once per week. The inspection will focus on identification and removal of foreign and/or spilled materials, assessing the extent of erosion and sedimentation resulting from rock placement (particularly during periods of precipitation), the extent of dusting and the transport of dust onto the surrounding tundra.

In addition, an inspection of each watercourse crossing along the all-weather roads throughout the annual ice-free period will be conducted in order to confirm structural integrity, confirm soil and permafrost stability in the immediate area and to confirm that the crossings have been located adequately with respect to the watercourses.

A record of the date, place and results of each inspection will be maintained as will a photographic record of “items of interest” (i.e., dusting, wildlife encounters, spilled material, etc.) identified during the inspection.

3.3 Post-Construction Inspections and Monitoring

3.3.1 Quarry

Visual Inspection

A visual inspection of each mined-out quarry will be completed at least once per year in order to ensure that the site remains safe and no environmental or public health and safety concerns have developed. In the event that potentially acid generating waste rock has been placed in one or more of the mined-out quarries, the area will be inspected to ensure that the 2 meter cover remains intact and that seeps from the material are not in evidence.

In the event that the inspection identifies ponded water within the mined-out quarry in sufficient volume to require pumping, the procedures or contingencies outlined in Section 2.2.3of this Plan will be followed.

Records of the inspections and findings of each will be maintained and reported in the appropriate manner.

3.3.2 Infrastructure and All-Weather Roads

Following completion of the construction of the road and pad areas, an inspection will be conducted by a qualified field geologist or geochemist in order to characterize the rock used in construction and to identify and sample ephemeral seeps occurring through the road construction material. The objective of this program will be to confirm that an environmentally-significant level of metal leaching (ML) is not occurring from the road materials.

In the event that quarry rock from any of the quarries is used in the construction of additional infrastructure, the area in which the rock is used will be incorporated in the ongoing seep and rock sampling program. The monitoring and sampling will be completed in order to ensure that the highest regulated requirement for the management of construction rock is uniformly applied throughout the Hope Bay Belt.

Seep Survey and Sampling

Seep surveys will be conducted during the spring freshet in the year following completion of construction using quarry rock. Details of seep survey monitoring following completion of construction using waste rock are outlined in the Hope Bay Project Waste Rock, Ore and Mine Backfill Management Plan (AEM 2022a).

Seeps will be located by walking along the downstream side of the roads and infrastructure, looking, and listening for signs of flowing water. In low-lying areas where the direction of surface water flow is not evident, both sides of the structure will be inspected. Where surface flows are identified, the upstream side will be inspected to determine whether the flow originates from the upstream side or whether it is likely to originate from within the rock fill material. Most samples will target the latter, more ideal type of seep. However, a selected number (maximum of one location for every 2 km of road) will be collected at locations where there is moderate upstream flow component. In these cases, samples will be collected from both upstream and downstream of the roads.

At a minimum, a water sample will be collected from 10% of the identified ephemeral seeps (regardless of the field measurement values) appropriately preserved and submitted for laboratory analysis.

All the samples collected will be preserved in an appropriate manner, labelled and submitted to an accredited laboratory for analysis of pH, total dissolved solids (TDS), acidity and/or alkalinity, sulphate, total ammonia, nitrate, and a full suite of dissolved metals by inductively coupled plasma mass spectrometry (ICP-MS). The results of the seep survey will be reported in the Waste Rock and Quarry Monitoring Report (which is referenced in the Construction Monitoring Report) and submitted by March 31 of the year following construction. The report will include a discussion of the interpretation of the geochemical data collected.

Infrastructure Inspection and Material Sampling

Rock characterization and sampling will be conducted once construction of the road and pad areas is completed by a qualified field geologist or geochemist to characterize the rock used in construction. The objective of this program is to confirm the geology and geochemistry of the quarry rock, and assess the ARD potential of the fine fraction, which tends to concentrate sulphide minerals.

All infrastructure areas will be visually examined to confirm the geology of the construction material, with an emphasis on rock type and sulphide content. Samples of in situ rock fill will be collected from pre-determined points of the infrastructure (approximately 1 sample per 0.5 kilometres of road, and five samples from each of the pad areas). At each sample location, a rock sample (<1” fraction) will be collected as well as a -2 mm sieved sample when available. The sample locations will be pre-determined to ensure that the samples reflect a random selection of a representative material of the *in situ* rock fill from each quarry used for construction.

All the samples will be submitted to an accredited external lab for sulphur analysis. In the event that the results return a sulphur value of greater than (>) 0.1 % sulphur, the samples will be subject to ABA and shake flask extraction tests on a representative subset of samples, as described in Section 3.1.3. Testing will be completed on both the fines and the bulk sample.

The results will be reported in the Waste Rock and Quarry Monitoring Report (which is referenced in the Construction Monitoring Report) and will include a discussion and interpretation of the geochemical data collected.

3.4 QA/QC Procedures for Water Sampling

Quality assurance and quality control (QA/QC) is a set of operating principles that, if strictly followed during sample collection and analysis, will produce data of known and legally defensible quality.

Sampling procedures include:

- Using clean sampling gloves for each composite sample;
- Cleaning sampling equipment between each composite sample;
- Collecting samples using bottles and jars provided by the laboratory following the instructions provided by the laboratory for each parameter type;
- Labelling sample containers clearly with the sample station, date, time, and analysis requested;
- Keeping samples cool and dark during storage and shipment to the laboratory; and
- Checking field notes for accuracy and completeness at the end of each sampling session.

Detailed QA/QC procedures are available in the Quality Assurance and Quality Control Plan Agnico (2022c).

4 Documentation and Reporting

The following reports will be prepared in accordance with the relevant water licences and the KIA Framework Agreement:

- Annual Construction Monitoring Report;
- Annual Waste Rock, Quarry and Mine Backfill Monitoring Report;
- Construction Summary Reports;
- Monthly Monitoring Report; and
- Annual Geotechnical Inspection Report.

All the aforementioned reports are to be submitted no later than March 31 of the year following construction, with the exception of the Monthly Monitoring Report, which is submitting on a monthly basis.

5 Contingencies

5.1.1 Identification of Inappropriate Quarry Rock

In the unlikely event that the visual inspection identifies potentially acid generation (PAG) rock in a quarry with material designated as suitable for construction, the geologist will "tag" the material for avoidance or removal. If the material is excavated, it will be transported to a waste rock storage area for disposal underground. If this is not possible at the time, the PAG rock will be buried in an active or previously mined-out quarry. If the PAG material is buried, it will be covered with a minimum of 2 metres of rock material that is approved for construction and will be clearly marked as inappropriate for use as construction material. In the quarry stored rock, permafrost is expected to slowly aggrade into the rock fill, slowing the rates of sulphide oxidation substantially, and eventually shutting off seepage pathways. The clean rock cover would act as a thermal blanket to keep the active freeze/thaw zone away from the more reactive rock.

In the unlikely event that the visual inspection identifies fibrous actinolite, the geologist will "tag" the material for avoidance or removal. If the material is excavated, it will be transported to a waste rock storage area for disposal underground. If this is not possible at the time, the material will be buried in one of the previously mined-out quarries and covered with a 1.0 m layer of benign rock and a record of the location maintained.

5.1.2 Inappropriate Construction Material Identified

In the unlikely event that the results of the seep monitoring/sampling program or the road material sampling program indicate the presence of potential ML or ARD further investigations will be undertaken to define the extent and assess the potential impacts of the material. If warranted, and after discussion with the appropriate regulatory agencies, the material will be excavated and hauled to a waste rock storage area or temporarily stored in one of the previously mined-out quarries prior to eventual disposal underground. The quarry stored rock fill will be placed within the quarry and covered with a minimum of 2 m of rock material that is approved for construction and will be clearly marked as inappropriate for use as construction material. Permafrost is expected to slowly aggrade into the rock fill, slowing the rates of sulphide oxidation substantially, and eventually shutting off seepage pathways. The clean rock cover will also act as a thermal blanket to keep the active freeze/thaw zone away from the more reactive rock.

5.1.3 Identification of Un-detonated or High ANFO Residue Areas

Material considered un-detonated or high in ANFO residue, which will contain potentially elevated levels of nutrients (primarily ammonia) will be selectively excavated and hauled to an established waste rock management area with any runoff from the area reporting to Pollution Control Ponds for ultimate disposal in the Tailings Impoundment Area (TIA).

5.1.4 Spill of ANFO

In the unlikely event that a spill of the ANFO occurs during the charging of the holes for blasting, all activities within the quarry will be suspended until the clean-up is complete in accordance with the Hope Bay Spill Contingency Plan (AEM 2022b). The clean-up of the spilled material will be initiated immediately and the material disposed of in accordance with the Explosives Management Plan.

5.1.5 Sump Water Requires Special Handling

In the event that the quarry water does not meet the discharge criteria, an inquiry of the cause of the noted exceedance will be conducted, and appropriate mitigation developed. Any non-compliant water that needs to be discharged would be transported to Contact Water Ponds for management and/or transported directly to the Doris North TIA for disposal or the Boston surge pond.

All compliant and non-compliant monitoring results are summarized in the monthly SNP reports to the NWB and a copy is provided to the Inspector. This monthly report would include details of the disposal of any non-complaint water.

6 References

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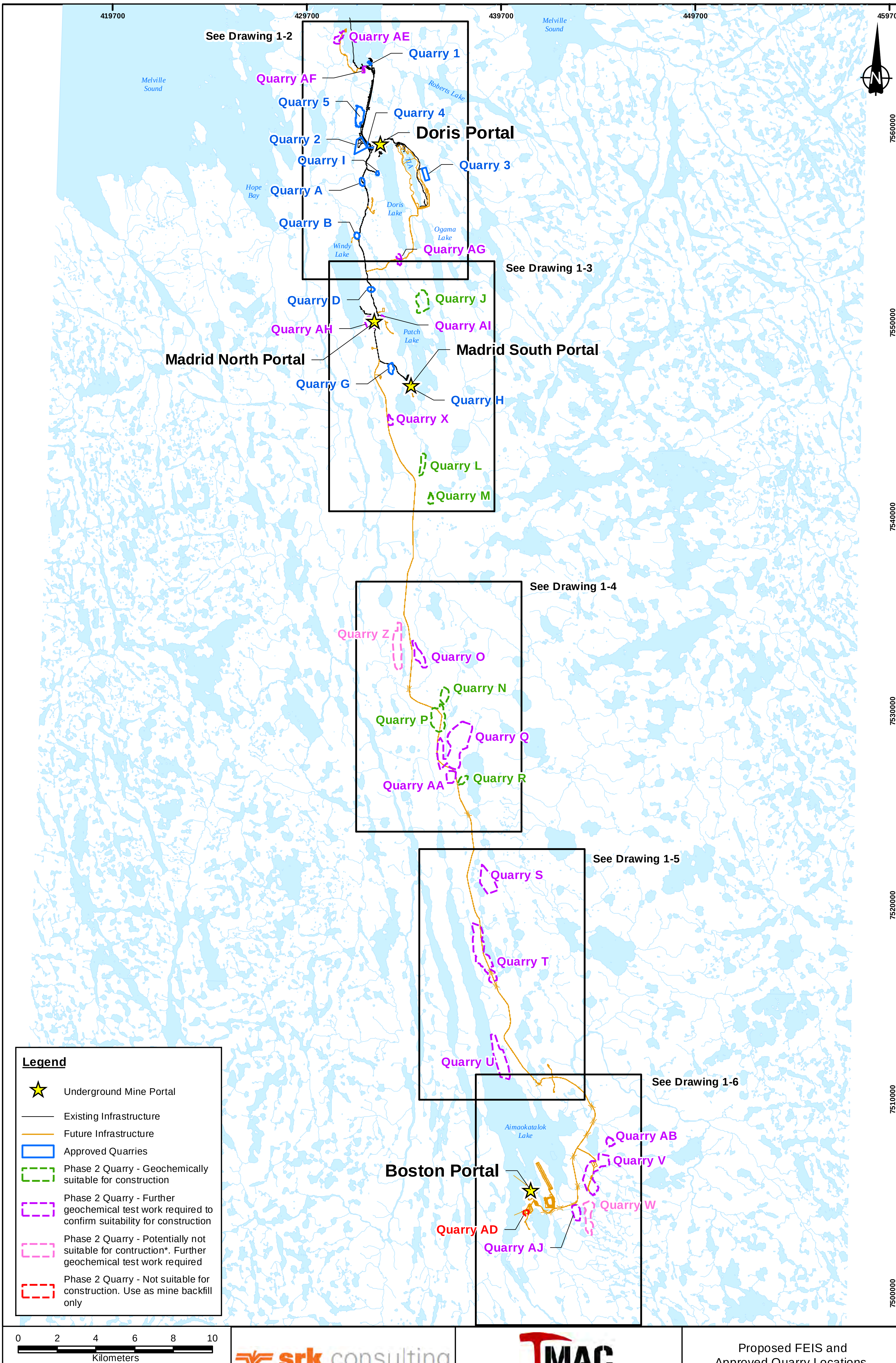
HOPE BAY PROJECT QUARRY MANAGEMENT PLAN

HOPE BAY, NUNAVUT

Attachment 1: Maps



Notes:
1. *Refer to Table 1-2 in the Quarry Management Plan
2. Coordinate System: NAD 1983 UTM Zone 13N
3. Base Topo Data: CanVec, Natural Resources Canada

srk consulting

TMAC RESOURCES

Proposed FEIS and Approved Quarry Locations, Hope Bay Project

Project No: 1CT022.013

Filename: 1CT022.013_Figure_01_FEISQuarries_rev6

HOPE BAY PROJECT

Date:	Approved:	Figure:
Dec 2017	LB/MCN	A-1

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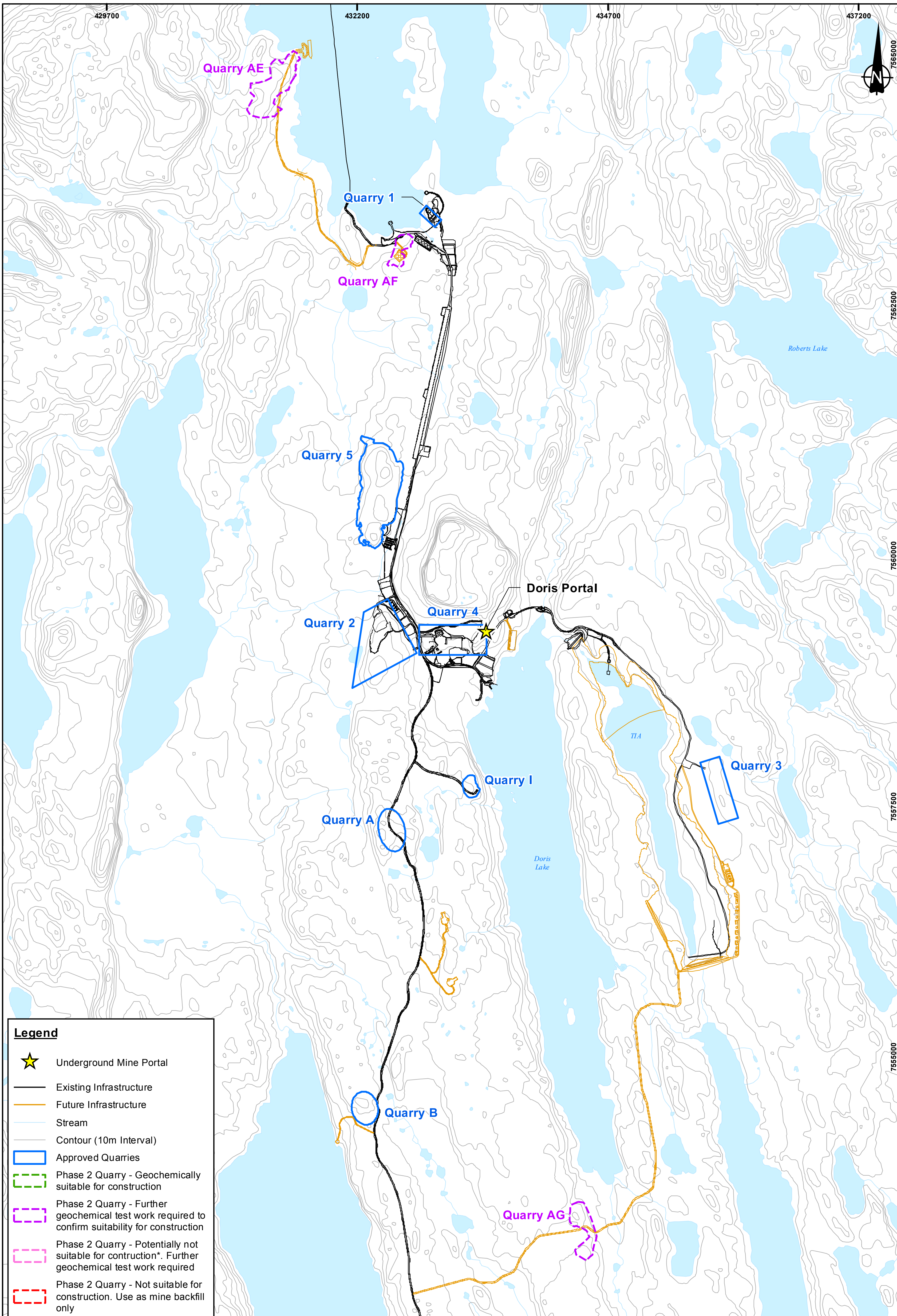

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Notes:
1. *Refer to Table 1-2 in the Quarry Management Plan
2. Coordinate System: NAD 1983 UTM Zone 13N
3. Base Topo Data: CanVec, Natural Resources Canada

srk consulting

TMAC RESOURCES

Proposed FEIS and Approved Quarry Locations, Hope Bay Project

Project No: 1CT022.013
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HOPE BAY PROJECT

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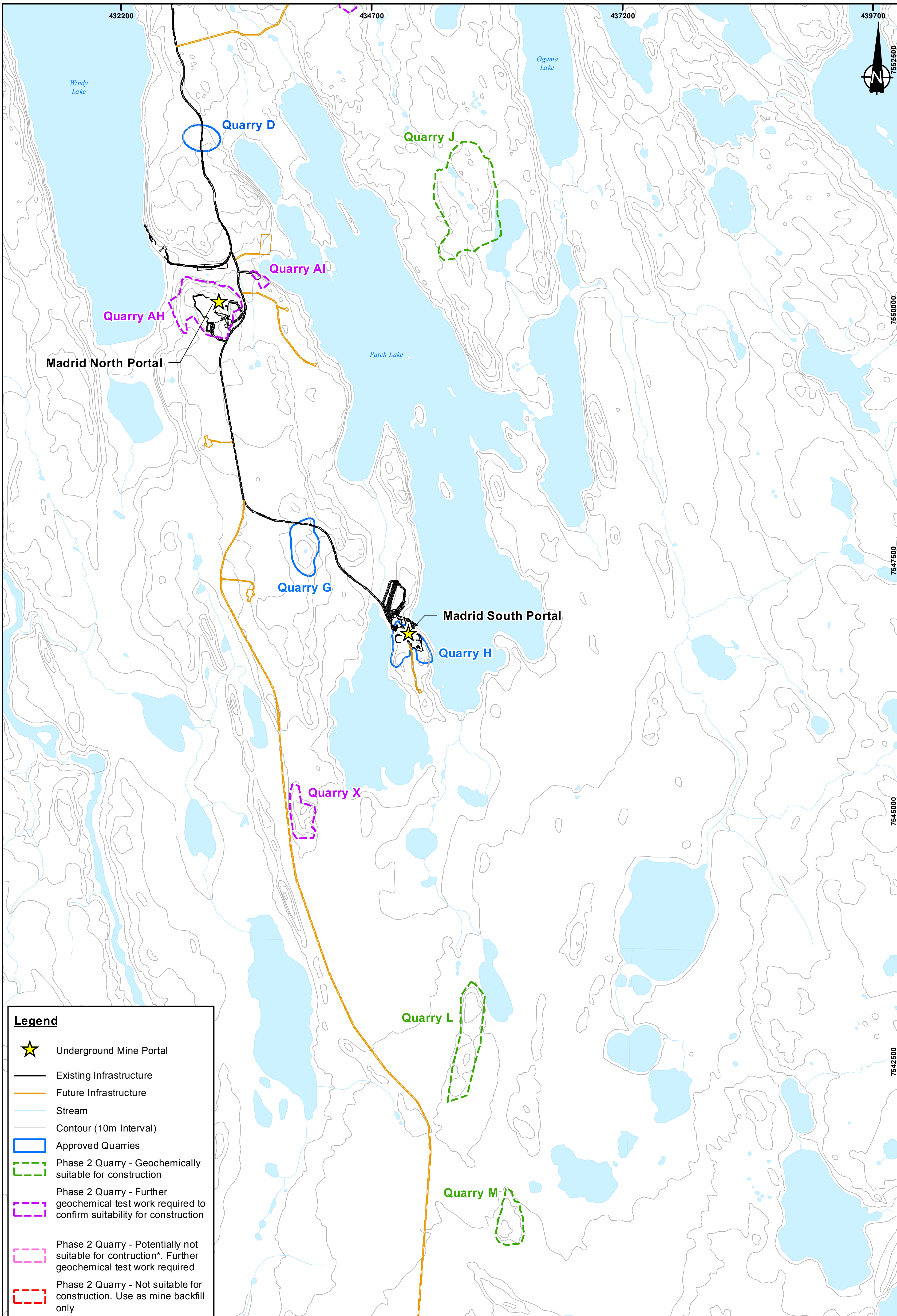

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Notes:
1. *Refer to Table 1-2 in the Quarry Management Plan
2. Coordinate System: NAD 1983 UTM Zone 13N
3. Base Topo Data: CanVec, Natural Resources Canada

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TMAC RESOURCES

Proposed FEIS and Approved Quarry Locations, Hope Bay Project

Project No: 1CT022.013

Filename: 1CT022.013_Figure_03_FEISQuarries_rev3

HOPE BAY PROJECT

Date:	Approved:	Drawing:
Dec 2017	LB/MCN	A-3

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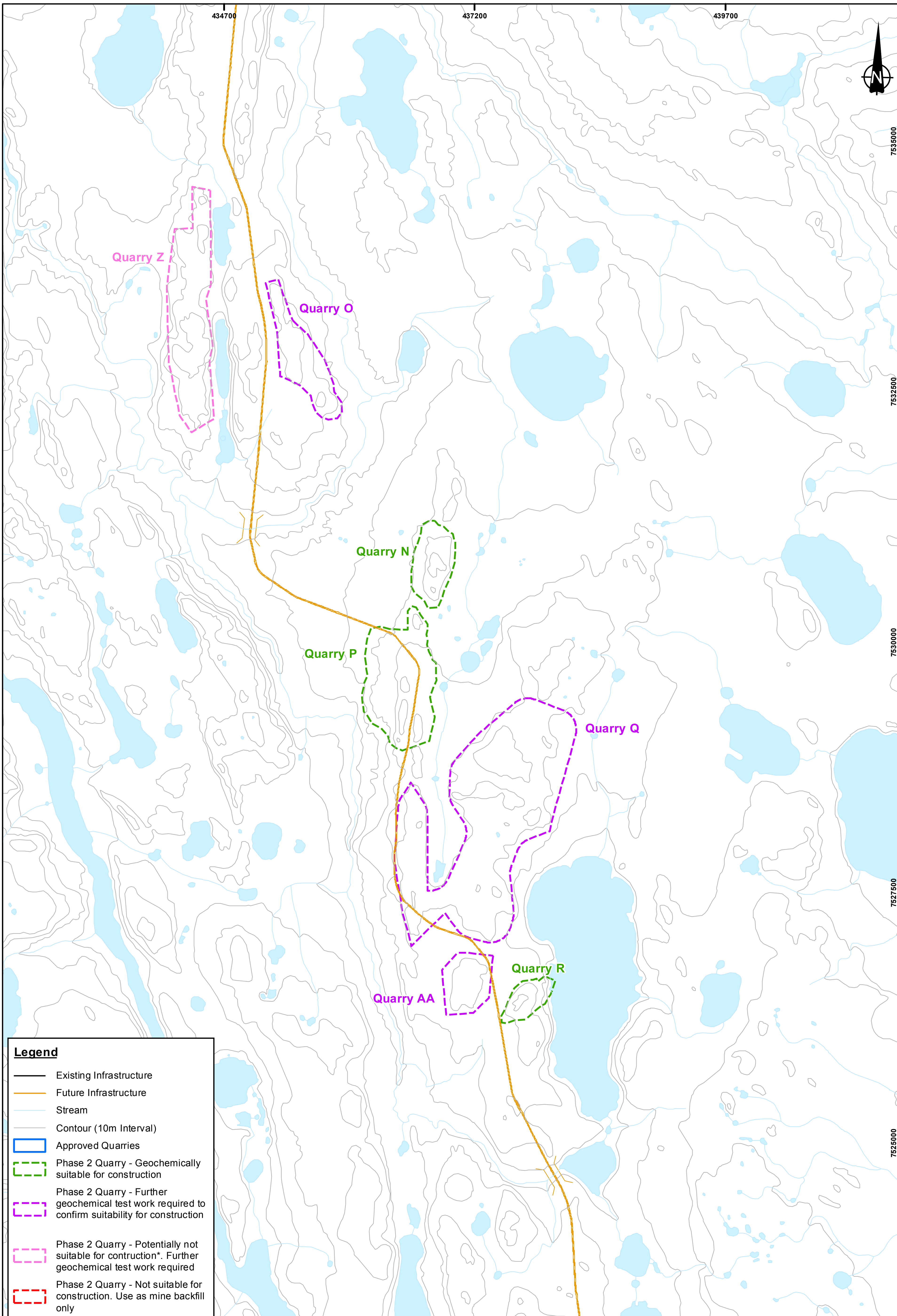

Notes:
1. *Refer to Table 1-2 in the Quarry Management Plan
2. Coordinate System: NAD 1983 UTM Zone 13N
3. Base Topo Data: CanVec, Natural Resources Canada

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TMAC RESOURCES

Proposed FEIS and Approved Quarry Locations, Hope Bay Project

Project No: 1CT022.013

Filename: 1CT022.013_Figure_04_FEISQuarries_rev3

HOPE BAY PROJECT

Date:	Approved:	Drawing:
Dec 2017	LB/MCN	A-4

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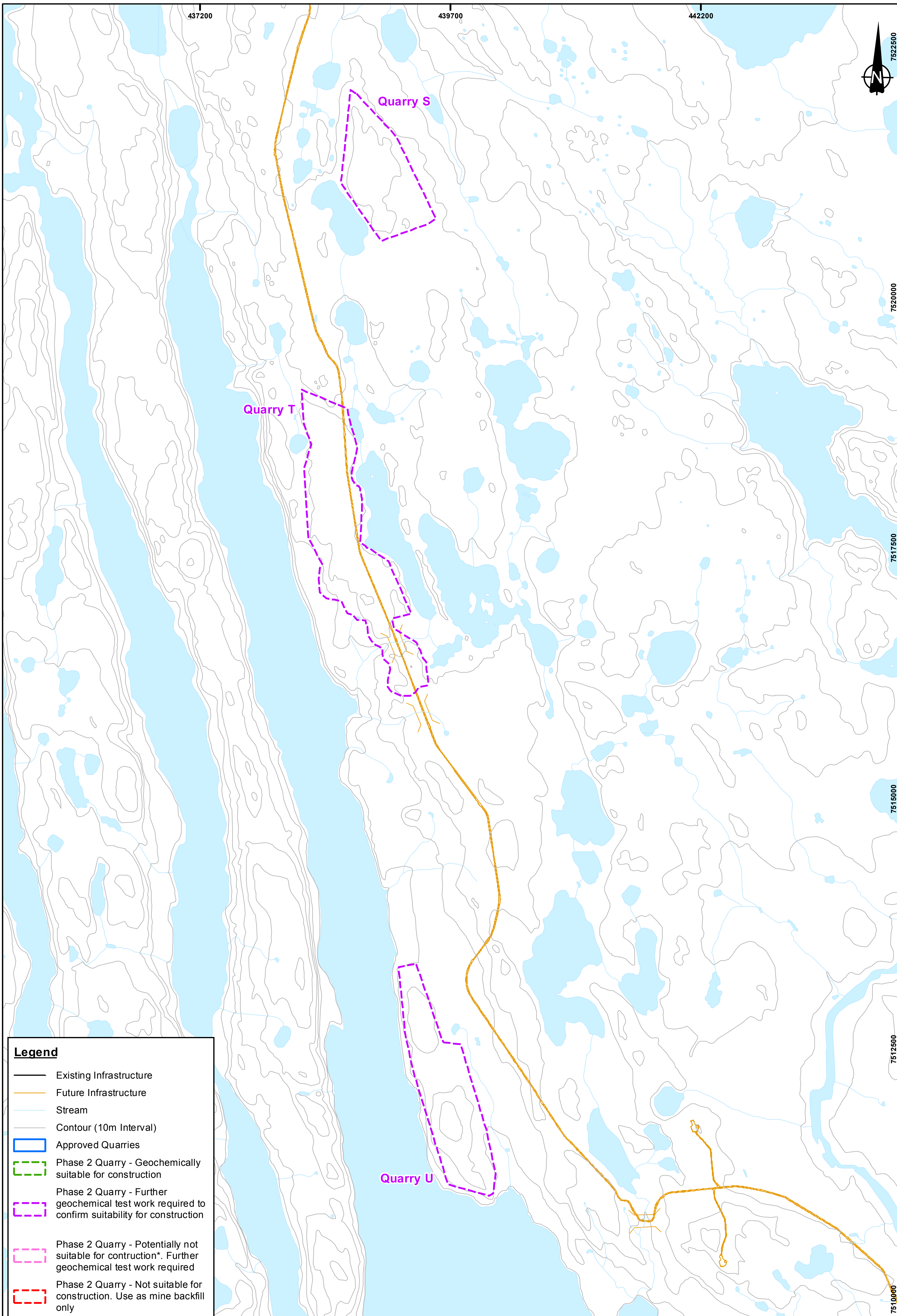

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Meters

Notes:
1. *Refer to Table 1-2 in the Quarry Management Plan
2. Coordinate System: NAD 1983 UTM Zone 13N
3. Base Topo Data: CanVec, Natural Resources Canada

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TMAC RESOURCES

Proposed FEIS and Approved Quarry Locations, Hope Bay Project

Project No: 1CT022.013

Filename: 1CT022.013_Figure_05_FEISQuarries_rev3

HOPE BAY PROJECT

Date:	Approved:	Drawing:
Dec 2017	LB/MCN	A-5

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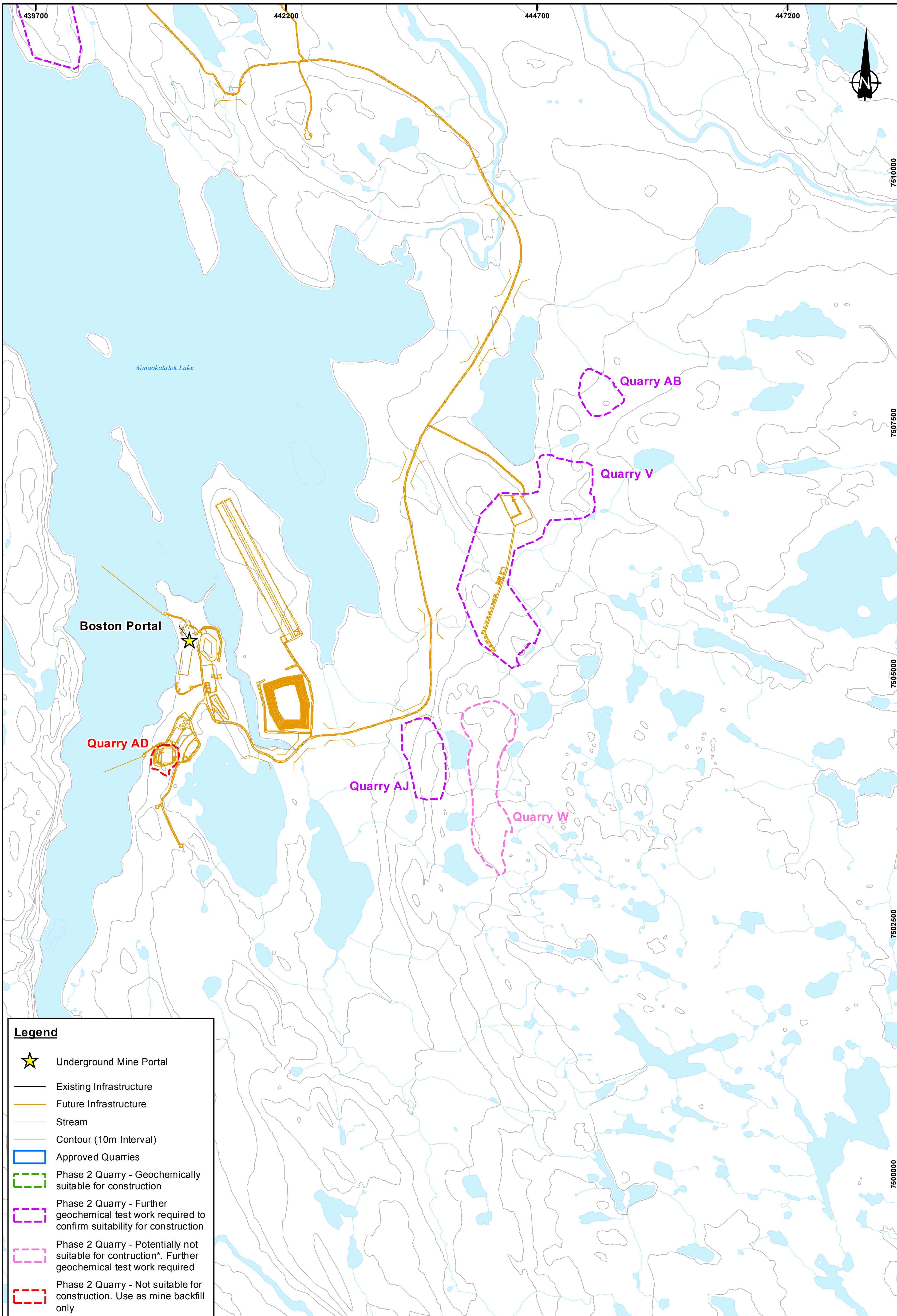

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Notes:
1. *Refer to Table 1-2 in the Quarry Management Plan
2. Coordinate System: NAD 1983 UTM Zone 13N
3. Base Topo Data: CanVec, Natural Resources Canada

srk consulting

Project No: 1CT022.013

Filename: 1CT022.013_Figure_06_FEISQuarries_rev4

TMAC RESOURCES

HOPE BAY PROJECT

Proposed FEIS and Approved Quarry Locations, Hope Bay Project

Date:	Approved:	Drawing:
Dec 2017	LB/MCN	A-6

HOPE BAY SPILL CONTINGENCY PLAN

AGNICO EAGLE
HOPE BAY

HOPE BAY, NUNAVUT

MARCH 2022

Hope Bay Spill Contingency Plan

Plain Language Overview:

This Plan describes the spill response procedures to be used at the Hope Bay mine site. This Plan ensures that 1) human life is protected and the potential for injury during spill response activities is minimized to the extent possible, 2) all potentially harmful environmental impacts are kept to a minimum, 3) resources are used effectively and efficiently, and 4) all required internal and regulatory reporting is completed on time and as required.

Hope Bay, Nunavut

Publication Date: March 2022

Agnico Eagle - Hope Bay
145 King St. East, Suite 400
Toronto, Ontario, M5C 2Y7
Phone: 1-416-947-1212

In accordance with Water Licenses 2AM-DOH1335, 2BB-MAE1727, 2BE-HOP1222, 2BB-BOS1727 and 2AM-BOS1835 and NIRB Project Condition 32.

Hope Bay Emergency Phone Numbers

Onsite Contacts	Day (7 am to 7 pm)	Night (7 pm to 7 am)
24 hour Emergency Line Mill Control Room Operator	1-867-988-6882 ext. 150	1-867-988-6882 ext. 150
Mine General Manager Eric Steinmetzer	1-867-988-6882 ext. 104	Offsite Cell: 1-514-234-3261
Interim Maintenance Superintendent Cody Kerr	1-867-988-6882 ext. 131	
Lab and Metallurgy) Superintendent Jamie Power	1-867-988-6882 ext. 145	
Manager of Mining TBD	1-867-988-6882 ext. 125	
Health and Safety Assistant Superintendent Brad Towle	1-867-988-6882 ext.138	
Environmental Superintendent Nancy Duquet-Harvey	1-867-988-6882 ext. 102	Offsite cell 1-819-856-4385
Medics Todd McDonald Vicky Hamelin	1-867-988-6882 ext. 105	1-867-988-6882 ext. 115
Security Officer Bob Fogarty John Fitzgerald	1-867-988-6882 ext. 165	
Offsite Contacts	**Day (7 am to 7 pm)**	**Night (7 pm to 7 am)**
V.P. Environment and Critical Infrastructure Michel Julien	1-416-947-1212 ext. 4013738	
Senior V.P., Operations – Canada and Europe Dominique Girard V.P. Nunavut Martin Plante	1-416-947-1212 ext. 4013747 1-819-759-3555	
V.P. Health, Safety, Social and Public Affairs Patrice Gilbert	1-416-644-2058	

Site Radio Channels

Channel 1	Emergency	Channel 6	Medic
Channel 2	Security	Channel 7	Environment
Channel 3	Aviation	Channel 8	General
Channel 4	Roads	Channel 9	Electrical
Channel 5	Site Services	Channel 10	Mill

Key Government Contacts

Organization	Contact	Location	Telephone	Fax
NT-NU Spill Centre	24 hour Spill Report Line	Yellowknife	867-920-8130	867-873-6924
Canadian Coast Guard – Central and Arctic Region (Any discharge to the marine environment)	24 hour Spill Report Line	Yellowknife	800-265-0237	
GN Department of Environment	Director Environmental Protection Division	Iqaluit	867-975-7748	
Nunavut Water Board	Executive Director	Gjoa Haven	867-360-6338	867-360-6369
Kitikmeot Inuit Association (KIA)	Sr. Lands Officer	Kugluktuk	867-982-3310	867-982-3311
CIRNAC (Crown-Indigenous Relations and Northern Affairs Canada)	Field Operations Manager	Iqaluit	867-975-4553	867-979-6445
CIRNAC (Crown-Indigenous Relations and Northern Affairs Canada)	Inspector	Iqaluit	867-975-4655	867-979-6445
ECCC (Environment and Climate Change Canada)	Manager of Enforcement	Yellowknife	867-669-4730	867-669-6831
ECCC (Environment and Climate Change Canada)	Environmental Enforcement Officer	Iqaluit	867-975-4644	
DFO (Fisheries & Oceans Canada)	Habitat Team Leader	Ottawa	705-522-9909	
Transport Canada, Marine	Regional Preparedness & Response Officer	Jasper	780-442-1945	780-495-8607

Offsite Resource Contacts

Organization	Contact	Location	Telephone
Riverspill	Ian Lambton	Burnaby	604-434-0994
Points West Archaeology	Gabriella Prager	Langley	780-980-2079
Focus Wildlife	Chris Bataglia	North Vancouver	1-800-578-3048

Immediately Reportable Spills

Per GNWT-ENR Report a Spill Website (https://www.enr.gov.nt.ca/en/services/report-spill)

Description of Contaminant	Amount Spilled	TDG Class
Explosives	Any amount	1.0
Compressed gas (toxic/corrosive)		2.3 / 2.4
Infectious substances		6.2
Sewage and Wastewater (Unless otherwise authorized)		6.2
Radioactive materials		7.0
Unknown substance		None
Compressed gas (Flammable) Compressed gas (Non-corrosive, non-flammable)	Any amount of gas from containers with a capacity greater than 100 L	2.1 2.2
Flammable Liquid	≥ 100L	3.1 / 3.2 / 3.3
Flammable Solid Substances liable to spontaneous combustion Water reactant substances	≥ 25kg	4.1 4.2 4.3
Oxidizing substances	≥ 50 L or 50 kg	5.1
Organic peroxides Environmentally hazardous substances intended for disposal	≥ 1 L or 1 kg	5.2 9.2
Toxic substances	≥ 5 L or 5 kg	6.1
Corrosive substances Miscellaneous products, substances or organisms	≥ 5 L or 5 kg	8.0
PCB mixtures of 5 or more ppm	≥ 0.5 L or 0.5 kg	9.1
Other contaminants – for example, crude oil, drilling fluid, produced water, waste or spent chemicals, used or waste oil, vehicle fluids, wastewater	≥ 100 L or 100 kg	None
Sour natural gas (i.e., contains H_2S) Sweet natural gas	Uncontrolled release or sustained flow of 10 minutes or more	None
Flammable liquid Vehicle fluid	≥ 20 L when released on a frozen water body that is being used as a working surface	3.1 / 3.2 / 3.3 None
Reported releases or potential releases of any substance that: Are near or in an open water body (freshwater or marine); Are near or in a designated sensitive environment or habitat; Pose an imminent threat to human health or safety; or Pose an imminent threat to a listed species at risk or its critical habitat	Any amount	None

In the event that a particular material spill meets or exceeds the amount specified or conditions outlined in the above table the Environmental Superintendent will immediately report the spill by telephone to the NT-NU 24 Hour Spill Report Line, Yellowknife, Tel: 867-920-8130 (Email: spills@gov.nt.ca; Fax: 867-873-6924) using the NT-NU Spill Report.

Any spill or discharge that occurs to the marine environment must immediately be reported to the Canadian Coast Guard – Central and Arctic Region station at Tel: 1-800-265-0237.

First Responder

When someone on site sees an unanticipated discharge or spill, he or she is immediately designated as the First Responder and, as such, shall complete the following actions

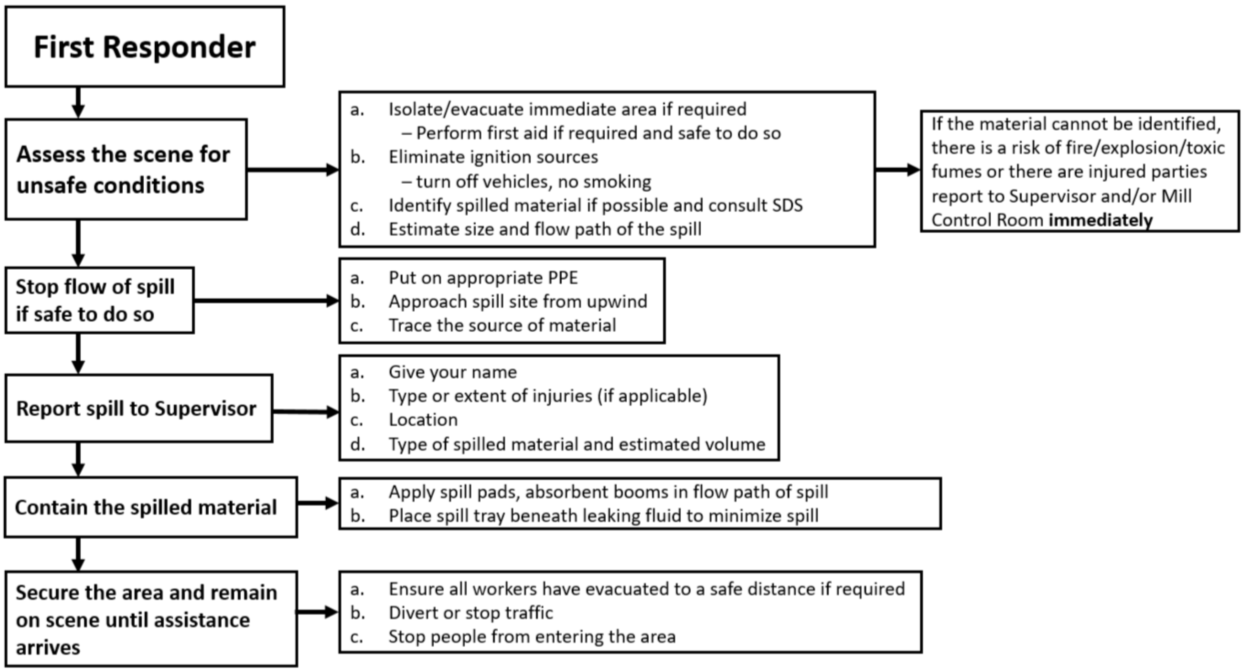

Figure I. First Responder Spill Response Actions

Spill Response Organization Structure

When a Supervisor receives a report of an unanticipated discharge or spill, he or she shall immediately complete the following actions:

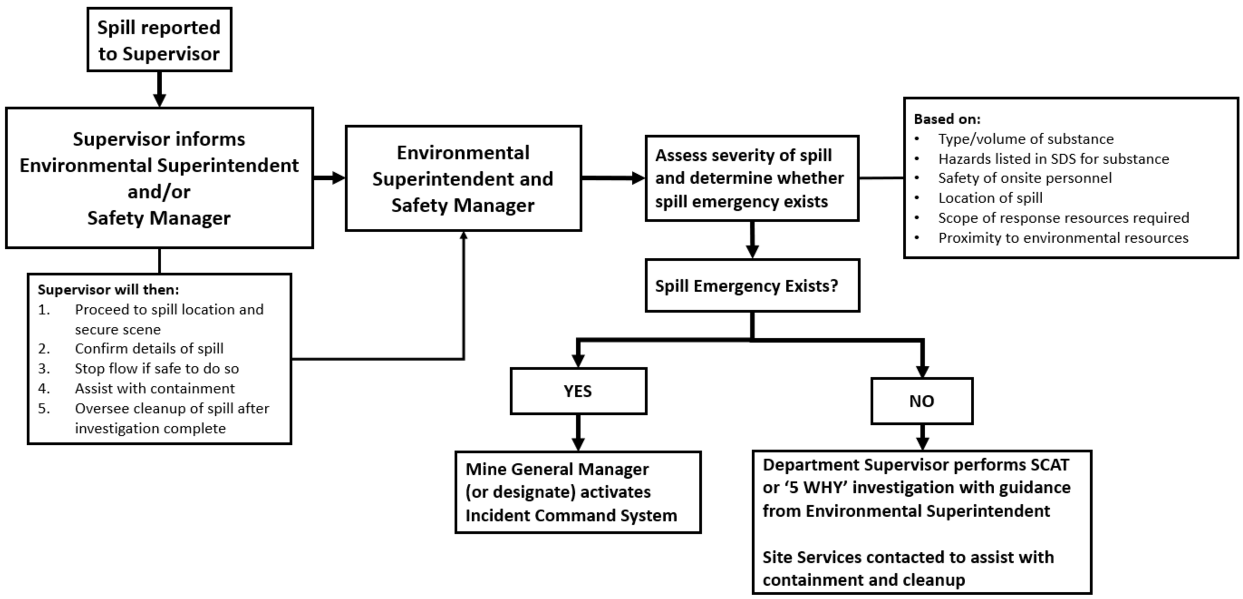

Figure II. Spill Response Organizational Structure

Spill Emergency Incident Command System

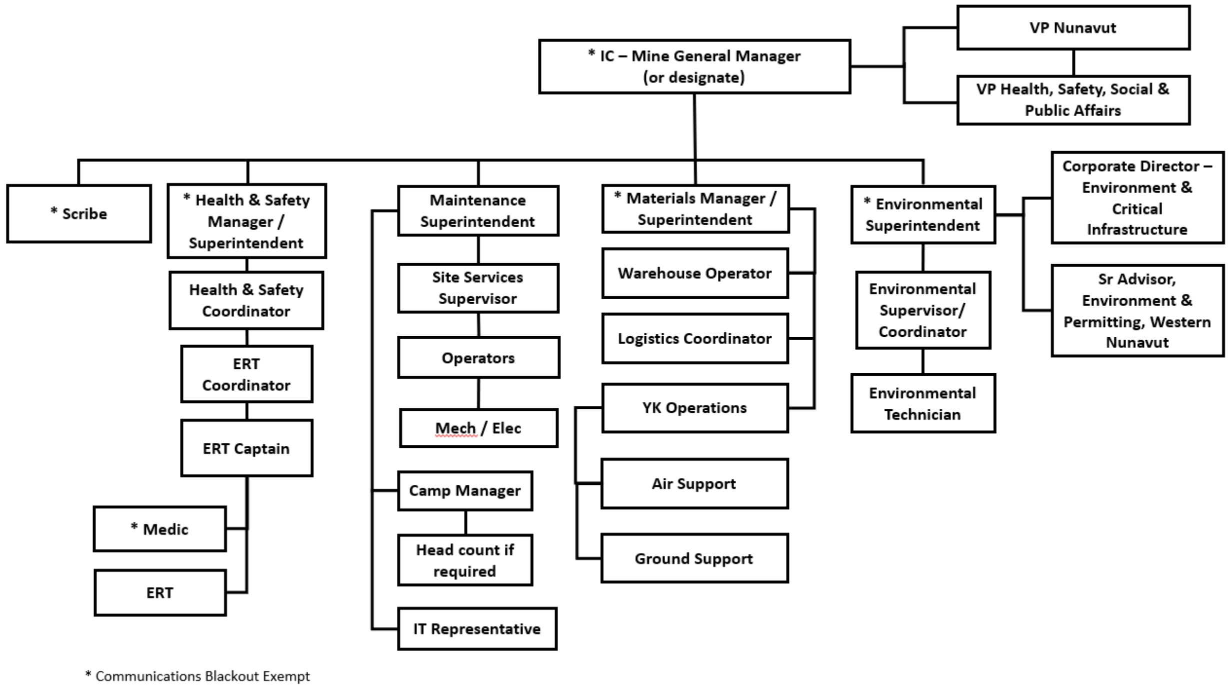

Figure III. Incident Command System organizational structure in the event of a spill emergency

Revisions

Revision #	Date	Section	Changes Summary
1	2009		Hope Bay Project Spill Contingency Plan, August 2009
2	Feb 2010		Update phone numbers
3	Jul 2010		Update phone numbers
4	2011	Throughout	Update channels, figures, included OPPP info, updated phone numbers, revised fuel storage locations
5	2012	Throughout	Overall revision for change to Care and Maintenance. Updated roles and responsibilities, phone numbers, fuel storage, added non-hydrocarbon chemicals, updated spill response procedures
6	2014	Throughout	Overall revision to include Care and Maintenance under ownership of TMAC Resources Inc. Updated roles and responsibilities, contact information, fuel storage, updated spill response procedures
7	Apr 2016	Throughout	Updated to reflect comments on 2014 Plan and other stakeholder inputs. Changes to document structure and addition of licence specific modules and Incident Command System response structure. Revisions to reflect Construction and Operations phases for Doris and anticipated chemical storage quantities. Inclusion of Product-specific response plans, updated contacts.
8	Jan 2017	Throughout	Revisions in consideration of comments on 2016 Plan, and in consideration of planned resumption of exploration activity at Boston
9	Nov 2017	Throughout	Revisions to emergency contact information, spill response organizational and ICS structure. Updates to fuel/chemical storage quantities/locations and spill kit location maps in all modules. Addition of Module C: Madrid as per licence 2BB-MAE1727. Revisions to Module D: Boston as per licence 2BB-BOS1727. Addition of Aviation fuel Product Specific Spill Response Plan to Module A.
10	Mar 2019	Throughout	Revisions to emergency contact information, spill response organizational and ICS structure. Updates to fuel/chemical storage quantities/locations and spill kit location maps in all modules.
11	Sep 2019	Throughout, Module A	Revisions to emergency contact information, addition of spill prevention measures along the Roberts Bay Discharge Pipeline in Module A
12	Mar 2020	Throughout, Appendix	Overall revisions to the plan
13	Mar 2021	Throughout Section 3.4	Updated to Agnico Eagle Mines Ltd ownership and format. Updated Emergency Phone Numbers, Site Radio Channels and Offsite Resource Contacts. Clarified scenarios where monitoring of spills is required.
14	Mar 2022	Throughout	Overall revision to incorporate comments from ECCC for compliance with E2 regulations and AEM internal policy on Environmental Incident

Contents

Tables

Figures

Appendices

Glossary

Term	Definition
Agnico Eagle	Agnico Eagle Mines Ltd. – Hope Bay
CWS	Canadian Wildlife Services
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada (formerly INAC)
DoE	Department of Environment
ECCC	Environment and Climate Change Canada
ERT	Emergency Response Team
ERP	Emergency Response Plan
GN	Government of Nunavut
IC	Incident Commander
ICS	Incident Command System
KIA	Kitikmeot Inuit Association
MGM	Mine General Manager
NWB	Nunavut Water Board
PSER	Product Specific Emergency Response Plan
PPE	Personal Protection Equipment
SDS	Safety Data Sheet

1 Introduction

This Hope Bay Spill Contingency Plan (the Plan) has been prepared by Agnico Eagle Mines Limited (Agnico Eagle) in accordance with various water licences held by Agnico Eagle associated with developments throughout the Hope Bay region. This Plan has been developed to also meet the requirements of the Environmental Emergency (E2) Regulations as well as the Metal and Diamond Mining Effluent Regulations enacted under the Canadian Environmental Protection Act (CEPA, 1999).

The Plan is intended primarily for use by Agnico Eagle Hope Bay and its contractors to ensure that best practices for response are implemented in the event of a spill or unintentional release, and that the conditions of water licences, project permits and relevant legislations are met.

This Plan is structured in a manner such that one document pertaining to spill response is approved and implemented across all Hope Bay sites, while still addressing site- and licence-specific needs: the main document outlines Agnico Eagle's approach to spill response planning and management as it pertains to all Agnico Eagle Hope Bay developments; subsequent modules provide details for each site and the associated water licence. In the event of a new water licence, or an existing licence amendment, only the specific modules pertaining to that licence and site may need to be revised. This is intended for consistency and efficiency across operations and for compliance management.

This Plan has been developed to be applicable for all phases of development at various Hope Bay mine sites. This Plan is reviewed annually and updated as necessary.

1.1 Objectives

Agnico Eagle's vision and values strive for zero harm and protection of people and the environment. Safe work procedures and training provided to all employees promote best practices and sound environmental management; however, the potential exists for unanticipated discharges or spills to occur during the course of operations. Agnico Eagle recognizes that prompt, effective and organized responses to an unanticipated discharge or spill will enhance the health and safety of all employees, minimize the potential adverse environmental impacts resulting from such an event, and ensure effective communication with the appropriate regulatory agencies and the public. Consistent with Agnico Eagle's intent to be a responsible operator, these objectives are described as follows:

- Provide procedures for every employee should he/she identify an unanticipated discharge or spill;
- Define roles, responsibilities and procedures for spill response actions, documentation, reporting, incident investigation and review following an event;
- Outline a process to be followed when conducting spill clean-up activities to promote safe and effective recovery of spilled materials and minimize impacts to the environment;
- Provide information on available resources and potential operational hazards/risks that may be encountered during spill response activities;
- Define methods to provide spill response training for all employees; and
- Implement a process to evaluate and continuously improve site spill response procedures.

1.2 Relevant Legislation and Guidance

Table 1.1 provides a summary of federal and territorial regulations relevant to this Plan and associated guidelines.

Table 1.1. List of Federal and Territorial Regulations Relevant the Hope Bay Spill Contingency Plan

Acts	Regulations	Guidelines
Federal		
Arctic Waters Pollution Prevention Act (R.S.C., 1985, c.A-12)	Arctic Shipping Pollution Prevention Regulations (C.R.C., c. 353)	
Canadian Environmental Protection Act (R.S.C.1999 c.33)	Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations (SOR/2008-197)	Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products (Canadian Council of the Ministers of Environment (CCME) 2003)
	Environmental Emergency Regulations (SOR/2019-51)	
	Interprovincial Movement of Hazardous Waste and Hazardous Recyclable Material Regulations (SOR/2002-301)	Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil (CCME2008)
	Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (SOR/2005-149)	
Fisheries Act (1985, c.F-14)	Metal and Diamond Mining Effluent Regulations (SOR/2002-222)	
Explosives Act (1985, c.E-17)	Explosives Regulations (C.R.C., c.1516)	
Nunavut Waters and Nunavut Surface Rights Tribunal Act (2002)	Nunavut Water Regulations (2013)	
National Fire Code of Canada (2010)		
Transportation of Dangerous Goods Act (1992, C.34)	Transportation of Dangerous Goods Regulations (SOR/2001-286)	2016 Emergency Response Guidebook (Transport Canada and U.S. Department of Transportation, 2016)
Territorial Lands Act (R. S. 1985, c.T-7)	Northwest Territories and Nunavut Mining Regulations (C.R.C., c.1516)	
	Territorial Land Use Regulations (C.R.C., c.1524)	
	Territorial Lands Regulations (C.R.C., c.1525)	
Hazardous Products Act	*Controlled Products Regulations*	*Workplace Hazardous Materials Information System (WHMIS)*
Nunavut Act (1993 c.28)		

Acts	Regulations	Guidelines
Territorial – Nunavut		
Environmental Protection Act	Spill Contingency Planning and Reporting Regulations (NWT Reg (Nu) 068-93) Used Oil and Waste Fuel Management Regulations (NWT Reg 064-2003) [The removal of hazardous materials will require the registration with the Government of Nunavut, Department of Environment (DOE) as a waste generator as well as carrier (if applicable) prior to transport]	Government of Nunavut (GN) Environmental Guidelines for the Management of: • General Management of Hazardous Waste in Nunavut (GN, 2010) • Waste Paint (GN, 2010) • Mercury-Containing Products and Waste Mercury (GN, 2010) • Industrial Waste Discharges into Municipal Solid Waste and Sewage Disposal Facilities (GN, 2011) • Waste Batteries (GN, 2011) • Waste Solvent (GN, 2011) • Waste Antifreeze (GN, 2011) • Used Oil and Waste Fuel (GN, 2012) • Biomedical and Pharmaceutical Waste (GN, 2014) • Canada-Wide Standards for Petroleum Hydrocarbons (PHC) In Soil (CCME 2008)
Mine Health and Safety Act (SNWT (Nu) 1994, c.25)	Mine Health and Safety Regulations (NWT Reg (Nu) 125-95)	
Workers' Compensation Act (RSNWT, 1998, c.W-6)	Workers' Compensation General Regulations (Nu Reg 017-2010)	
Explosives Use Act (RSNWT (Nu) 1988, c.E-10)	Explosives Regulations (RRNWT (Nu) 1990, c.E-27)	
Fire Prevention Act (RSNWT (Nu) 1988, c.F-6)	Fire Prevention Regulations (RRNWT (Nu) 1990, c.F-12)	
Motor Vehicles Act (RSNWT (Nu) 1988, c.M-16)	Large Vehicle Control Regulations (RRNWT (Nu) 1990, c.M-30)	
Public Health Act (RSNWT (Nu) 1988, c.P12)	Camp Sanitation Regulations (RRNWT (Nu) 1990, c.P-12)	
Safety Act (RSNWT 1988, c.S-1)	General Safety Regulations (RRNWT (Nu) 1990, c.P-16)	
	Work Site Hazardous Materials Information System Regulations (RSNWT 1988, c.81 (Supp))	
Transportation of Dangerous Goods Act (1990, RSNWT (Nu) 1988, c.81 (Supp))	Transportation of Dangerous Goods Regulations (1991, NWT Reg (Nu) 095-91)	

1.3 Related Agnico Eagle Documents

The documents listed in Table 1.2 are expected to be referenced and utilized in conjunction with the Spill Contingency Plan.

Table 1.2. List of Agnico Eagle documents related to the Hope Bay Spill Contingency Plan

Document Title	Year	Relevance
Hazardous Waste Management Plan	2020	Describes proper handling, storage and disposal procedures for hazardous wastes.
Non-Hazardous Waste Management Plan	2017	Describes proper handling, storage and disposal procedures for non- hazardous wastes.
Hope Bay Project Hydrocarbon Contaminated Material Management Plan	2017	Describes process for remediating hydrocarbon contaminated soil, water and gravel and criteria for determining level of remediation.
Emergency Response Plan	2021	Describes Incident Command System and actions relating to all surface emergencies.
Doris-Madrid Tailings Impoundment Area Operations, Management and Surveillance (OMS) Plan	2020	Describes the tailings management procedures and the aspects of the pipelines designed to reduce spills of tailings and effluent.
Oil Pollution Prevention and Oil Emergency Preparedness Plan	2020	Describes spill response actions associated with fuel transfer activities during annual sea-lift fuel offload.

1.4 Plan Management

This Plan has been prepared by Agnico Eagle, with review by relevant stakeholders, in accordance with various licences held by Agnico Eagle associated with developments throughout the Hope Bay region. The plan is updated and submitted for review annually as required by the licences. Stakeholder comments that were considered in the development of this Plan are provided in Appendix 4.

The Mine General Manager (MGM) has the overall responsibility for implementing this plan at the Hope Bay site and providing on-site support and resources for spill response management. The MGM will act as Incident Commander (IC) in the event that a spill occurs that requires activation of the Emergency Response Plan (ERP). As Incident Commander, the MGM will coordinate the spill response efforts that protect the health and safety of all responders and minimizes impacts to the environment.

The Environmental Superintendent is responsible for reviewing and revising this plan. In the event that a spill requires activation of the Emergency Response Plan, the Environmental Superintendent will provide guidance to the MGM regarding implementing response actions according to this plan and evaluating priorities for protection of sensitive habitats/species and archeological features at risk. The Environmental Superintendent will also ensure that regular inspections of spill response resources are conducted and documented.

The Environmental Coordinators will assist departmental supervisors with investigation of spill incidents, development of corrective actions for those incidents as necessary, maintain records of all spill events, and complete appropriate reporting as required by Agnico Eagle policies and relevant regulations as identified in this plan. Plan Implementation

In accordance with the requirements of the General Conditions (Part B) of the applicable water licences, the Environmental Emergency Regulations (SOR/2019-51) and the Metal and Diamond Mining Effluent Regulations (SOR/2002-222), this plan will be immediately implemented following its submission, subject to any modifications proposed by the NWB or applicable regulatory agencies as a result of the review and approval process.

This plan will be reviewed annually and updated as necessary to capture changes to site operational structure/contacts, response technologies or applicable legislation and regulations.

1.5 Project Description

Hope Bay is a gold mine located in the West Kitikmeot region of Nunavut approximately 705 km northeast of Yellowknife and 153 km southwest of Cambridge Bay. The nearest settlements are Umingmaktok (Bay Chimo), located 62 km to the west, and Kingaok (Bathurst Inlet), located 130 km southwest. Umingmaktok and Kingaok are seasonal settlements, and the nearest permanently populated settlement is Cambridge Bay. These settlements are not expected to be impacted by an environmental emergency. The various elements of the Hope Bay mine are centered at approximately N 68° 09' and W 106° 40' and extend from the head of Roberts Bay (an extension of Melville Sound) at the north end of the property to south of the Boston site located approximately 60 km to the south. Two jetties extend into Roberts Bay and are located on foreshore Crown Land. The Hope Bay mineral exploration rights property comprises an area of 1078 km^2 and forms a contiguous block that is approximately 80 km long by up to 20 km wide. Descriptions of infrastructure pertinent to each licence area are provided in the appended modules.

The Hope Bay area has a low arctic eco-climate and consists of coastal lowland habitats with numerous fresh water lakes and ponds. The drainage basins are generally long and narrow and predominately oriented along the north-south axis and are separated by bedrock ridges. Continuous permafrost covers the project area with a surficial active layer of approximately 1 m. Groundwater movement only occurs in the shallow active layer during the seasonal thaw period and within the talik zones (unfrozen ground underlying larger water bodies). Permafrost underlying the area is generally impervious to groundwater movements.

1.6 Plan Structure

Section 2 outlines the Spill Incident response including the responsibilities of the individuals involved in spill response actions. Investigation and follow up reporting requirements are presented in Section 3. Section 4 summarizes potential spill risks (worst case scenarios) and the management and mitigation measures employed to reduce the likelihood of these occurrences. Training and Spill Response simulation exercises are summarized in Section 5.

A comprehensive set of modules and appendices are included at the end of the Plan. The modules contain details pertaining to the chemical storage specific to each of the developments throughout the Hope Bay region. Appendices 1 to 3 include substance specific spill responses plans, spill response resources and environmental resource maps, respectively. Appendix 4 includes the stakeholder comments that were considered in the development of this Plan.

2 Spill Response and Management

2.1 Environmental Incident and Level of Confinement Definition

Agnico considers a leak or spill to be an Environmental Incident if it results in a release of a potential contaminant or substance from a confinement with higher Level of Confinement (LOC) to a lower one, whether there's a release to the environment or not. A spill that has an impact but remains below the regulatory limit, would still be considered an Environmental Incident. All environmental incidents should be reported in Agnico's internal Incident Management Database System (INTELEX).

The Level of Confinement (LOC) is an important consideration for spills at Agnico. For a substance (liquid or gas) stored in a confinement infrastructure (reservoir, basin, pond, tank, etc), the LOC is the description of the confinement of this infrastructure offers to this substance. The LOC is meant to be defined in simple and clear terms referring to a reservoir (generic term) as open, enclosed, inside a building, outside a building, with or with no groundwater protection system, with or without an animal-human intrusion system, etc. For example:

- Fuel tank outside: LOC = enclosed reservoir outside
- Open reservoir inside a building: LOC = open reservoir inside a building
- Collecting basin around an open reservoir inside a building: LOC = open reservoir inside a building
- Closed reservoir outside a building: LOC = enclosed reservoir outside a building
- Collecting basin around an enclosed reservoir outside a basin: LOC = open reservoir outside a building
- A pond with a liner to protect leak in groundwater: LOC = open reservoir outside with groundwater protection system
- A sump outside a pond with no leak protection system: LOC = open reservoir outside with no groundwater protection system

The following scenarios explain the LOC change during a spill:

- An outside fuel tank leak into its confinement reservoir would be an EI. It went LOC: enclosed reservoir outside to LOC: open reservoir outside
- A spill from an open tank inside a mill, spilling into its open collecting reservoir would not be an EI. It went from a LOC: open reservoir inside a building to a LOC: open reservoir inside a building.
- A spill from an outside lined pond into an unlined sump would be an EI. It went from a LOC : open reservoir with groundwater protection system to a LOC: open reservoir with no groundwater protection system

2.2 Spill Incident Alerts

Any person on the Hope Bay mine site who comes across or sees an unanticipated discharge or spill is designated as the First Responder and will complete the following actions (Figure I):

1. Assess the Site:
   (a) Isolate/evacuate immediate area if required;
   (b) Perform first aid if required and safe to do so;
   (c) Eliminate ignition sources – turn off vehicles, no smoking;
   (d) Identify spilled material if possible and consult product SDS; and
   (e) Estimate size and flow path of the spill.

   NOTE: If the material cannot be identified, there is a risk of fire/explosion/toxic fumes produced or there are injured parties report to Supervisor **immediately** or call **Mill Control** if applicable (Step 3)**.**

2. Stop flow of spill if safe to do so:
   (a) Put on appropriate PPE;
   (b) Approach spill site from upwind; and
   (c) Trace the source of material.

3. Report spill to Supervisor:
   (a) Give your name;
   (b) Type or extent of injuries (if applicable);
   (c) Location; and
   (d) Type of spilled material and estimated volume.

   NOTE: Mill Control can be contacted on Radio **Channel 1**, Phone Extension **911** or **150**.

4. Contain the spilled material:
   (a) Apply spill pads, absorbent booms in flow path of spill; and
   (b) Place spill tray beneath leaking fluid to minimize spill.

5. Secure the area and remain on scene until assistance arrives:
   (a) Ensure all workers have evacuated to a safe distance if required;
   (b) Divert or stop traffic; and
   (c) Stop people from entering the area.

All personnel receive appropriate training during their initial site orientation of what to do when he/she sees an unanticipated discharge or spill anywhere at the Hope Bay mine site. A flow-chart summarizing the First Responder spill actions is provided in Figure I as a quick reference at the beginning of this plan and is available in all spill kits on site.

2.3 Spill Response Organizational Structure

Once a spill has been identified by the First Responder the following spill response organizational structure will be implemented. The responsibilities of the individuals involved in spill response actions are summarized in the sections below. A flow-chart summarizing this structure is provided in Figure II as a quick reference at the beginning of this plan.

2.3.1 Supervisors

In the event that a Supervisor is informed of a spill by an employee, he/she will immediately inform the Environmental Superintendent and/or Safety Manager that a spill has occurred and provide details of the spill as outlined in Section 2.1 above. The Supervisor will proceed to the spill location, secure the scene, confirm the type of material/size of the spill and assist with containment actions. Depending on the severity of the spill incident, either the Mine General Manager (MGM) or Environmental Superintendent will provide direction to the Supervisor regarding the removal, storage and disposal of the spilled material. The incident scene is not to be disturbed until an incident investigation can be completed.

Removal and disposal of spill materials is only to be conducted after this investigation is complete and the scene is released by the MGM and/or Environmental Superintendent.

2.3.2 Mine General Manager

Once notified of the spill, the MGM will consult with the Environmental Superintendent and Health & Safety Manager/Superintendent to assess the severity of the spill incident and determine whether a spill emergency exists that requires activation of the Incident Command System (ICS) emergency procedures. This assessment will take into account the type and volume of the substance that has spilled, the location of the spill, safety of site personnel, scope of resources required to respond and the proximity of the spill to environmental resources at risk, including water bodies, sensitive habitat, archeological sites or sensitive species in the area.

The ICS is a command structure used in the Emergency Response Plan (ERP) at the Hope Bay mine site. This structure is designed to have a documented sequence of decisions that has been reviewed in advance of an emergency situation and establishes a chain of command to minimize confusion, so that employees will have no doubt who has the authority for making decisions.

If the ICS is activated in response to a spill emergency, the MGM (or designate) becomes the Incident Commander and implements the ICS command system outlined in Figure III at the beginning of this plan. The Incident Commander will communicate with onsite managers and direct all efforts in the spill response including evacuating personnel, identifying resources required to respond to the incident and activating the Emergency Response Team (ERT). The Incident Commander will direct the Maintenance Superintendent to coordinate containment and clean-up actions based on safety of the responders and environmental protection priorities as identified by the Health & Safety Manager/Superintendent and the Environmental Superintendent. In the event of a large spill, the Incident Commander may direct the Materials

Manager/Superintendent to secure off-site resources and facilitate shipment to the Hope Bay site. The Incident Commander will establish communications with the VP Nunavut and VP Health, Safety, Social & Public Affairs and regularly brief these individuals on the status of the spill emergency. A scribe will be assigned to the Incident Commander to document all communications and response actions of the spill incident.

After the spill emergency has been contained, the Incident Commander will conduct an incident investigation with the assistance of the Environmental Superintendent, Health & Safety Manager/Superintendent and other site managers as required.

If the spill is not deemed an emergency by the MGM, the ICS will not be activated and the Environmental Superintendent will provide direction to Site Services for containment and clean-up of the spill after an incident investigation has been completed.

2.3.3 Environmental Superintendent

The Environmental Superintendent will assist the MGM in evaluating the severity of a spill situation to determine whether a spill emergency exists. The Environmental Superintendent will identify environmental resources at risk, including water bodies, sensitive habitat and species, or archeological sites in proximity to the spill based on the size/location of the spill, anticipated path of flow and weather conditions at the time. If a spill emergency exists that triggers the ICS, the Environmental Superintendent will advise the Incident Commander on the prioritization of containment and clean-up efforts. If the ICS is not triggered, the Environmental Superintendent will provide direction to Site Services for containment and clean-up of the spill after an incident investigation has been completed.

The Environmental Superintendent is also responsible for ensuring that incident reporting as outlined in Section 3 of this plan is completed and that follow-up monitoring actions deemed necessary to evaluate the extent of the spill and effectiveness of clean-up/remediation efforts are implemented. The Environmental Superintendent will communicate with the Corporate Director – Environment & Critical Infrastructure and the Sr Advisor – Environment & Permitting, Western Nunavut at any time as required to determine effective clean-up measures, discuss reporting submissions and implement environmental monitoring as necessary.

2.3.4 Environmental Supervisor/Coordinators

The Environmental Supervisors/Coordinators will assist departmental Supervisors to document and investigate the cause of all spills, and work with onsite managers to develop corrective actions as required to prevent a repeat occurrence of the incident.

The Environmental Supervisors/Coordinators will oversee any follow-up monitoring actions deemed necessary to evaluate the extent of the spill and effectiveness of clean-up/remediation efforts at the direction of the Environmental Superintendent.

2.3.5 Health & Safety Manager/Superintendent

The Health & Safety Manager/Superintendent will assist the MGM in evaluating the severity of a spill situation in instances where hazardous conditions may exist for site personnel as a result of a spill. This includes events involving injured personnel or damage to property resulting from the event, and/or situations where risk of fire, explosion or toxic fumes may be created as a result of the spill. The Health & Safety Manager/Superintendent will identify risks to site personnel and emergency responders and advise the Incident Commander on the response in conjunction with the Emergency Response Plan (ERP).

2.3.6 Emergency Response Team Coordinator

The Emergency Response Team (ERT) Coordinator is responsible for the implementation and training of the Emergency Response/Mine Rescue Team. During a spill emergency event, the ERT Coordinator will organize the response action of the ERT as directed by the Mine General Manager.

2.3.7 Emergency Response Team/Mine Rescue Team

The Emergency Response Team/Mine Rescue Team (ERT/MRT) may be the primary responders to a spill emergency event depending on the severity of spill incident and the containment and clean-up efforts.

2.3.8 Communications Delegate

In the event of a spill emergency, a Communications Delegate will be identified by Agnico Eagle who will communicate regularly with the Incident Commander to monitor the spill response and maintain a log of internal and external communications. The Communications Delegate will inform all appropriate agencies, which may include the Kitikmeot Inuit Association, the Nunavut Water Board, the Nunavut Impact Review Board, Environment and Climate Change Canada, Crown-Indigenous Relations and Northern Affairs Canada, the Department of Fisheries and Oceans Canada and will advise the public in the immediate vicinity of the spill if warranted. The communication will be in the form of a phone call and email and will include the type of material and size of the spill. The Communications Delegate may designate alternative personnel to perform these communications. This individual will also update the Agnico Eagle Executive as required.

2.3.8.1 Spill Response Communications

During a spill emergency, on-site staff WILL NOT communicate directly with regulatory agencies, the press or other parties off of the mine site. All external communication is to be through the Communications Delegate. Communication systems will be shut down at the direction of the Incident Commander and only emergency radio and phone lines identified in the Incident Command organizational structure will remain operational.

All on-site communication with the Communications Designate will occur through or at the direction of the Incident Commander. On-site communications will use portable radios on designated radio channels. Independent satellite phones are available for crews for emergency communications in the unlikely event that the radio and phone systems fail.

2.3.9 Spill Response Actions

Most chemicals stored onsite are kept in small quantities and not expected to result in a major spill incident. Any chemical product which is listed under the E2 Regulations and which will be stored in quantities on site equal to or greater than that listed in Schedule 1 of these regulations will have an additional Product Specific Emergency Response (PSER) Plan detailed for that product. These PSER plans can be found in Appendix 1 of this document.

Chemical containers are appropriately labelled to identify their contents in the event of a spill. The product label will be used to identify the substance and hazards, the Safety Data Sheet (SDS) will be consulted to determine the proper PPE requirements and appropriate spill response procedures. The following sections outline general spill response actions to be taken in the event of a spill in each associated environment. The basic spill response steps to be taken in the event of the spill are illustrated in Figure 2.1 below.

Note that some substances can be highly reactive in contact with water, air, or other substances and should not be addressed unless safe to do so.

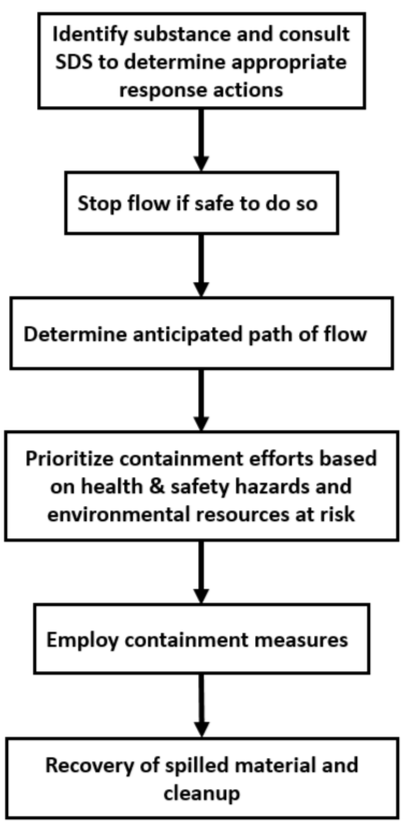

Figure 2.1. General Spill Response Actions

2.3.10 Spills on Land and Water

In the event of a liquid spill on gravel, rock, soil or vegetation, it is very important to prevent the liquid from entering any body of water where it will spread and likely have greater environmental impact. Liquid spills on land will be contained and cleaned up by:

- Covering the spill with appropriate absorbent pads and placing absorbent booms in the path of flow of the spill;
- Constructing temporary berms from soil or snow at the leading edge of the spill to minimize flow:
  - Plastic tarps can be placed over and at the foot of the berm to capture pooling liquid and facilitate recovery; and
  - Temporary berms are an interim measure and will be removed as soon as possible after the spill is contained and remedial actions complete.
- Pumping spilled material to empty drums or tanks;
- Using a vacuum truck to recover spilled material;
- Excavators and other heavy equipment may be used to excavate contaminated materials; and
- If safe to do so, blow torches (Tiger Torches) may be used to clean small hydrocarbon spills that occur on unlined areas of the camp pad to reduce waste generation and handling.

In the event of a spill on water, the spread of the spilled material will be limited to the extent possible. The following steps will be taken to contain and clean-up a spill on water:

- Identify the direction and speed of the flow path of the product based on weather conditions and drainage patterns:
  - Monitor the spread of the material using a drone or from a helicopter if possible to identify the area of spread.
- Use appropriate absorbent pads, socks and similar materials to recover spilled product:
  - Granular sorbent materials are NOT to be used for spill response on water.
- Hydrophobic absorbent booms will be deployed to contain large spills and to facilitate recovery:
  - Absorbent booms will be drawn slowly in to encircle the spilled product and absorb it.
  - High winds, waves and other factors may limit the effectiveness of these materials.
- Skimmers will be deployed in open-water areas to remove product from the water surface and boards or plywood may be used in streams or culverts to reduce the flow of spilled product on the surface and limit the area of the spill on the water;
- Use of sub-surface barriers to contain spilled product that may sink;
- Pump contaminated water into tanks or storage bladders if possible:
  - A vacuum truck may be used to recover spilled product.

- Contaminated substrate and vegetation will be removed either manually or with the use of heavy equipment if feasible; and
- Chemical dispersants should not be used as a spill response technique at the Hope Bay project, seek direction from the Corporate Director – Environment & Critical Infrastructure and the Sr Advisor – Environment & Permitting, Western Nunavut
- Also see Section 2.3.18 of this document for guidance related to additional spill protection, clean-up, and reporting measures for environmentally sensitive species and archaeological sites.

2.3.11 Spills in a Marine Environment

The most effective way to minimize environmental damage is to focus on source control and to prevent product from spreading. The following steps will be taken in the event of a spill in the marine environment:

- Identify the direction, speed and flow path of the product based on weather conditions and drainage patterns:
  - Monitor the spread of the material using a drone or from a helicopter if possible to identify the area of spread.
- Use of appropriate absorbent pads, socks and similar materials to recover small volumes of spilled product:
  - Floating spill response booms will be used to encircle a barge prior to off-loading chemicals and fuel from the barge as a precautionary measure.
  - Granular sorbent materials are NOT to be used for spill response on water.
- Hydrophobic absorbent booms will be deployed to contain large spills and to facilitate recovery:
  - Absorbent booms will be drawn slowly in to encircle the spilled fuel and absorb it.
  - High winds, waves and other factors may limit the effectiveness of these materials.
  - Granular sorbent materials are NOT to be used for spill response on water.
- Skimmers will be deployed in open-water areas to remove product from the water surface;
- Use of sub-surface barriers to contain spilled product that may sink;
- Pump contaminated water into tanks or storage bladders if possible; and
- Chemical dispersants should not be used as a spill response technique at the Hope Bay project, seek direction from the Corporate Director – Environment & Critical Infrastructure and the Sr Advisor – Environment & Permitting, Western Nunavut .

Also see Section 2.3.18 of this document for guidance related to additional spill protection, clean-up, and reporting measures for environmentally sensitive species and archaeological sites.

Spill response measures specific to bulk fuel offloads completed at Roberts Bay are detailed in the Hope Bay Ocean Pollution Prevention Plan/Oil Pollution Emergency Plan (OPPP/OPEP). The OPPP/OPEP is the main document of reference for spill control actions during a fuel offload at the Hope Bay project and is revised annually.

2.3.12 Spills on Snow

Spills on snow will be contained and recovered by:

- Use of appropriate absorbent pads, socks and similar materials to recover spilled product;
- Compacting the snow into snow-berms and placing a liner of plastic sheeting at the toe and over the berm to collect spilled material and facilitate recovery;
- Using the snow as a natural absorbent to collect spilled product; and
- An excavator, grader or other heavy equipment may be used to scrape up contaminated snow to be stored in a lined containment area or placed in steel drums.

2.3.13 Spills on Ice

Spills on ice will be contained and cleaned up by:

- Use of appropriate absorbent pads, socks and similar materials to recover spilled product;
- Creating snow-berms by compacting snow around the edge of the spill and placing a liner of plastic sheeting at the toe and over the berm to collect spilled material and facilitate recovery;
- Scraping contaminated snow/ice from the ice surface and placing in lined containment:
  - Snow may act as a natural absorbent to collect spilled product.
- In broken-ice conditions a skimmer may be used to collect product on the surface of open-water areas:
  - Caution must be used when conducting spill response efforts in broken-ice situations. An appropriate Task Hazard Analysis safety plan and PPE must be determined before initiating these actions.
- An excavator, grader or other heavy equipment may be used to scrape up contaminated ice to be stored in a lined containment area or placed in steel drums:
  - A vacuum truck may be employed to recover large volumes of spilled material.

2.3.14 Spills under Ice of Substances that Float

Hydrocarbon spills under ice will be addressed by:

- An appropriate Task Hazard Analysis safety plan and PPE must be determined before initiating these actions;
- Testing of the ice to ensure thickness is safe for personnel to work on the surface;

- Once ice has been deemed safe, slots will be cut in the ice surface in the area surrounding the spill and downstream of the anticipated direction of flow/spread:
  - Contaminant will rise to the surface within the slots.
  - Determine the direction of any currents (if expected; this would not be the case in an ice-covered lake) to identify the direction of flow and conduct ice profiling beyond the extent of the spill to identify any spread of the contaminant.
- Contaminant will be skimmed/scooped out from within the slots and placed into empty pails/drums as it is recovered;
- Pockets within the ice where contaminants can pool will be identified (this applies to ice which may have buckled areas where spills may pool; largely an ocean occurrence);
- Absorbent pads and booms will be used to contain spill if there is water moving past the ice edge (if any) where the spill took place:
  - Set booms ahead of the spill based on the direction of anticipated flow.
- A vacuum truck may be employed to recover larger volumes of spilled material or utilizing an Auger and pump system to pump spilled material into containers (e.g., drums).

2.3.15 Spills under Ice of Substances that Sink

- Response to spills below ice of substances which sink will be evaluated on a quantity, substance-specific, and risk basis. In many circumstances, particularly for small releases of non-toxic substances, the appropriate response may solely be to limit discharge as soon as possible and safe to do so. Agnico Eagle will assess each individual situation and may consult a remediation specialist for advice in addition to discussions with the KIA, CIRNAC, DFO, and ECCC, where appropriate unless there is additional information or clarification;
- Allowing substance to settle with minimal disturbance to limit spread (for waterbodies without current);
- A vacuum truck may be employed to recover larger volumes of spilled material or utilizing an Auger and pump system to pump spilled material into containers (e.g., drums);
- Use of sub-surface barriers to contain spilled product if there is water moving past the ice edge (if any) where the spill took place; and
- Appropriate subsurface containment will be used to contain spilled material if there is water moving past the ice edge (if any) where the spill took place.

2.3.16 Spills under Ice of Substances that Dissolve

- Response to spills below ice of substances which dissolve will be evaluated on a quantity, substance-specific, and risk basis. In many circumstances, the appropriate response may solely be to limit discharge as soon as possible and safe to do so. Agnico Eagle will assess each individual situation and may consult a remediation specialist for advice in addition to discussions with the KIA, CIRNAC, DFO, and ECCC, where appropriate;

- A vacuum truck or an Auger and pump system may be used to pump contaminated water into containers (e.g., drums) if rate of dissolution is slow enough/contaminated water volume is small enough to make this feasible; and
- For Sodium Cyanide spills see substance-specific emergency response plan in Appendix 1.

2.3.17 Spills of Compressed Gas

If an accidental release of compressed gas occurs:

- Stop the source if safe to do so;
- Ventilate the area well to dilute the gas;
- Cordon off the area to prevent accidental ignition, explosion or inhalation by personnel; and
- Only employees with proper training and PPE will attempt to mitigate the release.

2.3.18 Burning Spills

Small spills of hydrocarbons (< 100 L) may be removed from unlined camp pad areas by using a propane torch (Tiger torch). This response method would reduce the waste production and handling/storage of contaminated materials associated with the spill and would reduce the risk of spreading or contaminating other areas during transport of these materials. No water would be used and no waste would be deposited to water as a result of this response method.

Extra safety precautions must be taken prior to the use of a propane torch in the event of a spill. A Task Hazard Analysis will be completed prior to undertaking this activity. The SDS for the product will be reviewed to check for the reaction of the substance to heat. PPE such as Fire Resistant clothing and the proper gloves and respirator will also be worn and a spotter with a fire extinguisher rated for the type of spill and fire must be present during the clean-up.

Burning of larger spills may be considered on a case by case basis and only once Agnico Eagle has consulted with and received approval from ECCC, the KIA, the CIRNAC Inspector and any other associated regulatory agencies. This method of response is only useful if quick action is possible, and prior to natural spill dispersal and loss of the more ignitable hydrocarbon fraction.

2.3.19 Spills Affecting Environmentally Sensitive Species or Archeological Sites

The Hope Bay mine site contains a number of habitats, species and sites of archeological and historical importance. The possibility exists for a spill or an environmental emergency to impact these environmental and cultural resources.

Agnico Eagle and previous companies operating on the Hope Bay site have conducted numerous ecological surveys to identify these areas at risk, with the focus of identifying those areas immediately surrounding mine infrastructure which are at greatest risk of impact from a spill.

In the event that a spill enters the natural environment, the Environmental Superintendent may use maps identifying these sensitive areas to prioritize the protection of these resources. Prioritization of environmental sensitivities will not be at the expense of safety or of reaching or maintaining control of the release. Sensitivity maps are provided in Appendix 3.

Should decisions be required which protect some sensitive areas at the expense of others, the hierarchy of protection will attempt to favour (except as directed otherwise by regulatory agencies):

1. waterbodies;
2. sensitive habitat types;
3. archaeological sites;
4. rare plants; and
5. active raptor nest or wildlife den.

For spills in water, prioritization will attempt to avoid vegetated and finer substrate shoreline areas (sand, gravel and cobble) from which recovery is most difficult and which may be of high value to fish.

All of the communications outlined in this section would occur in addition to any appropriate spill reporting outlined in Section 3.

2.3.19.1 Mitigation of Impacts to Wildlife

All reasonable measures will be taken to deter wildlife from coming into contact with any spilled material. In the event that wildlife does come in contact with a spilled material, Agnico Eagle will contact the KIA and either ECCC (in the case of migratory birds (does not include raptors)) or GN Wildlife Officers (in the case of other animals) to inform them of the impact and determine an appropriate course of action. In cases where wildlife can be rescued, wildlife spill response experts will be contacted for assistance and guidance.

2.3.19.2 Mitigation of Impacts to Birds

In the event that a contaminant is released to a body of water, initial wildlife response measures will be exercised in alignment with the Birds and Oil-CWS Response Plan Guidance document if migratory birds are or may be impacted. Environment and Climate Change Canada's Canadian Wildlife Service (ECCC-CWS) will be consulted to determine response strategies including the most appropriate humane treatment of oiled wildlife. Agnico Eagle may also engage contract response agencies specialized in wildlife response actions during a spill event. Initial wildlife response measures should include:

- Hazing to deter wildlife from using spill area:
  - Watercraft;
  - Sound makers such as whistles or horns; and
  - Helicopter* (if available and safe to do so).

- Wildlife monitoring:
  - Assessment surveys for oiled and unoiled wildlife; and
  - Wildlife observers will be on vessels and aircraft if possible.
- Bird Collection*:
  - To collect dead and live birds within the spill area and adjacent. All response vessels should be equipped with dip nets, large plastic collecting bags to hold dead birds, and cloth bags or cardboard boxes to hold live oiled birds.

** The use of aircraft to deter migratory birds and the collection of live and dead birds require an authorization from ECCC-CWS.*

2.3.19.3 Mitigation of Impacts to Archeological Features and Sensitive Habitats

If a spill is determined to have impacted any archeological or historic resources, prior to removing soil or vegetation, Agnico Eagle will immediately contact the Project Archaeologist. The Project Archaeologist will provide advice on next steps, and may travel to site to mitigate the archeological site. The Archeologist will also coordinate permits and communications with the Government of Nunavut Territorial Archaeologist.

In the event that shoreline substrates or aquatic vegetation have been impacted, Agnico Eagle will contact Environment and Climate Change Canada and the Department of Fisheries and Ocean for advice prior to initiating removal.

2.4 Disposal of Contaminated Materials

All contaminated materials generated during a spill event will be contained and disposed of as per the product specific SDS and as outlined in the Hazardous Waste Management Plan and Non-Hazardous Waste Management Plan. Empty drums, barrels, mega-bags and storage tanks are available to store contaminated materials for disposal.

Hydrocarbon contaminated soil, snow and water may be remediated in Landfarm facilities if these materials meet the requirements for remediation as per the Hydrocarbon Contaminated Material Management Plan or may be placed within the underground mine.

2.5 Spill Response Resources

2.5.1 On-Site Resources

Spill Response Kits will be available near (within 200 m) any areas where chemicals are stored and used on site, including near all bulk fuel berms and smaller fuel tanks. Spill response kits will be easily accessible for personnel responding to a spill. As project activities evolve and new locations of chemical storage and use are identified new spill kits will be added as needed, and all active construction areas where equipment is operating will also have a spill kit located within 200 m.

Additional spill response equipment is maintained for response in an aquatic environment. This equipment is stored in ten moveable containers that can be relocated for rapid response to a spill in a stream, lake or marine environment.

Agnico Eagle maintains an on-site supply of appropriate Personal Protective Equipment compatible with the chemical products used on site, including chemical resistant suits, gloves and boots, face shields/goggles and respirators. In the event of a spill, this equipment is used by spill responders as outlined in the product SDS. Specialty equipment, such as Self-Contained Breathing Apparatus, air quality monitors and fire retardant clothing are available and used as needed to ensure a safe response to a spill incident.

All fuel transfer vehicles are also equipped with a spill kit designed to address smaller spills of hazardous fluids (< 40 L). Personnel are trained in proper fueling procedures and spill trays are used during all fueling activities to minimize the potential of an unintentional release.

A list of supplies contained in each spill kit type, supplies in the aquatic spill response containers, and PPE/specialized equipment for spill response is provided in Appendix 2.

Agnico Eagle also maintains an on-site supply of roll, pad and mat absorbents, plug and dyke kits, mini booms, absorbent socks, peat moss, crushed corn cobs, coconut mats, hand tools, empty storage tanks and various pieces of heavy equipment including a vacuum truck, grader, dozers, loaders, excavators and haul trucks that would be used in the event of a large spill.

Spill kits are replenished as needed after use and inspected at least once per quarter. The purpose of the inspection is to evaluate the location of spill kit proximity to associated work activities, inspect the condition of the spill kit, and check that all required contents are available and in good condition.

The aquatic response supplies and equipment are inspected annually prior to fuel offloading events and after use in the event of a spill to the aquatic environment.

2.5.2 Off-Site Resources

The Hope Bay Project is a remote location that is only accessible by plane for the majority of the year, with a short open-water ship access season. The Hope Bay Project Spill Contingency Plan does not rely on off-site resources to successfully respond to anticipated upset conditions. The Plan has been developed such that the resources required to respond to spills have been positioned on site. It is anticipated that the Hope Bay Project will have sufficient resources and trained personnel to respond to all types/sizes of spills that could potentially occur on site.

Additional off-site resources would be procured and flown to site as needed in the event that onsite resources were exhausted.

3 Spill Investigation, Documentation and Reporting

3.1 Spill Investigation

A spill investigation will be completed for all spill events that occur at the Hope Bay site. This investigation will be aimed at determining the root cause of a spill and identifying corrective actions that may reduce the risk of a repeated incident.

For spills that exceed the volume thresholds outlined in the Immediately Reportable Spills table at the beginning of this plan, a ‘Systematic Cause Analysis Technique’ (SCAT) Investigation will be completed. SCAT is an in-depth root cause analysis used to investigate significant incidents and identify corrective actions. The SCAT investigation form will be completed by the departmental Supervisor with support from the departmental Manager/Superintendent and the Environmental Superintendent within 7 days of the spill occurrence. The Safety Manager/ Safety Superintendent and MGM may participate in the investigation and assist in developing corrective actions.

For spills that do not exceed the volume thresholds outlined in the Immediately Reportable Spills table, a ‘5 Why’ Investigation will be completed. The ‘5 Why’ method is a simple question-asking technique used to determine the cause/effect relationships underlying a spill. The objective is to identify the root cause by repeatedly asking ‘Why?’ the event occurred. The ‘5 Why’ investigation form will be completed by the departmental Supervisor within 48 hours of the event and forwarded to the Environmental Supervisor/Coordinator.

Records of all spill events and investigations will be maintained by the Environmental department and documented in the Environmental Incident Register. Any corrective actions that are identified will be entered into the Environmental Incident Register and implemented immediately by the departmental Supervisor and/or Manager/Superintendent.

3.2 Agnico Eagle Internal Reporting

An Incident Event notification will be sent by the departmental Supervisor to the Environmental Superintendent prior to the end of the shift in which the spill event occurred. This notification will provide a brief description of the spill, consequences of the spill, root cause of the event if identified and a brief description of the response including containment and cleanup actions. All Environmental Incidents are documented in Agnico’s Incident Management Database System (Intelex). All incidents that have a that have a consequence ≥ 3 are communicated to the Environmental Corporate representative within 24 hours. If the incident has a consequence of level 5, the investigation lead will be the VP of Environment, otherwise the investigation lead is the Environmental Superintendent. The investigation has a deadline of 14 days. Results of the SCAT Investigation and the ‘5 Whys’ Investigation will be communicated to all site Supervisors, Superintendents and Managers, as well as offsite Environmental personnel. Corrective actions generated by these investigations will be discussed with all personnel at the Hope Bay site through email communications and/or discussions at departmental safety meetings. All details of the spill investigation and implementation of corrective/preventative actions will be documented in the Environmental Incident Register by the Environmental department. The investigation report is attached to the incident report in Intelex and communicated in the weekly update report.

3.3 External Reporting Requirements

In the event that a particular material spill meets or exceeds the amount specified in the Immediately Reportable Spills Table (located at https://www.enr.gov.nt.ca/en/services/report-spill, and at the beginning of this plan), the Environmental Superintendent or delegate will complete the NT-NU Spill Report form (available through the preceding link) and report the spill to the NT-NU 24 Hour Spill Report Line by phone (867-920-8130) and/or e-mail (spills@gov.nt.ca) as soon as possible within 24 hours of the event. The CIRNAC Inspector and the KIA will be copied on these submissions. The submission of the report will not be delayed even if not all information is available at the time of submission.

In the event that a spill or an unauthorized deposit of a deleterious substance has occurred to the marine environment, the MGM and/or Environmental Superintendent will also notify the ECCC Enforcement Officer, the KIA and the Canadian Coast Guard station immediately and provide details on the time and location of the discharge, type and quantity of pollutant, description of assistance and salvage measures employed and any other relevant information. A written report will also be submitted within 24 hours. A copy of this report will be submitted to a Transport Canada Marine Safety Inspector if required.

The Environmental Superintendent will communicate with the Corporate Director – Environment and Critical Infrastructures and the Sr Advisor – Environment & Permitting, Western Nunavut during the incident to determine additional notifications to be submitted to regulatory agencies during the event.

In the unlikely event that an environmental emergency occurs which may adversely affect members of the public (closest community is located >120km away) the Mine General Manager will work with the Communications Delegate to provide notification to the public during and after the event. The communication will initially be in the form of a phone call but will be expanded as necessary to protect the safety of the community members. This may include a press release and/or Facebook/Twitter post.

Within 30 days of the event, the Environmental Superintendent or delegate will submit a detailed written spill report to the appropriate regulatory agencies. This report will include a description of the spill location, type and quantity of spilled material, associated causes that led to the incident, details of actions taken to remediate affected areas and potential effects of the spill, measures undertaken to reduce the potential for a reoccurrence of a similar incident, results of monitoring activities undertaken and details of any further actions required. Other applicable details such as the names of agencies on the scene, persons or agencies advised concerning the spill, a chronological sequence of events including internal/external notifications, and lessons learned from events leading up to the spill and the response actions taken may be included in this report. Additional follow-up engagement may occur as deemed appropriate by the Corporate Director – Environment and Critical Infrastructures based on the specific spill and stakeholder input.

A list of spills reported to the NT-NU Spill Report Line will also be provided in the annual report for each of the licence areas.

3.4 Monitoring and Restoration

Specific monitoring requirements for spills will be determined on a case by base basis dependent on the nature of the spill. Monitoring will be conducted in the event that i) spilled material cannot be removed, ii) spill occurs to water of substances that dissolve, sink, or where substance recovery is unlikely and iii) externally reportable spills to land for which recovery is unlikely or incomplete. Details of follow-up monitoring conducted in response to a spill will be detailed in the 30 day follow-up spill report submitted to the NT-NU Spills Hotline, the CIRNAC Inspector and the KIA.

Monitoring activities will be conducted to assess the impacts of the spill and the effectiveness of associated cleanup/remediation efforts in the event spilled material cannot be removed. This may include a number of monitoring techniques and collection of samples for laboratory analysis. The monitoring program will be developed by the Environmental Superintendent in consultation with the Environmental Affairs Department and associated regulatory agencies.

Monitoring will be triggered in the event of spills to water of substances that dissolve or sink or where substance recovery is unlikely. Samples will be collected to characterize 1) the material discharged (if not of known characteristics), 2) the water at the location of entry into the waterbody as soon after the discharge as possible, and 3) water at a ‘reference’ location, preferably within the same waterbody but outside of the area of potential impact and collected at approximately the same time as the sample collected at the point of entry.

Monitoring will also be triggered in the event of externally reportable spills to land for which recovery of spilled material is unlikely or may be incomplete. Samples will be collected from locations of suspected highest remaining contamination, or as a composite sample from the remediated area. Samples will be compared to soil remediation criteria and background soil concentration data to verify appropriate clean-up has occurred.

The Environmental Supervisor/Coordinators will be responsible for overseeing the implementation of these monitoring activities at the direction of the Environmental Superintendent. No person will be permitted to sample spilled materials unless that person has received adequate training in the identification of the hazards associated with the spilled material, the selection and use of appropriate personal protective equipment, and safe sampling procedures.

The final required clean-up, restoration (or mitigation) and on-going monitoring will be conducted as needed, and where appropriate in consultation with, and satisfaction of, the CIRNAC Inspector and the KIA. Site specific studies may be required to determine the appropriate final clean-up criteria.

If required, continuing and progressive sample collection/analysis will be conducted and reported upon until the completion of all prescribed remedial activities.

3.5 Incident Review and Root Cause Analysis

A review of incidents and root cause analysis will be conducted by the Environmental Superintendent quarterly. The purpose of this review will be to identify trends in root cause. Lessons learned from this exercise will be used to develop additional corrective actions including awareness campaigns for site personnel, improvements to operational equipment and spill response resources.

4 Spill Management and Mitigation

Site supervisors and managers are responsible for ensuring work area inspections and risk assessments are conducted of their respective work areas. Risk assessments include evaluation of hazardous materials available and in use in the work area, and likelihood and potential consequences of various spills. Where appropriate based on likelihood and potential severity, mitigation, management and/or substance-specific spill response plans will be developed.

The following section outlines currently identified potential spill risks with potential for high severity and/or probability of occurrence (worst case scenarios) and the management and mitigation measures employed to reduce the likelihood of these occurrences and/or the potential severity. Additional scenarios, as well as appropriate management and mitigation actions, will be added to this section through time as they are identified.

4.1 Issue: Spill from a Chemical Storage Tank or Other Containment

A fuel storage tank, containment area, sump, emergency dump catch basin or other product container may release their contents for a number of reasons, such as damage due to puncture, openings developed over time due to degradation (such as rusting), or overfilling.

Equipment malfunction or facility failure may cause a spill event to occur, particularly during extreme winter temperature conditions experienced at the Hope Bay mine site.

4.1.1 Management Response

This risk is minimized through the use of secondary containment and spill containment. All bulk fuel facilities are located in secondary containment (i.e., containment designed to contain volumes equivalent or greater than 110% of the aggregate or total volume of the largest container in the containment – whichever is greater). Smaller chemical storage tanks are either double walled (have built-in secondary containment), and are located in spill trays such that any leakage from hoses or lines are further contained or are located in secondary containment berms. Spill trays are used under fuel drums and other smaller chemical containers.

Inspections of all containment structures will be conducted weekly to ensure concerns are noted and are addressed promptly.

In the event that a spill exceeded the capacity of a containment berm (for example, if more than one container in a berm was breached) or a containment berm became compromised, the spill response actions outlined in Section 2 would be implemented. Containment measures would be deployed to prevent the spread of the chemical into the natural environment. This would include deploying absorbent materials or booms and constructing diversion trenches or sumps to intercept the spilled product. The vacuum truck and all available pumps would be deployed to transfer spilled product into empty storage tanks or alternative containment berms if necessary.

4.2 Issue: Spill during Transport

Spills may occur during the transport of chemicals from one site location to another.

4.2.1 Management Response

As new chemicals, fuels and hazardous materials are brought to site, standard operating procedures are developed that outline the process for safely transporting or transferring these products between locations at site. Experienced operators transport these materials and are familiar with site road conditions. Traffic right-of-way procedures are established that reduce the risk of an accident between two vehicles and all vehicles are equipped with radio communication to ensure operators can remain in contact at all times. A spotter is used to direct operators loading and off-loading these materials from transport vehicles to reduce the risk of damage to chemical storage containers during transport and loading. Spill trays are used when chemicals are transferred to equipment or secondary containers for use.

4.3 Issue: Spill during Transfer

Spills have an increased likelihood of occurring during transfer of chemicals. This may be the case during equipment refuelling, transfer of chemicals between containers, or transfer of wastewater or tailings in pipelines. Such spills may result from human error (overfilling, inaccurate filling) or equipment malfunction (such as a break in the transfer line/pipe due to wear or freeze/thaw cycles).

4.3.1 Management Response

As new chemicals, fuels and hazardous materials are brought to site, standard operating procedures are developed that outline the process for safely using these chemicals during operations. Workers who use chemicals or fuels during daily operational activities receive training in the proper handling, storage and disposal of these materials prior to commencement of work. Any applicable SDS sheets are reviewed by all workers using these chemicals to identify potential hazards. Workers are encouraged to plan work activities before beginning a task to reduce the potential for inadvertent errors.

Fueling of mobile equipment generally takes place at designated fueling stations, which are located inside of secondary containment berms, minimizing risk to the environment. Remote fueling, such as occurs for stationary equipment and helicopters, requires a spill kit be easily accessible and spill trays are used.

Fuel tanks are not filled to full capacity, to reduce the possibility of overflow during fueling or due to expansion.

Workers are provided with on-site training in spill response techniques and are familiar with the response resources available in the event of a spill.

Wastewater transfer pipelines, for sewage as well as other wastewaters, are constructed to reduce breakage due to freeze/thaw cycles and are routinely inspected to ensure they are functioning. Delineators are used to mark pipelines to ensure vehicle and equipment operators are aware of pipeline locations when travelling on site roads.

Additional design features of the tailings lines which reduce the risk of spills are outlined in the Hope Bay Project Phase 2 Doris Tailings Impoundment Area Operations, Maintenance and Surveillance (OMS) Manual.

Should any of the above measures fail, spill response would be undertaken as outlined in this document.

4.4 Issue: Spills from Equipment

Spills may occur from mobile and stationary equipment during routine maintenance or due to equipment malfunction or wear combined with extreme weather conditions.

4.4.1 Management Response

All equipment at site undergoes routine preventative maintenance, and mobile equipment is subject to daily pre-operational inspections to identify specific issues for mechanical resolution. Where possible, all equipment maintenance is performed in designated maintenance areas. During equipment maintenance, spill trays are used as needed. Spill trays are also used for stationary equipment, or those parked for extended periods of time.

4.5 Issue: Health and Safety of Spill Responders

Some products and chemicals used at the Hope Bay site may pose a risk to the health and safety of personnel responding to a spill. Spilled materials may create toxic, explosive or flammable hazards that must be considered during response efforts.

4.5.1 Management Response

Personnel working at the Hope Bay site are provided on-site training in the proper handling, storage and disposal of chemicals related to their tasks. The product SDS is reviewed by personnel prior to using these chemicals to identify potential hazards related to handling these materials.

The SDS for each chemical outlines the specific personal protective equipment (PPE) required when handling each product and provides information on methods for clean-up in the event of an accidental release to the environment. SDS sheets are maintained at site for all chemicals stored and used at the Hope Bay Project.

In the event that a spill poses toxic, explosive, flammable or other hazards that endanger personnel or the environment, the Emergency Response Team (ERT) will be activated through the Incident Command System. Members of the ERT are equipped with additional PPE that allows them to safely respond to hazardous situations and receive additional training in response techniques for these scenarios.

Site chemicals are reviewed annually and compared to the Environmental Emergency Regulations. If any chemicals are anticipated to be stored in quantities exceeding the quantity thresholds outlined in these regulations a Product Specific Emergency Response Plan will be developed and submitted as an addendum to this Plan. Product Specific Emergency Response Plans identified as necessary for products stored at the Hope Bay site are located in Appendix 1 of this Plan.

4.6 Issue: Spills to Water

Spills to water are of particular concern due to the sensitivity of water environments and potential of rapid spread of spills into water.

4.6.1 Management Response

No chemicals are stored within 31 m of water. All chemicals are kept in containment, and spill kits are located nearby which contain small booms and absorbent pads. In the event of a large spill to water, additional itemized and audited Aquatic Spill Response Equipment is located at Roberts Bay in movable seacans. Response actions protective of wildlife are outlined in Section 2.2.18 Environmentally Sensitive, above.

4.7 Issue: Operational Considerations for Spill Response

Hope Bay is a remote project site that experiences extreme weather conditions and seasonal daylight variations which may impact the effectiveness of spill response actions. The Hope Bay Project is only accessible by plane for the majority of the year, with a short open-water ship access season.

4.7.1 Management Response

This Plan has been developed such that the resources required to respond to spills have been positioned on site. It is anticipated that the Hope Bay Project will have sufficient resources and trained personnel to respond to all types/sizes of spills that could potentially occur on site.

The majority of activities conducted at the site occur on the project infrastructure roads and camp pads. In the event that a spill occurs off the site infrastructure, helicopters and off-road tundra (low impact) vehicles, such as the Rim-pull, will be used to mobilize spill response resources. The impact from these vehicles will be monitored and damage to the surrounding tundra minimized to the extent possible.

Extreme weather conditions, such as sub-zero temperatures, that may impact the response capabilities of personnel will be mitigated by rotating personnel from response activities to break areas as needed. This may include using heated vehicles, portable shelters or heated buildings.

Portable light plants are available on-site and will be used in seasonal darkness to aid in spill response containment, clean-up and remedial actions.

4.8 Risk Identification Matrix

As part of Environmental Incident Management, a risk assessment exercise using the AEM RMMS risk quantification and classification methodologies and risk criteria for Critical Infrastructures was completed. The risk assessment was also used to identify the Worst-Case Scenario and Alternative Worst-Case Scenario as defined by reporting requirements of the E2 Regulations. The matrix defines the level of risk (low risk ≤ 3, high risk ≥ 12) by considering likelihood and consequence severity. The exercise increases the visibility of risks and identifies potential risk areas, as well as determines the fate of spilled products and their environmental effects. The risk assessment exercise is documented in Intelex.

4.8.1 Worst-Case Scenario (WCS)

Under Section 4(2)(3) of the E2 Regulations, the Worst-Case Scenario is the release of the greatest quantity of a hazardous substance, contained in the largest container or not in a container system, irrespective of the impact distance to an endpoint being inside or outside the boundary of a facility. The scenario does not need to be reasonable.

A diesel spill from a 5 ML storage tank at the Roberts Bay Laydown Facility would be the Worst-Case scenario at Hope Bay. In this scenario, the entire storage tank contents are emptied, the containment berm fails, and diesel is released to the surrounding area. The maximum quantity of diesel that can be released from a single tank is 5 ML. At this volume, the spill is expected to follow topography and reach Roberts Bay (< 1 km away). Potential receptors from the spill include the waterbody, fish, and wildlife habitat. Given the isolation of the site, there is no potential for impact on communities.

4.8.2 Alternate Worst-Case Scenario (AWCS)

The Alternate Worst Case Scenario is described in Section 4(2)(f) of the E2 Regulations. This scenario is more likely to occur than the worst-case scenario and has the longest impact distance to an endpoint outside the boundary of the facility.

A spill during the transport of fuel at Roberts Bay is considered the Alternate Worst-Case Scenario at Hope Bay. In this scenario the spill occurs during a fuel tanker truck accident while transporting fuel from the Roberts Bay tank farm. The spill is between 10,000 – 15,000 L (~ 20-30% of the storage). At this volume, the spill is expected to reach Roberts Bay (>1 km away). Potential receptors from the spill include the waterbody, fish, and wildlife habitat. Given the isolation of the site, there is no potential for impact on communities. The impact distance is outside the boundary of the facility and is controlled by sea conditions in Roberts Bay.

4.8.3 Alternate Scenario (AS)

The Alternate Scenario is an E2 environmental emergency scenario, that has not been assigned as the WCS or AWSC. It is a scenario that could reasonably be expected to occur at a facility and that would likely cause harm to the environment or constitute a danger to human life or health. A spill during the transfer of fuel at fueling stations is considered an Alternate Scenario at Hope Bay. In this scenario the spill occurs while workers fuel vehicles/equipment at fueling stations, or when transferring fuel into portable tanks for use. The worker is distracted and responds within 5 minutes to stop the spill. In this case the spill is between 1000 – 5,000 L. Potential receptors from the spill include the tundra environment, the waterbody (Doris Lake), fish and/or wildlife habitat. Given the isolation of the site, there is no potential for impact on communities.

5 Training

All personnel working at the Hope Bay site receive onsite training during the initial site orientation. At that time, every employee is informed that he/she is potentially a First Responder to any spill or unanticipated discharge event and is provided a brief explanation of the actions expected of every First Responder and where to find the First Responder SOP (flow chart) which is included in the site spill kits. Spill response plans are also located in accessible public locations on site.

Supervisors provide task-specific training to workers using chemicals onsite which includes appropriate handling, storage, disposal, and where to find guidance on spill response for these chemicals. Workers are provided with information on spill response requirements and the locations of spill kits in their immediate work area. Spill response techniques are reviewed in departmental safety meetings by representatives of the Environmental department on an annual basis as part of a tool-box session. The lessons learned from spill investigations are communicated to all workers as corrective actions are developed.

Additionally, more detailed training is provided to workers involved in fuel offloading activities, through consultants such as Riverspill Response Canada Ltd. The instructional sessions include site safety, materials properties and strategies as well as tactics for containment and recovery in-facility, on land (brief) and on water spills. This training also includes the performance of mock spill response practical exercises (tabletop and field drills) in years of fuel offload, including deployment of spill response equipment under typical operating conditions.

Members of the Emergency Response Team receive frequent training regarding a variety of incident scenarios and response techniques applicable at the Hope Bay site. This training includes response to fire, explosive or toxic incidents, including spill of materials that could result in these conditions.

As per the Environment Emergency Regulation, a yearly simulation exercise will be conducted, and a full-scale exercise will occur every five years. Supervisory training of the SCP occurs annually prior to the yearly simulation exercise. Debriefing of the simulation exercise will allow to determine the aspect of the current plan (training, prevention, communication) that will need to be improved. This SCP will be updated to reflect the conclusions and improvement needed.

These training programs ensure that personnel understand the procedures in the Hope Bay Spill Contingency Plan, the hazards of the materials stored on-site, who is responsible for what activities, how to initiate a response, where to find and use response equipment, and how to obtain off-site resources. Training is delivered by the Health & Safety and Environment Groups. Supervisors are responsible to ensure that their employees are trained for the tasks.

5.1 Spill Response Simulation Exercises

A spill response simulation exercise will be conducted annually in coordination with Agnico Eagle Management and the Emergency Response Team. The exercise will simulate one of the environmental emergencies identified in Appendix 1 for an E2 Schedule 1 listed hazardous chemical or product stored on site. The exercise will simulate the release of one of these products to the environment and will test the response actions of the Incident Command System and Emergency Response Teams.

Every 5 years, a full-scale simulation exercise will be conducted which will test the response actions of the Incident Command System and Emergency Response Teams, and will include deployment of personnel, resources and equipment during the simulation.

Each annual exercise will simulate the release of a different E2 Schedule 1 listed product stored on site until all environmental emergencies identified in the Product Specific Emergency Response Plans have been tested, at which point the cycle will begin again. Emergency Response Plans for E2 Schedule 1 listed products stored on site are provided in Appendix 1 of this Plan.

Details of spill response simulation exercises will be documented and improvements identified will be incorporated into updates to the Spill Contingency and Emergency Response Plans. A record of these exercises, results and modifications to these plans will be maintained on file for 5 years and available for inspection upon request.

Once completed, a notice regarding the simulation exercise will be submitted to the Minister as outlined in Schedule 5 of the Environmental Emergency Regulations.

6 References

2010. *Consolidation of Environmental Protection Act* (R.S.N.W.T 1988, c.E-7). Current to August 29, 2010, Government of Nunavut.

2011. *Nunavut Waters and Nunavut Surface Rights Tribunal Act* (S.C.2002, c.10) Current to May 5, 2011, Aboriginal Affairs and Northern Development Canada.

Consolidation of Environmental Emergency Regulations (S.O.R. 2019-51). Current to November 19, 2019, Environment and Climate Change Canada.

Consolidation of Regulation R-068-93 Spill Contingency Planning and Reporting Regulations as provided by the Government of Nunavut website.

Contingency Planning and Spill Reporting in Nunavut, A Guide to the New Regulations. Environmental Protection Service, Department of Sustainable Development, Government of Nunavut.

Implementation Guidelines for Environmental Emergency Regulations. 2011. Environment and Climate Change Canada.

Canadian Wildlife Services. 2012. *Birds and oil-CWS Response Plan*.

INAC. 2007. *Guidelines for Spill Contingency Planning*. Water resource Division, Indian and Northern Affairs Canada, April 2007.

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Mudder, T.I. *Cyanide Spills Prevention and Response.*

HOPE BAY SPILL CONTINGENCY PLAN

HOPE BAY, NUNAVUT

Module A: Doris

Conformity Table

Licence	Part	Item	Topic	Report Section
2AM-DOH1335	H	1.	The Licensee shall implement the following plans as approved by the Board: *Surface Emergency Response Plan*, *Underground Emergency Responses Plan*, and *Hope Bay Project Spill Contingency Plan*. The Licensee shall comply with the Plan(s) and any changes deemed significant shall require the submission and subsequent approval of the Board in writing.	This Plan
		2.	All sumps and fuel caches shall be located at a distance of at least thirty one (31) metres from the ordinary High Water Mark of any adjacent Water body and inspected on a regular basis.	Section 2 Section 4.6
		3.	The Licensee shall prevent any chemicals, petroleum products or wastes associated with the project from entering Water.	Section 2 Section 4.6
		4.	The Licensee shall provide secondary containment for fuel and chemical storage as required by applicable standards and acceptable industry practice.	Section 4.1
		5.	The Licensee shall perform weekly inspections of petroleum products storage and containment facilities, fuel tanks and connectors, for leaks and settlement and shall keep a written log of inspections to be made available to an Inspector upon request. More frequent inspections may be requested by an Inspector.	Section 4.1
		8.	The Licensee shall conduct emergency maintenance and servicing on equipment, in designated areas, and shall implement measures to collect motor fluids and other Waste to prevent and contain spills.	Section 4.4
		9.	The Licensee shall, subject to Section 16 of the Regulations, report any unauthorized deposits or foreseeable unauthorized deposits of waste and/or discharges of Effluent, and:	See below
		9a.	• employ the Spill Contingency Plan;	Section 2
		9b.	• report the incident immediately via the 24-Hour Spill Reporting Line *[see pg. iii Key Government Contact List]*, to the Inspector at [see pg. iii Key Government Contact List] and to the Kitikmeot Inuit Association at *[see pg. iii Key Government Contact List]*; and	Section 3.3
		9c.	• for each spill occurrence, submit a detailed report to the Inspector, no later than thirty (30) days after initially reporting the event, which includes the amount and type of spilled product, the GPS location of the spill, and the measures taken to contain and clean up the spill site.	Section 3.3
		10.	The Licensee shall, in addition to Part H, Item 9, regardless of the quantity of releases of harmful substances, report to the NWT/NU Spill Line if the release is near or into a Water body.	Section 3.3
	I	11.	The Licensee shall submit to the Board for review, at least sixty (60) days prior to operation of the Roberts Bay Discharge System, an addendum to the Spill Contingency Plan detailing spill prevention measures along the pipeline.	A3

Licence	Part	Item	Topic	Report Section
	Schedule B		The Annual Report referred to in Part B, Item 2 shall include the following:	See below
		8.	A list and description of all reportable unauthorized discharges including volumes, spill report line identification number and summaries of follow-up action taken	Section 3.3

A1 Introduction

The Type A Water Licence No. 2AM-DOH1335 issued by the Nunavut Water Board (NWB) requires the development of a Spill Contingency Plan in accordance with Part I. The Spill Contingency Plan has been prepared and is being submitted by Agnico Eagle to address this requirement, and also includes the plan for spill response throughout the Hope Bay belt.

The 2AM-DOH1335 Licence area includes the Doris Camp and the necessary infrastructure to support surface exploration, underground mining and development activities, and ore processing. Refer to Module C of this plan for details and description of chemical storage related to Madrid infrastructure under this licence.

A2 Chemical Storage at Doris

A list of fuel and chemical storage facilities, containment capacity, products stored and maximum expected quantity to be stored within each facility for the Doris area is provided in Table A.1 below. Table A.1. is a comprehensive list of the chemical storage at Doris, exclusions under the E2 regulations have not been considered. Chemical storage locations are also depicted on the photographs provided below, in addition to the default spill kit locations.

Table A.1. Doris Fuel and Chemical Storage Total Quantities

Products Stored	Total Maximum Expected Quantity Stored
Diesel Fuel	32,627,151 L
Jet-A Fuel	420,160 L
Waste Oil	1,700 L
Amex (Ammonium nitrate)	900,000 kg
Collector	90,000 kg
Promoter	30, 100kg
Frother	16,000 kg
Flocculant Low pH	16, 000 kg
Sodium Cyanide	240,000 kg
Caustic Soda	450,000 kg
Flocculant High pH	2,000 kg
Sodium Metabisulphate	240,000 kg
Copper Sulphate	125,000 kg
Hydrochloric Acid	4000 kg
Sodium Benzoate	20,000 kg
Silica Sand	5000 kg
Borax	12,500 kg
Soda Ash	8750 kg

Potassium Nitrate	5000 kg
Calcium Chloride	11,030 tonnes
Acetylene	3600 cu. ft.
Propane	3000 lbs
Oxygen	79,400 L

Table A.2. Doris Fuel and Chemical Storage Locations

Storage Location	Facility Description/ Storage Capacity	Tank Description	Containment Capacity	Products Stored	Maximum Expected Quantity Stored
Roberts Bay Bulk Fuel Storage Facility (Quarry 1 / ST-6a)	1 @ 5,000,000 L Tank	Field-erected	Gravel/HDPE, 6,270,000 L	Diesel Fuel	5,000,000 L (1)
Roberts Bay Bulk Fuel Storage Facility (ST-6b)	4 @ 5,000,000 L 1@ 400,000 L Tanks	Field-erected, individual tanks	Gravel/HDPE, 9,190,000 L	Diesel Fuel Jet-A	20,000,000 L 400,000 L (1)
Batch Plant/ equipment storage	2 @ 1240 L	Pre-fabricated, double-walled, portable	Spill containment	Diesel Fuel	2 @1116 L (2)
Doris Camp Site Fuel Storage Facility (ST-5)	5 @ 1,500,000 L Tanks Dispensing Module (Active)	Field Erected tanks interconnected with double manual valves and electrically interlocked motor actuated valve	Gravel/HDPE, 2,976,000 L	Diesel Fuel	7,500,000 L (1)
Doris Helipad (office, washcar)	1 @ 1240 L	Pre-fabricated, double-walled, portable	Insta-berm, spill containment	Diesel Fuel	1116 L (2)
Doris Helipad (Jet-A Storage)	Drums in Seacan (maximum 64 drums) 2 @ 3000 L Tanks	Drums Pre-fabricated, double-walled, portable	HDPE spill containment Spill containment	Jet A Fuel Jet-A Fuel	13,120 L 5400 L (1)
Doris Helipad (landing pads)	Drum fuel (8) placed at each active helicopter landing pad	Drums	Plastic spill pallets, 220 L	Jet A Fuel	1640 L (1)
Doris Muster Station	1 @ 1240 L	Pre-fabricated, double-walled, portable	HDPE/Wood spill containment	Diesel Fuel	1116 L (2)
Doris Powerhouse (old)	1 @ 15,000 L	Pre-fabricated, double-walled, portable	HDPE/Wood spill containment	Diesel Fuel	15,000 L (1)
Doris Powerhouse (new)	4 @ 5000 L	Pre-fabricated, double-walled, portable	4 @ 5500 L each, Concrete	Diesel Fuel	20,000 L (1)

Storage Location	Facility Description/ Storage Capacity	Tank Description	Containment Capacity	Products Stored	Maximum Expected Quantity Stored
Roberts Bay Waste Management Facility Generator	Internal tank @ 2250 L	Pre-fabricated, double-walled,	Internal steel spill containment	Diesel Fuel	2025 L (2)
Roberts Bay Incinerator	1 @ 1500 L (Inactive)	Pre-fabricated, double-walled	Steel Spill containment	Diesel Fuel	1350 L (2)
	2 @ 1000 L (Inactive)	Pre-fabricated, double-walled		Diesel Fuel	2 @ 1000 L (1)
Quarry 2 Incinerator	1 @ 4500 L	Pre-fabricated, double-walled	Steel Spill containment	Diesel Fuel	4500 L (1)
Waste Management Facility Waste Oil Burner	2 @ 850 L	Plastic Cube	Spill containment	Waste Oil	1700 L (2)
Rob Bay Muster Station	1 @ 1240 L	Pre-fabricated, double-walled, portable	Steel Spill containment	Diesel Fuel	1116 L (2)
Doris Vent Raise	1 @ 70,000 L	Pre-fabricated, double-walled, portable	Gravel/HDPE, 77,000 L	Diesel Fuel	70,000 L (1)
Doris Airport Tower Generator	1 @ 1240 L	Pre-fabricated, double-walled, portable	Steel spill containment; in seacan	Diesel Fuel	1116 L (2)
Doris Pump House	1 @ 1240 L	Pre-fabricated, double-walled, portable	HDPE/Wood spill containment	Diesel Fuel	1116 L (2)
Geotech Shop	1 @ 1240 L	Pre-fabricated, double-walled, portable	Steel spill containment	Diesel Fuel	1116 L (2)
Main Shop	2 @ 1240 L	Pre-fabricated, double-walled, portable	Steel spill containment	Diesel Fuel	2 @ 1116 L
Explosive Berm (TIA Access Road)	Seacan	NA	NA	Amex (Ammonium nitrate)	900,000 kg (3)
Mill Building	1 @ 1240 L	Pre-fabricated, double-walled, portable	Steel spill containment	Diesel Fuel	1116 L (2)
Upper Laydown TIA Reagent Berm	Locked Seacan	NA	Seacans	Collector	90,000 kg (3)
	Locked Seacan	NA	Seacans	Promoter	30, 100kg (3)
	Locked Seacan	NA	Seacans	Frother	16,000 kg (3)
	Locked Seacan	NA	Seacans	Flocculant Low pH	16, 000 kg (3)
	Locked Seacan	NA	Seacans	Sodium Cyanide	240,000 kg (3)
	Locked Seacan	NA	Seacan	Caustic Soda	450,000 kg (3)

Storage Location	Facility Description/ Storage Capacity	Tank Description	Containment Capacity	Products Stored	Maximum Expected Quantity Stored
	Locked Seacan	NA	Seacans	Flocculant High pH	2,000 kg (3)
	Locked Seacan	NA	Seacan	Sodium Metabisulph ate	240,000 kg (3)
	Locked Seacan	NA	Seacans	Copper Sulphate	125,000 kg (3)
	Locked Seacan	NA	Seacans	Hydrochloric Acid	4000 kg (3)
	Locked Seacan	NA	Seacans	Sodium Benzoate	20,000 kg (3)
	Locked Seacan	NA	Seacans	Silica Sand	5000 kg (3)
	Locked Seacan	NA	Seacans	Borax	12,500 kg (3)
	Locked Seacan	NA	Seacans	Soda Ash	8750 kg (3)
	Locked Seacan	NA	Seacans	Potassium Nitrate	5000 kg (3)
Lower Laydown	Seacans with 1000 kg mega bags	NA	NA	Calcium Chloride	11,030 tonnes (3)
	Seacan	NA	NA	Acetylene	10 - WTL bottles (~3600 cu. ft. of product) (3)
	Seacan	NA	NA	Propane	30 – 100 lb bottles (3000 lbs) (3)
	Seacan ERT building ERT building	NA	NA	Oxygen	10 - K bottles (6900 L ea) 3 - M bottles (3000 L ea) 4 - D bottles (350 L ea) (~79,400 L. of product) (3)

(1) Maximum Capacity of Container System
(2) Safe Fill Zone Capacity
(3) Normal quantity stored in container

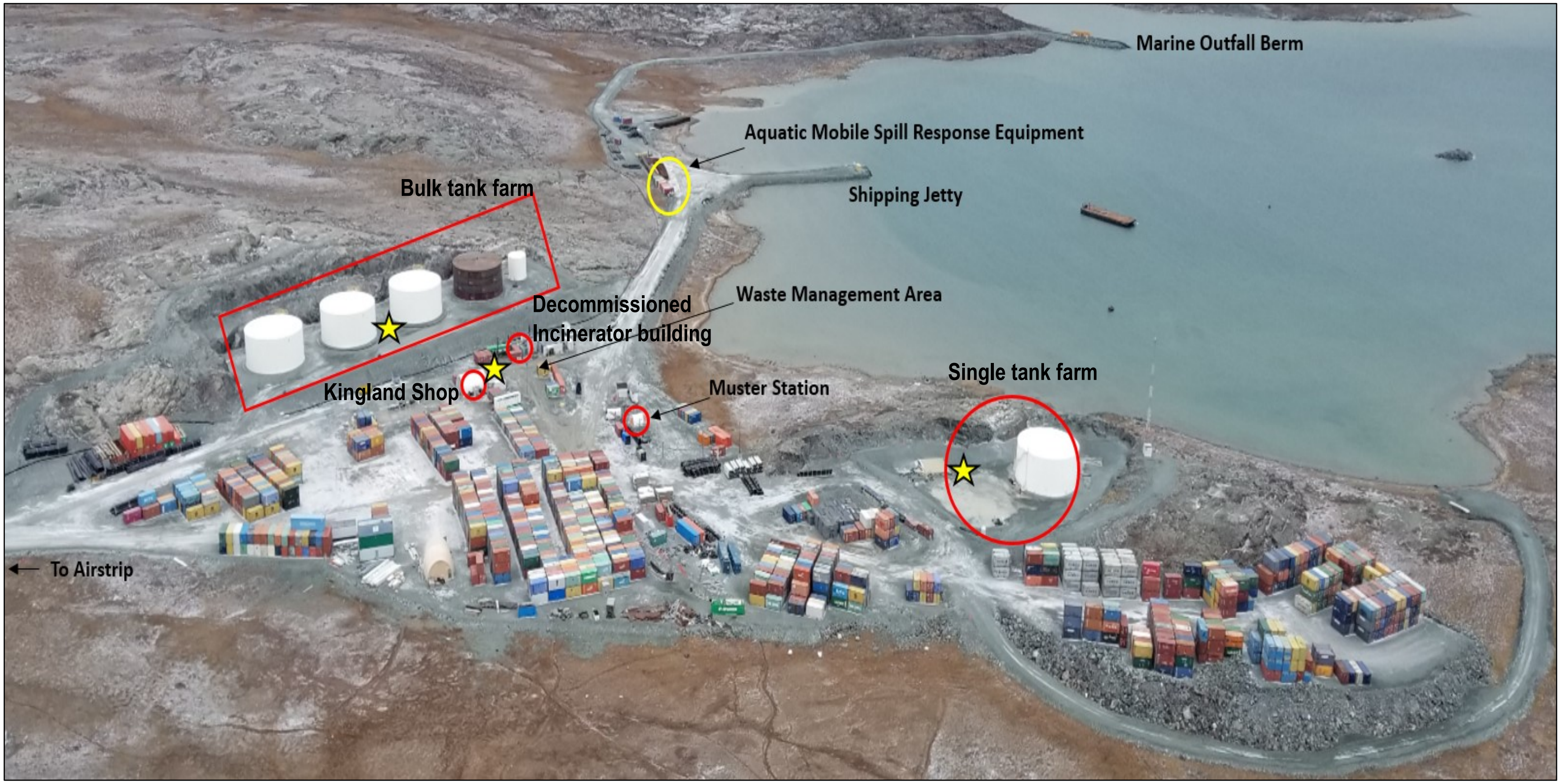


Plate A.1. Roberts Bay Laydown (Note: Red circles are fuel or chemical storage locations, smaller containment locations may vary. Yellow stars [or a yellow circle in the case of the aquatic mobile response spill response equipment] indicate default spill kit locations.)

Plate A.2. Doris Camp (Note: Red circles are fuel or chemical storage locations, smaller containment locations may vary. Yellow stars indicate default spill kit locations.)

Plate A.3. Quarry 2, Laydowns, Airstrip (Note: Red circles are fuel or chemical storage locations, smaller containment locations may vary. Yellow stars indicate default spill kit locations.)

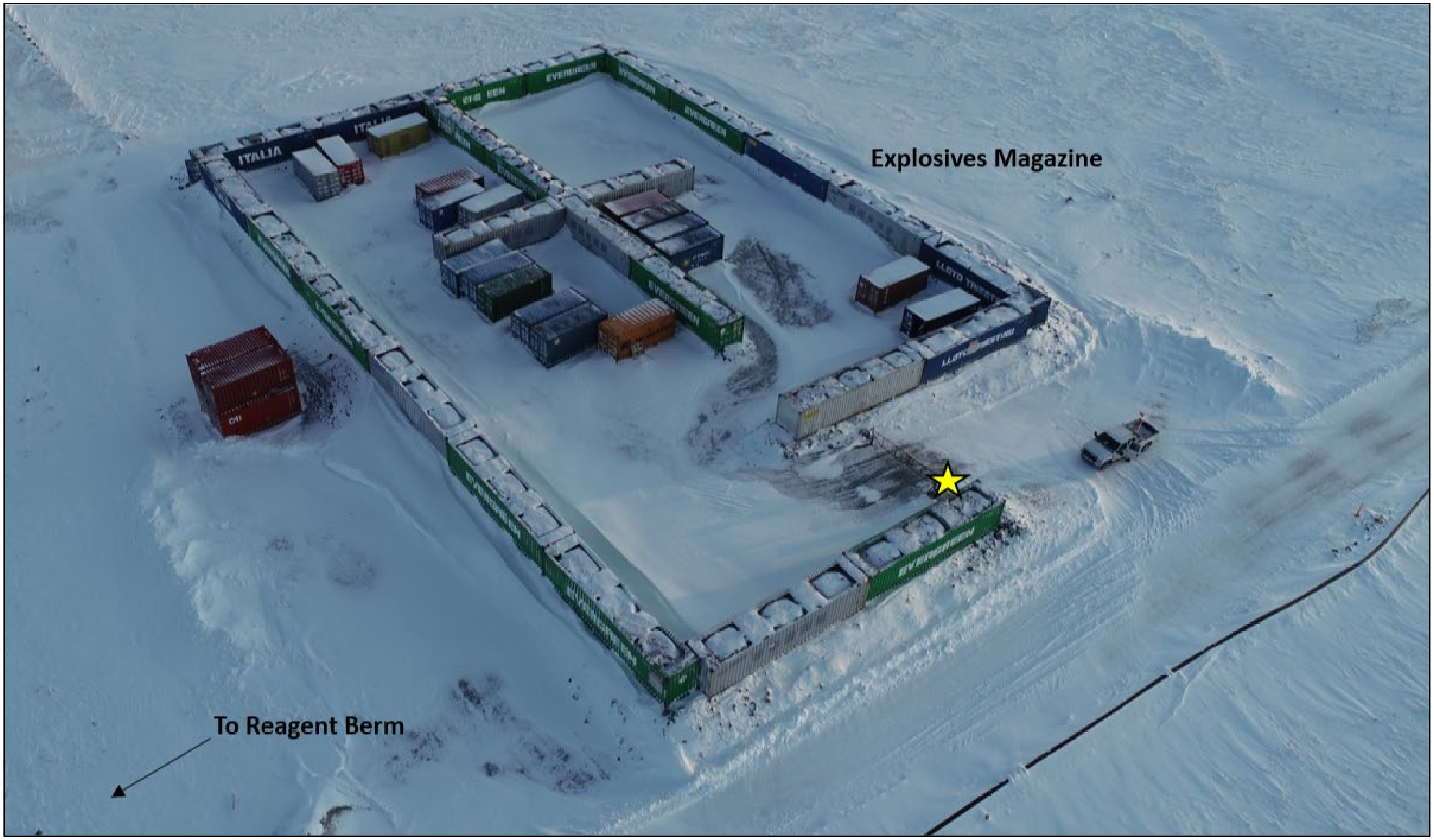


Plate A.4. Explosive Magazine (Note: Yellow star indicate default spill kit locations.)

A3 Water Treatment Process

Underground mine water is pumped from a settling sump system to a Water Treatment Plant (WTP) on surface designed to provide Total Suspended Solids (TSS) removal from the effluent stream prior to being pumped to the RBDS Water Management Facility and to final discharge to Roberts Bay. The multi-stage process consists of coarse suspended solids removal via a lamella clarifier and the addition of a polymer flocculent and coagulant followed by fine suspended solids removal utilizing multimedia filters. This treatment process is capable of meeting the authorized limits for TSS outlined in Schedule 4 of the MDMER.

A4 Roberts Bay Discharge System

The Roberts Bay Discharge System (RBDS) is designed to transport compliant effluent from the Doris underground mine and excess water from the Tailings Impoundment Area (TIA) to a subsea diffuser extending 2.1km into Roberts Bay. The Roberts Bay Discharge System consists of an insulated pipeline, the Roberts Bay Discharge Pipeline, which runs from the RBDS Water Management Facility, along to the Primary Road and the airstrip to the Roberts Bay Laydown Areas. At Roberts Bay the pipeline runs in front of the 20 ML fuel tank farm, along the south side of the Roberts Bay Jetty Access Road and laydown pads, to the Roberts Bay shoreline along the south side of the Roberts Bay Discharge Access Road. The discharge pipeline enters the Roberts Bay marine environment through a Marine Outfall Berm, and terminates at the Roberts Bay Diffuser, situated approximately at 20 m depth and 1.4 km from shore.

A5 Spill Prevention

All pipelines in the system are constructed from HDPE material resistant to wear. Each pipe connection has been fuse welded to remove the risk introduced by Victaulic clamp installations which are susceptible to expansion during freeze/thaw conditions and wear resulting in leaks. The number of elbow joints on the pipelines has been minimized to the extent possible; elbow joints are more susceptible to wear over time due to increased force/pressure of effluent travelling through the joint. The system will operate at relatively low pressures, therefore leakage from normal operating modes is highly unlikely.

Flow meters have been installed between the TIA Intake Pump station and the RBDS Water Management Facility, and between the RBDS Water Management Facility and the Marine Outfall Berm Pump station to monitor flow within the pipeline. These flow meters are connected by fibre optic communication lines linked to a PLC system which communicates real-time flow measurements to the Process Plant Control Room. The Process Plant Control Room is manned 24hrs a day allowing for continuous monitoring of the discharge pipeline. An unanticipated drop in flow registered on these flow meters will trigger an immediate inspection of the pipeline to investigate cause. If a leak is detected during this inspection, discharge from the pipeline will be immediately shut down minimizing the volume of the release.

Inline instrumentation has been installed to measure TSS in each effluent stream prior to being combined. TSS is also measured after the effluent streams have been combined to determine compliance with the authorized limits for TSS outlined in Schedule 4 of the MDMER prior to discharge from the Final Discharge Point (FDP) to the environment. Low and high level alarms have been established to provide early notification of an increase in TSS to the Process Plant Control Room. If the low level alarm is triggered, the Water Treatment Operator is notified and is able to respond to any potential treatment upsets. If the high level alarms are triggered for either effluent stream, the system is automatically placed into recirculation back to the TIA until effluent streams are determined to be in compliance with the authorized discharge limits, and discharge to the environment may then be resumed. This real time monitoring significantly reduces the likelihood of non-compliant effluent being discharged to the environment.

The pipeline connecting the Underground sump system to the RBDS Water Management Facility is located upstream of the Doris Sedimentation and Pollution Control Ponds. Any leak from this system would report to these water management ponds and be transferred to the TIA.

Delineators are used to mark pipelines to ensure vehicle and equipment operators are aware of pipeline locations when travelling on site roads. Pipelines in this system have been aligned adjacent to roadways to the extent possible to allow for thorough inspections and to reduce the risk of vehicle and equipment interaction with the pipelines.

Pipeline inspections are conducted during each 12hr shift. This inspection includes driving the entire length of the pipeline and visually assessing the line for signs of leaks or spills.

AGNICO EAGLE
HOPE BAY

Hope Bay Spill Contingency Plan

Hope Bay, Nunavut

Module B: Windy

Conformity Table

Licence	Part	Item	Topic	Report Section
2BE-HOP1222	B	2.	The Licensee shall file an Annual Report on the appurtenant undertaking with the Board no later than March 31st of the year following the calendar year being reported which shall contain the following information:	See below
		2.e	• an update to the Spill Contingency Plan, if required, including contact information in the form of an addendum.	This report
	H	1.	The Licensee has submitted, September 23, 2011, a Spill Contingency Plan entitled Hope Bay Project Spill Contingency Plan, for the Hope Bay Project, which encompasses the Hope Bay Belt projects including Roberts Bay, the Doris, Boston and Windy camps. This Plan covers the Windy Camp with respect to care and maintenance of the site. The Licensee shall submit to the Board for approval in writing, within ninety (90) days of issuance of this Licence, a revised Plan that takes into consideration the status of the entire Hope Bay Belt project as it influences the activities, environmental and safety issues of the Windy Camp and the Hope Bay Regional Exploration Project.	This report
		2.	Licensee shall submit to the Board for approval in writing, sixty (60) days prior to the resumption of exploration activity at the Hope Bay Regional Exploration Project, a revised Spill Contingency Plan that is specific to the scope of this Licence and prepared in accordance with the *Spill Contingency Planning and Reporting Regulations* developed under Section 34 of the *Environmental Protection Act*.	Plan filed in March 2014, updated here. Sections 2 and B2
		3.	The Licensee shall, if not approved by the Board, revise the Plan referred to in Part H, Item 1, and resubmit to the Board for approval within thirty (30) days of receiving notification of the Board's decision.	Section 1.5
		4.	The Licensee shall implement the Plan specified in Part H, Item 1 as and when approved by the Board.	Section 1.5
		5.	The Licensee shall review the Plan referred to in this Part as required by changes in operation and/or technology and modify the Plan accordingly. Revisions to the Plan are to be submitted in the form of an Addendum, to be included with the Annual Report unless directed otherwise by an Inspector.	Section 1.4
		6.	The Licensee shall ensure that any chemicals, petroleum products or wastes associated with the project do not enter water. All sumps and fuel caches shall be located at a distance of at least thirty one (31) metres from the ordinary high water mark of any adjacent water body and inspected on a regular basis.	Section 2 Section 4.6
		7.	The Licensee shall ensure that any equipment maintenance and servicing be conducted only in designated areas and shall implement special procedures (such as the use of drip pans) to manage motor fluids and other waste and contain potential spills.	Section 4.4
		8.	If during the term of this Licence, an unauthorized discharge of waste occurs, or if such a discharge is foreseeable, the Licensee shall:	See below
		8a.	• employ the Spill Contingency Plan;	Section 2
		8b.	• report the spill immediately to the 24-Hour Spill Line and to the Inspector at *[see pg. iii Key Government Contact List]*; and	Section 3.3
		8c.	• for each spill occurrence, submit to the Inspector, no later than thirty (30) days after initially reporting the event, a detailed report that will include the amount and type of spilled product, the GPS location of the spill, and the measures taken to contain and clean up the spill site.	Section 3.3

B1 Introduction

The Type B Water Licence No. 2BE-HOP1222 issued by the Nunavut Water Board (NWB) requires the development of a Spill Contingency Plan in accordance with Part H. The Spill Contingency Plan has been prepared and is being submitted by Agnico Eagle to address this requirement, and also includes the plan for spill response throughout the Hope Bay belt.

B2 Chemical Storage at Windy

Windy Camp is located 10km south of Doris Camp at N 68° 03.715’ W 106° 37.109’ and is in the process of being decommissioned. Fuel storage at Windy Camp is limited to one tank (double-walled Tidy Tank) containing a maximum of 1240L of diesel fuel. This tank is located more than 31 m from any waterbody and fuels a generator used to heat a pump house structure located at the potable freshwater intake south of Windy Camp. Water is used to supply Doris Camp with potable water, and regular inspection of this facility occurs as per the requirements of the Doris Water Licence. In case of a potential spill involving the Tidy Tank, there is a spill kit located at the pump house (at the shoreline).

No other hydrocarbons or chemicals are stored at Windy Camp. Any hydrocarbons or chemicals needed for decommissioning the camp structures will be brought to Windy Camp and consumed on an as-needed basis. Spill kits will be available within 200 m of working equipment during these activities. Chemical storage and spill kit locations at Windy Camp are shown in the photo below.

The Bulk Fuel Storage Facility at Patch Lake was fully dismantled in 2012 and the area is in the process of being reclaimed. There are no hydrocarbons or chemicals stored at the Patch Lake Facility. Fuel or lubes required to complete reclamation work will be brought in for immediate equipment use, and a spill kit will be available on site to support operating machinery.

In case of exploration drilling on land and on ice, chemicals will be brought in to assist with the drilling process and stored within secondary containment. Each drill will have its own fully stocked spill kit and chemicals stored will be kept to an amount needed for each shift. Excess chemicals will not be stored within Windy Camp.

One permitted facility for explosives materials is located at Quarry A on the west side of the Doris-Windy all-weather road. This facility can store a maximum of 40,800 kg of explosive materials containing ammonium nitrate. In the event of a spill of this material, the spill response actions would be completed as outlined in the Product Specific Emergency Response plan in Appendix 1 of this document.

B3 Windy Fuel and Chemical Storage Locations

Plate B.1. Windy Camp (Note: Red circle is fuel storage location. Yellow star indicates spill kit location.)

Plate B.2. Quarry A Explosives Magazine (Note: Yellow star indicates spill kit location.)

HOPE BAY SPILL CONTINGENCY PLAN

HOPE BAY, NUNAVUT

Module C: Madrid (Exploration and Operations)

Conformity Table

Licence	Part	Item	Topic	Report Section
2AM-DOH1335	H	1.	The Licensee shall implement the following plans as approved by the Board: Surface Emergency Response Plan, Underground Emergency Responses Plan, and Hope Bay Project Spill Contingency Plan. The Licensee shall comply with the Plan(s) and any changes deemed significant shall require the submission and subsequent approval of the Board in writing.	This Plan
		2.	All sumps and fuel caches shall be located at a distance of at least thirty one (31) metres from the ordinary High Water Mark of any adjacent Water body and inspected on a regular basis.	Section 2 Section 4.6
		3.	The Licensee shall prevent any chemicals, petroleum products or wastes associated with the project from entering Water.	Section 2 Section 4.6
		4.	The Licensee shall provide secondary containment for fuel and chemical storage as required by applicable standards and acceptable industry practice.	Section 4.1
		5.	The Licensee shall perform weekly inspections of petroleum products storage and containment facilities, fuel tanks and connectors, for leaks and settlement and shall keep a written log of inspections to be made available to an Inspector upon request. More frequent inspections may be requested by an Inspector.	Section 4.1
		8.	The Licensee shall conduct emergency maintenance and servicing on equipment, in designated areas, and shall implement measures to collect motor fluids and other Waste to prevent and contain spills.	Section 4.4
		9.	The Licensee shall, subject to Section 16 of the Regulations, report any unauthorized deposits or foreseeable unauthorized deposits of waste and/or discharges of Effluent, and:	See below
		9a.	• employ the Spill Contingency Plan;	Section 2
		9b.	• report the incident immediately via the 24-Hour Spill Reporting Line [see pg. iii Key Government Contact List], to the Inspector at [see pg. iii Key Government Contact List] and to the Kitikmeot Inuit Association at *[see pg. iii Key Government Contact List]*; and	Section 3.3
		9c.	• for each spill occurrence, submit a detailed report to the Inspector, no later than thirty (30) days after initially reporting the event, which includes the amount and type of spilled product, the GPS location of the spill, and the measures taken to contain and clean up the spill site.	Section 3.3
		10.	The Licensee shall, in addition to Part H, Item 9, regardless of the quantity of releases of harmful substances, report to the NWT/NU Spill Line if the release is near or into a Water body.	Section 3.3
	I	11.	The Licensee shall submit to the Board for review, at least sixty (60) days prior to operation of the Roberts Bay Discharge System, an addendum to the Spill Contingency Plan detailing spill prevention measures along the pipeline.	A3
	Schedule B		The Annual Report referred to in Part B, Item 2 shall include the following:	See below
		8.	A list and description of all reportable unauthorized discharges including volumes, spill report line identification number and summaries of follow-up action taken	Section 3.3
2BB-MAE1727	B	2.	The Licensee shall file an Annual Report on the Appurtenant Undertaking with the Board no later than 31st of March, of the year following the calendar year being reported, containing the following information:	See below

Licence	Part	Item	Topic	Report Section
		2j.	• Updates or revisions to the Water Management Plan, Abandonment and Restoration Plan, QA/QC, Waste Rock and Ore Storage Plan, and Spill Contingency Plan and/or any other management plan.	This Plan
	H	1.	The Licensee shall submit for Board approval in writing, within ninety (90) days following issuance of the Licence, a spill contingency Plan that is specific to the scope of this Licence, addresses comments received by the parties, and is prepared in the format set out by the Consolidation of Spill Contingency Planning and Reporting Regulations, R-068-93.	This Plan
		2.	The Licensee shall prevent any chemicals, petroleum products or wastes associated with the project from entering water. All Sumps and fuel caches shall be located at a distance of at least thirty-one (31) metres from the ordinary High Water Mark of any adjacent water body and inspected on a regular basis.	Section 2 Section 4.1
		3.	The Licensee shall conduct any equipment maintenance and servicing in designated areas and shall implement special procedures (such as the use of drip pans) to manage motor fluids and other waste and contain potential spills.	Section 4.4
		4.	If during the term of this Licence, an unauthorized discharge of waste occurs, or if such a discharge is foreseeable, the Licensee shall:	See below
		4a.	• employ the Spill Contingency Plan;	This plan
		4b.	• report the spill immediately to the 24-Hour Spill Line at *[see pg. iii Key Government Contact List]* and to the Inspector at *[see pg. iii Key Government Contact List]*; and	Section 3.3
		4c.	• for each spill occurrence, submit to the Inspector, no later than thirty (30) days after initially reporting the event, a detailed report that will include the amount and type of spilled product, the GPS location of the spill, and the measures taken to contain and clean up the spill site.	Section 3.3
		5.	The Licensee shall, in addition to Part H, Item 4, regardless of the quantity of releases of harmful substances, report to the NWT/NU Spill Line if the release is near or into a Water body.	Section 3.3

C1 Introduction

The Type A Water Licence No. 2AM-DOH1335 and the Type B Water Licence No. 2BB-MAE1727 issued by the Nunavut Water Board (NWB) requires the development of a Spill Contingency Plan in accordance with Part H. The Spill Contingency Plan has been prepared and is being submitted by Agnico Eagle to address this requirement, and also includes the plan for spill response throughout the Hope Bay belt.

The 2AM-DOH1335 Licence Area includes the Madrid North and Madrid South sites. Work at the Madrid North site began in 2019 and includes the necessary infrastructure to support surface mining at the Naartok East Crown Pillar trench and underground mining at the Madrid North portal. This infrastructure includes the Madrid North Contact Water Pond, Madrid North Waste Rock storage pad, as well as laydown pads and shop facilities.

Work at the Madrid North site was suspended in March 2020 due to the Covid-19 global pandemic and mining remains inactive at this site. Routine monitoring of fuel and chemical storage locations is conducted to ensure not spill of stored product occurs.

No work has yet been conducted at the Madrid South site.

C2 Chemical Storage at Madrid North and Madrid South

A list of fuel and chemical storage facilities, containment capacity, products stored and maximum expected quantity to be stored within each facility for the Madrid North site is provided in Table C.1 below. Table C.1. is a comprehensive list of the chemical storage at Madrid, exclusions under the E2 regulations have not been considered. All storage facilities will be located at a distance greater than 31 m from any water body. Currently there is no chemical storage at Madrid South.

Table C.1. Madrid North Fuel and Chemical Storage Total Quantities

Products Stored	Expected Total Quantity Stored
Calcium Chloride	11,030 tonnes
Diesel Fuel	9,010,000 L

Table C.2. Madrid North Fuel and Chemical Storage Locations

Location*	Facility Description/ Storage Capacity	Tank Description	Containment Capacity	Products Stored	Expected Quantity Stored
Madrid North Fuel Storage Area ** (MMS-8)	3 @ 1,500,000 Tanks	Field erected	Gravel/HDPE	Diesel Fuel	4,500,000 L

Table C.2. Madrid South Fuel and Chemical Storage Locations

Location*	Facility Description/ Storage Capacity	Tank Description	Containment Capacity	Products Stored	Expected Quantity Stored
Madrid South Fuel Storage Area ** (MAE-07)	1 @ 750,000 Tank	Field erected	Gravel/HDPE	Diesel Fuel	4,500,000 L

**Additional portable storage facilities may be used depending on Project activity.*
*** Facility not yet constructed.*

C3 Madrid Fuel and Chemical Storage Locations

Plate C.1. Surface Equipment Shop and former Office/Lunchroom. (Note: Red circles are fuel or chemical storage locations, smaller containment locations may vary. Yellow stars indicate default spill kit locations.)

Plate C.2. Naartok East Crown Pillar Recovery Trench (Note: Yellow stars indicate default spill kit locations.)

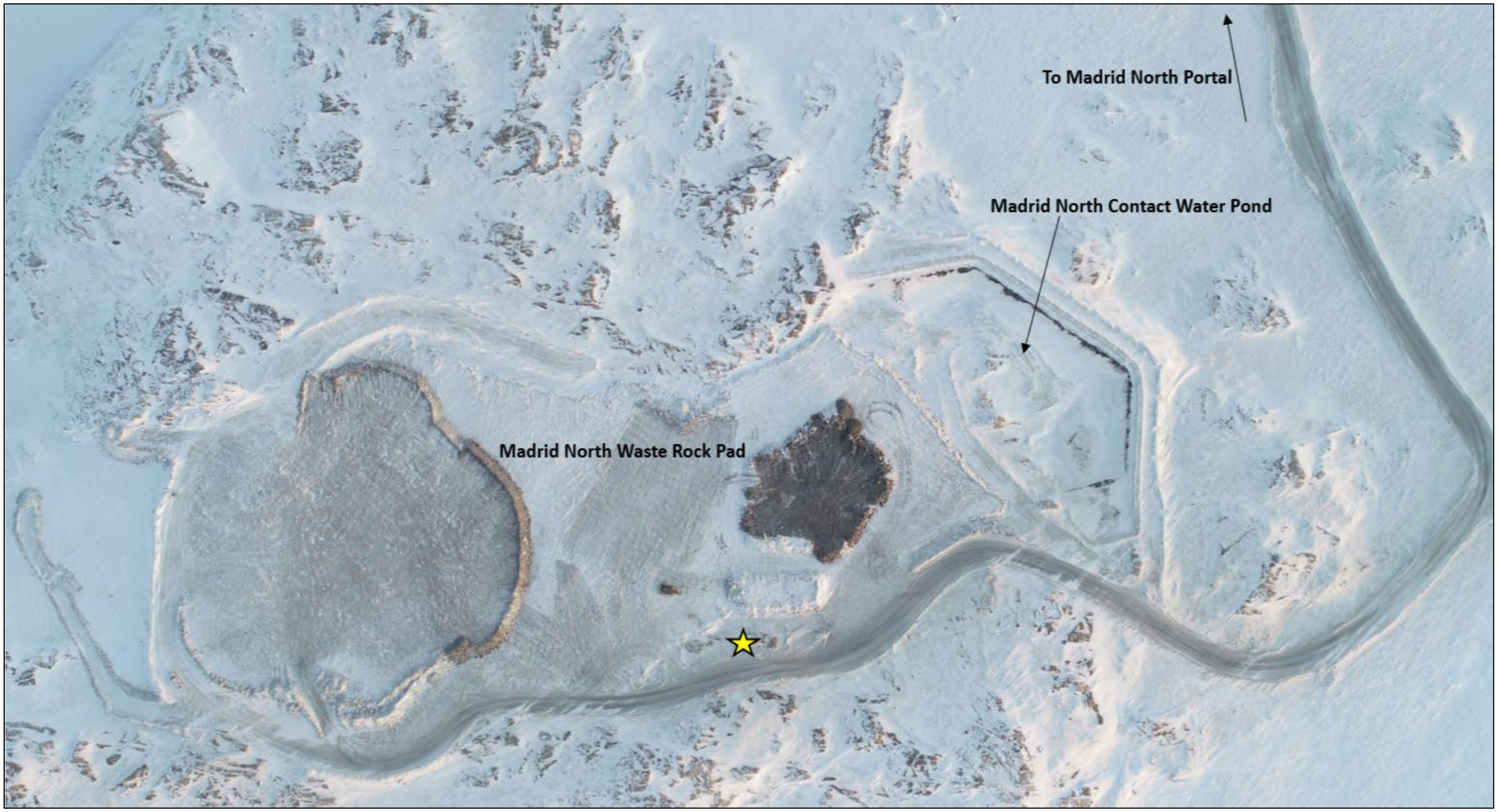


Plate C.3. Madrid North Contact Water Pond and Waste Rock Pad (Note: Yellow stars indicate default spill kit locations.)

AGNICO EAGLE
HOPE BAY

HOPE BAY SPILL CONTINGENCY PLAN

HOPE BAY, NUNAVUT

Module D: Boston (Exploration and Operations)

Conformity Table

Licence	Part	Item	Topic	Report Section
2BB-BOS1727	B	9.	The Licensee shall file an Annual Report on the appurtenant undertaking with the Board no later than March 31st of the year following the calendar year being reported which shall contain the following information:	See below
		9l.	• updates or revisions to the Abandonment and Restoration Plan, QA/QC, Waste Rock and Ore Storage Plan, Spill Contingency Plan, and Landfarm Plan.	This Plan
	H	2.	The Licensee shall prevent any chemicals, petroleum products or wastes associated with the project from entering Water. All Sumps and fuel caches shall be located at a distance of at least thirty-one (31) metres from the ordinary High Water Mark of any adjacent Water body and inspected on a regular basis.	Section 2 Section 4.1
		3.	The Licensee shall conduct any equipment maintenance and servicing in designated areas and shall implement special procedures (such as the use of drip pans) to manage motor fluids and other waste and contain potential spills.	Section 4.4
		4.	If during the term of this Licence, an unauthorized discharge of waste occurs, or if such a discharge is foreseeable, the Licensee shall:	See below
		4a.	• employ the Spill Contingency Plan;	This plan
		4b.	• report the spill immediately to the 24-Hour Spill Line at *[see pg. iii Key Government Contact List]* and to the Inspector at *[see pg. iii Key Government Contact List]*; and	Section 3.3
		4c.	• for each spill occurrence, submit to the Inspector, no later than thirty (30) days after initially reporting the event, a detailed report that will include the amount and type of spilled product, the GPS location of the spill, and the measures taken to contain and clean up the spill site.	Section 3.3
		5.	The Licensee shall, in addition to Part H, Item 4, regardless of the quantity of releases of harmful substances, report to the NWT/NU Spill Line if the release is near or into a Water body.	Section 3.3
2AM-BOS1835	H	1.	The Licensee shall implement the following plans as approved by the Board: *Surface Emergency Response Plan*, *Underground Emergency Responses Plan*, and *Hope Bay Project Spill Contingency Plan*. The Licensee shall comply with the Plan(s) and any changes deemed significant shall require the submission and subsequent approval of the Board in writing.	This Plan
		2.	All sumps and fuel caches shall be located at a distance of at least thirty one (31) metres from the ordinary High Water Mark of any adjacent Water body and inspected on a regular basis.	Section 2 Section 4.6
		3.	The Licensee shall prevent any chemicals, petroleum products or unauthorized Wastes associated with the project from entering Water.	Section 2 Section 4.6
		4.	The Licensee shall provide secondary containment for fuel and chemical storage as required by applicable standards and acceptable industry practice.	Section 4.1
		5.	The Licensee shall perform regular inspections of Fuel Storage and Containment Facilities, Sumps, Emergency Dump Catch Basins, other fuel tanks and connectors for leaks and movement and shall keep a written log of inspections to be made available to an Inspector upon request. More frequent inspections may be required at the request of an Inspector	Section 4.1

Licence	Part	Item	Topic	Report Section
		8.	The Licensee shall conduct emergency maintenance and servicing on equipment, in designated areas, and shall implement measures to collect motor fluids and other Waste to prevent and contain spills.	Section 4.4
		9.	The Licensee shall, subject to Section 16 of the Regulations, report any unauthorized deposits or foreseeable unauthorized deposits of waste and/or discharges of Effluent, and:	See below
		9a.	• employ the Spill Contingency Plan;	Section 2
		9b.	• report the incident immediately via the NT-NU 24-Hour Spill Reporting Line *[see pg. iii Key Government Contact List]* and to the Inspector at *[see pg. iii Key Government Contact List]*; and	Section 3.3
		9c.	• for each spill occurrence, submit a detailed report to the Inspector, no later than thirty (30) days after initially reporting the event, which includes the amount and type of spilled product, the GPS location of the spill, and the measures taken to contain and clean up the spill site.	Section 3.3 Section D3.2
		10.	The Licensee shall, in addition to Part H, Item 9, regardless of the quantity of release of harmful substance, report to the NT-NU 24-Hour Spill Report Line if the release is near or into a Water body.	Section 3.3
		11.	The Licensee shall submit to the Board for review, at least sixty (60) days prior to operation of the Aimaokatalok Lake Discharge System, an addendum to the Spill Contingency Plan detailing spill prevention measures along the pipeline.	To be provided 60 days prior to operation of Aimaokatalok Lake Discharge System
	Schedule B		The Annual Report referred to in Part B, Item 2 shall include the following:	See below
		8.	A list and description of all reportable unauthorized discharges including volumes, spill report line identification number and summaries of follow-up action taken.	Section 3.3

D1 Introduction

The Type A Water Licence No. 2AM-BOS1835 and Type B Water Licence No. 2BB-BOS1727 issued by the Nunavut Water Board (NWB) require the development of a Spill Contingency Plan in accordance with Part H. The Spill Contingency Plan has been prepared and is being submitted by Agnico Eagle to address this requirement, and also includes the plan for spill response throughout the Hope Bay belt.

The 2BB-BOS1727 Licence Area includes the current Boston Camp site, which is opened seasonally to support exploration activities.

Facilities outlined in the 2AM-BOS1835 Licence have not yet been constructed and there is no activity occurring at Boston Camp under this licence at this time.

D2 Chemical Storage at Boston

Photos of current chemical storage locations and a list of current fuel and chemical storage facilities, containment capacity, products stored and maximum expected quantity to be stored within the facility for the Boston Licence area is provided below. All storage facilities are located at a distance greater than 31m from any water body.

Photos of anticipated fuel and chemical storage locations associated with facilities identified in the licence 2AM-BOS1835 for the Boston Project will be provided when these facilities are constructed.

The current and anticipated fuel and chemical storage facilities, containment capacity, products stored and maximum expected quantity to be stored within each facility associated with development of Boston are provided in Table D.1 below. Table D.1 is a comprehensive list of the chemical storage at Boston, exclusions under the E2 regulations have not been considered.

D3 Additional Spill Contingency Management at Boston

D3.1 Issue: Bulk Fuel Tank Farm

Eight fuel tanks are currently located in a lined fuel berm covered with crush material at the Boston Site. The berm was constructed on permafrost and the crush pad is thin in some areas which may lead to permafrost degradation beneath the berm over time. Foundation settlement of the tanks due to permafrost degradation could potentially occur over time and could cause the fuel tank to destabilize creating risk of one or more of the fuel tanks to destabilize and tip.

D3.2 Management Response

Fuel tanks are visually monitored for differential settlement during seasonal visits when the Boston site is accessible and during annual geotechnical inspections. Measurements of tank movement may also be collected if visual monitoring indicates a potential issue with one or more of the tanks. This may involve measuring the vertical angle of the fuel tank sidewall. A comparison of these values over time will indicate if differential settlement is occurring.

If settlement of the fuel tanks at the Boston site are detected beyond an acceptable limit, Agnico Eagle will discontinue the use of the tank(s) that are effected by settlement and engage the Engineer of Record (SRK Consulting) for guidance and recommendations for correcting the settlement issue.

Table D.1. Boston Fuel and Chemical Storage Total Quantities

Products Stored	Expected Total Quantity Stored
Diesel Fuel	7,883,742 L
Gasoline	628 L
Jet A Fuel	52,890 L

Table D.2. Boston Fuel and Chemical Storage Locations

Location*	Facility Description/ Storage Capacity	Tank Description	Containment Capacity	Products Stored	Expected Quantity Stored
Boston Camp Bulk Fuel Storage Facility (BOS-5)	6 @ 77,000L Tanks 2 @ 33,500L Tanks	Pre-fabricated	Gravel/HDPE, 84,700 L	Diesel Fuel	377,127 L (1)
Boston Fuelling Stations (tidy tank beside bulk storage)	1 @ 1374 L	Pre-fabricated, double-walled, portable	Gravel/HDPE spill containment	Diesel Fuel	1236 L (2)
Boston Fuelling Stations (fly tank beside bulk storage)	1 @ 785 L	Pre-fabricated, double-walled, portable	Gravel/HDPE spill containment	Gasoline	628 L (2)
Boston Helipad	Drum storage (8 drums)	Drums	Plastic spill pallets, 220 L each	Jet A Fuel	1640 L (1) (empty when Project closed)
Boston Jet A fuel storage	Drum storage (Portable Insta-Berm)	Drums	2 x 25,500 L	Jet A	51,250 L (1)
Boston Generator Daytanks	2 @ 1240 L	Pre-fabricated, double-walled, portable	Gravel/HDPE spill containment (2)	Diesel Fuel	2232 L (2)
Boston Tent Heaters Daytank	1 @ 1374 L	Pre-fabricated, double-walled, portable	Gravel/HDPE spill containment	Diesel Fuel	1236 L (2)
Boston Daytank (inside)	1 @ 350 L	Pre-fabricated, Single walled	Steel floor and kickplate	Diesel Fuel	315 L (2)
Boston Camp Daytank (NE side of camp between main camp and tents	1 @ 1374 L	Pre-fabricated, double-walled, portable	Gravel/HDPE spill containment	Diesel Fuel	1236 L (2)
Boston Incinerator	1 @ 400 L	Pre-fabricated, double-walled	Steel spill containment	Diesel Fuel	360 L (1)

Location*	Facility Description/ Storage Capacity	Tank Description	Containment Capacity	Products Stored	Expected Quantity Stored
Boston Bulk Fuel Storage Facility**	5 @ 1,500,000	Field erected	Gravel/HDPE spill containment	Diesel Fuel	7,500,000

(1) Maximum Capacity of Container System

(2) Safe Fill Zone Capacity

(3) Normal quantity stored in container

** Additional portable storage facilities may be used depending on Project activity.*

*** Anticipated fuel storage as part of proposed Phase 2 Boston development outlined in Type A Water Licence 2AM-BOS1835. Facility not constructed at this time.*

D4 Boston Fuel and Chemical Storage Locations

Plate D.1. North end Boston Camp (Note: Red circles are fuel or chemical storage locations, smaller storage locations may vary. Yellow star indicates spill kit locations.)

Plate D.2. South end Boston Camp (Note: Red circles are fuel or chemical storage locations, smaller storage locations may vary. Yellow star indicates spill kit locations.)

Plate D.3. Boston Airstrip (Note: Red circles are fuel or chemical storage locations, smaller storage locations may vary. Yellow star indicates spill kit locations.)

AGNICO EAGLE
HOPE BAY

HOPE BAY SPILL CONTINGENCY PLAN

HOPE BAY, NUNAVUT

Appendix 1: Hazardous Materials and Product Specific Emergency Response Plans

Poisonous and Toxic Substances

Sodium Cyanide Specific Spill Response Plan

Note: Sodium cyanide is not currently listed in Schedule 1 of the E2 regulations. However, a Product Specific Emergency Response Plan has been developed for this product based on the environmental and health and safety impacts of a potential spill. Hydrogen cyanide is produced when sodium cyanide reacts with water, acids or oxidizing agents. Hydrogen cyanide is listed in Schedule 1 of the E2 regulations.

CAS No: 143-33-9 (Sodium cyanide)

Hazards Identification:

Physical State: Solid (granular), White
Odor: Almond-like

Emergency Overview: DANGER. MAY BE FATAL IF INHALED, ABSORBED THORUGH SKIN OR SWALLOWED

Potential Acute Health Effects: Very hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, and of inhalation. Corrosive to eyes and skin. Cyanide is classified as extremely toxic.

Environmental Effects: Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Usage: Sodium cyanide is used in gold recovery process within the process plant.

Storage: Sodium cyanide briquettes will be packaged in 1,000 kg bags. These bags must be kept dry, away from heat and sources of ignition. Keep away from oxidizing agents, acids and moisture. Bags will be stored on pallets in lined seacans or located in a lined containment berm or inside the Mill building as used. Do not store above 24°C. Avoid exposure to acid, water or weak alkalines which can react to form a toxic hydrogen cyanide (HCN) gas.

Personal Protective Equipment for Spill Response

- Self-contained breathing apparatus (SCBA) while conducting air quality monitoring to confirm HCN levels prior to initiating response and clean-up;
- SCBA required for response activities if HCN levels >2.5ppm;
- Full face respirator with vapor or dust cartridges, half face respirator with vapor or dust cartridges and splash goggles or safety glasses with face shield may be worn if HCN levels <2.5ppm;
- Full body chemical resistant suit (rubber);
- Rubber boots (chemical resistant); and

- Rubber gloves (chemical resistant).

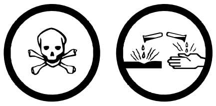
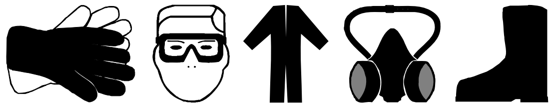
Emergency response for a Sodium Cyanide Spill

- Isolate and evacuate the spill area if HCN has potentially been released.
  - Evacuation of other site locations may be required (large spills in water may require protection of personnel up to 5 km downwind).
- Report spill to Supervisor immediately. Provide location, estimated quantity, physical nature of the spilled material (e.g., solid or solution) and other substances/conditions that may create hazardous conditions during response (e.g., exposure of substance to water, acids, oxidizing agents).
- Supervisor will report the spill immediately to the Environmental Superintendent or Safety Coordinator.
- Mine General Manager will activate Incident Command System and Emergency Response Team if required for response:
  - Based on size, location of spill and potential hazardous conditions/environmental impacts; and
  - SDS will be consulted to confirm appropriate response measures and associated hazards.
- Ventilate the area of the spill or leak and eliminate all ignition sources.
  - Air quality monitoring will be conducted in enclosed spaces to determine concentration of hazardous vapours prior to initiating spill response efforts.
- Stop the flow of spill.
- Contain the spill by placing spill booms or constructing interception dikes ahead of the flow (prioritizing prevention of release to waterways or onto ice).
- Protect the spill area from water runoff by constructing dike/berm. If raining, use tarps to cover the area to minimize water contact and spread of contamination.
- For spill to land:
  - Recover spilled solid material by shoveling into drums or containers free from impurities, seal container with lid and clearly label per WHMIS guidelines.
  - Minimize dust generated to the extent possible. Use water spray to reduce vapours; avoid contact of water spray with spilled material. Use tarps to cover spill area if water spray is used to reduce vapours.
  - Recovered solids, if free from impurities, may be suitable for its intended use. In this case, material is to be placed into containers with lid, and clearly labeled as per WHMIS guidelines.
  - Recovered material which cannot be used will be packaged into drums for offsite disposal at an approved waste management facility.

  - Neutralize residual spill material with appropriate agent as recommended by the SDS (sodium or calcium hypochlorite solution) or continue to excavate area until no visible spilled solid remains. Use suitable spill absorbent or soil to absorb the neutralized residue.
- For spill to water:
  - NaCN dissolves in water producing highly toxic hydrogen cyanide gas – use extreme caution.
  - Pump contaminated water to drums, tanks or lined containment berms if possible. Isolate/confine the spill by damming or diversion if feasible.
  - Water treatment is only effective if it can be accomplished in conjunction with the spill.
  - Treatment chemicals (sodium or calcium hypochlorite) must not be added to surface waters (e.g., streams, lakes) as these are not generally effective and could result in additional environmental impacts.
  - Hydrogen peroxide for treatment of solution spills or a sulfur dioxide/air process for treatment of slurry spills may be considered. This measure may only be used as a last resort if containment is not achievable and the spill can be treated directly at the point of release.
- For indoor spills:
  - Recover spilled solid material by shoveling into drums or containers free from impurities, seal container with lid and clearly label per WHMIS guidelines.
  - Minimize dust generated to the extent possible. Use water spray to reduce vapours; avoid contact of water spray with spilled material. Use tarps to cover spill area if water spray is used to reduce vapours.
  - Recovered solids, if free from impurities, may be suitable for its intended use. In this case, material is to be placed into containers with lid, and clearly labeled as per WHMIS guidelines.
  - Recovered material which cannot be used will be packaged into drums for offsite disposal at an approved waste management facility.
  - Neutralize residual spill material with appropriate agent as recommended by the SDS (sodium or calcium hypochlorite solution) or continue to excavate area until no visible spilled solid remains. Use suitable spill absorbent or soil to absorb the neutralized residue and package into drums for offsite disposal at an approved waste management facility.
  - Mop the affected area using detergent and water.
  - Place this water in labeled waste drums for offsite disposal at an approved waste management facility
- Remove, bag and label personal protective equipment for offsite disposal.
- Thoroughly wash skin with soap.

Material Safety Data Sheet

SODIUM CYANIDE (CH)

WHMIS	Protective Clothing	TDG
		

1 . Product and company identification

Product name : SODIUM CYANIDE (CH)

Supplier : QUADRA CHEMICALS LTD.
3901 F.X. Tessier
Vaudreuil-Dorion, Quebec
Canada J7V 5V5
Tel: 1-800-665-6553

Material uses : Industrial applications

Code : Q07182

Validation date : 2/24/2016.

Responsible name : Regulatory Affairs / Affaires réglementaires

In case of emergency : **TRANSPORTATION EMERGENCY - 24HRS/DAY - 7 DAYS/WEEK IN CANADA - CALL 1-800-567-7455**

2 . Hazards identification

Physical state : Solid. [Granular. Deliquescent.]

Odor : Almond-like.

Emergency overview : DANGER!

MAY BE FATAL IF INHALED, ABSORBED THROUGH SKIN OR SWALLOWED. CAUSES RESPIRATORY TRACT, DIGESTIVE TRACT, EYE AND SKIN BURNS. CAN CAUSE TARGET ORGAN DAMAGE.

Very toxic by inhalation, in contact with skin and if swallowed. Corrosive to the eyes, skin, respiratory system and digestive tract. Causes burns. Handling and/or processing of this material may generate a dust which can cause mechanical irritation of the eyes, skin, nose and throat. Do not breathe dust. Do not ingest. Do not get in eyes or on skin or clothing. Can cause target organ damage. Use only with adequate ventilation. Keep container tightly closed and sealed until ready for use. Wash thoroughly after handling.

Routes of entry : Dermal contact. Eye contact. Inhalation. Ingestion.

Potential acute health effects

Inhalation : Very toxic by inhalation. Corrosive to the respiratory system. Exposure to decomposition products may cause a health hazard. Serious effects may be delayed following exposure.

Ingestion : Very toxic if swallowed. Corrosive to the digestive tract. Causes burns.

Skin : Corrosive to the skin. Causes burns. Very toxic in contact with skin.

Eyes : Corrosive to eyes. Causes burns.

Potential chronic health effects

Chronic effects : Can cause target organ damage. Repeated or prolonged inhalation of dust may lead to chronic respiratory irritation.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

2 . Hazards identification

Target organs : Causes damage to the following organs: blood, cardiovascular system, central nervous system (CNS), thyroid.

Over-exposure signs/symptoms

Inhalation : Adverse symptoms may include the following:
respiratory tract irritation
coughing

Ingestion : Adverse symptoms may include the following:
stomach pains

Skin : Adverse symptoms may include the following:
pain or irritation
redness
blistering may occur

Eyes : Adverse symptoms may include the following:
pain
watering
redness

Medical conditions aggravated by over-exposure : Pre-existing disorders involving any target organs mentioned in this MSDS as being at risk may be aggravated by over-exposure to this product.

See toxicological information (section 11)

3 . Composition/information on ingredients

Name	CAS number	%
sodium cyanide	143-33-9	60 - 100

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

4 . First aid measures

Eye contact : Call medical doctor or poison control center immediately. Check for and remove any contact lenses. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical attention immediately.

Skin contact : Call medical doctor or poison control center immediately. In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention immediately.

Inhalation : Call medical doctor or poison control center immediately. Move exposed person to fresh air. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Ingestion : Call medical doctor or poison control center immediately. Wash out mouth with water. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

Notes to physician : In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

5 . Fire-fighting measures

Flammability of the product : No specific fire or explosion hazard.

Extinguishing media

Suitable : Use an extinguishing agent suitable for the surrounding fire.

Not suitable : None known.

Special exposure hazards : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide
nitrogen oxides
metal oxide/oxides
hydrogen cyanide

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

6 . Accidental release measures

Personal precautions : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Do not breathe dust. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment (see section 8).

Environmental precautions : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods for cleaning up

Spill or leak : Move containers from spill area. Vacuum or sweep up material and place in a designated, labeled waste container. Dispose of via a licensed waste disposal contractor.

7 . Handling and storage

Handling : Put on appropriate personal protective equipment (see section 8). Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Do not get in eyes or on skin or clothing. Do not breathe dust. Do not ingest. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Empty containers retain product residue and can be hazardous. Do not reuse container.

Storage : Store in accordance with local regulations. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials and food and drink. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination.

8 . Exposure controls/personal protection

Product name	Exposure limits
sodium cyanide	**ACGIH TLV (United States). Absorbed through skin.** CEIL: 5 mg/m³

Consult local authorities for acceptable exposure limits.

Recommended monitoring procedures : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment.

8 . Exposure controls/personal protection

Engineering measures : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal protection

Respiratory : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Hands : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.

Eyes : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists or dusts. If operating conditions cause high dust concentrations to be produced, use dust goggles. Recommended: splash goggles

Skin : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
Recommended: chemical-resistant protective suit

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

9 . Physical and chemical properties

Physical state : Solid. [Granular. Deliquescent.]

Color : White.

Odor : Almond-like.

Molecular weight : 49.01 g/mole

Molecular formula : NaCN

Boiling/condensation point : 1496°C (2724.8°F)

Melting/freezing point : 564°C (1047.2°F)

Relative density : 1.6 [@ 25/4°C]

Vapor pressure : 0.13 kPa (1 mm Hg) @ 817°C

Volatility : 0% (v/v) @ 21°C

Solubility : Soluble in the following materials: cold water.

10 . Stability and reactivity

Stability : The product is stable.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Conditions to avoid : No specific data.

Materials to avoid : oxidizing materials
metals
acids
alkalis
moisture

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

11 . Toxicological information

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
sodium cyanide	LD50 Dermal	Rat	11.28 to 14.63 mg/kg	-
	LD50 Oral	Rat	6.44 mg/kg	-

Conclusion/Summary : Not available.

12 . Ecological information

Environmental effects : Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

13 . Disposal considerations

Waste disposal : The generation of waste should be avoided or minimized wherever possible. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe way. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Waste and empty packaging must be disposed of in accordance with federal, provincial, and municipal environmental control regulations.

Refer to Section 7: HANDLING AND STORAGE and Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION for additional handling information and protection of employees.

14 . Transport information

Regulatory information	UN number	Proper shipping name	Classes	PG*	Label	Additional information
TDG Classification	1689	SODIUM CYANIDE	6.1	I		**ERAP Index** 1000 **Remarks** ERP / PIU # 2-0032

PG* : Packing group

15 . Regulatory information

WHMIS (Canada) : Class D-1A: Material causing immediate and serious toxic effects (Very toxic).
Class E: Corrosive material

Canada inventory : All ingredients are listed or exempted.

16 . Other information

Additional information : **This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.**

Other special considerations : Not available.

Regulatory Affairs Department : 1 800 665-6553

Notice to reader

16 . Other information

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

Ammonium Nitrate Specific Spill Response Plan

Notes: Ammonium Nitrate is a substance listed on Schedule 1 of the E2 Regulations, with a threshold of 20 tonnes. Ammonium nitrate is part of the Amex explosives (UN No 0082) mixture used at site.

CAS No: 6484-52-2 (Ammonium Nitrate)

UN No: 0082 (Amex)

Hazards Identification:

Physical State: Solid, pale oil-covered prills
Odour: Fuel oil

Emergency Overview: DANGER. STRONG OXIDIZER. CONTACT WITH OTHER MATERIALS MAY CAUSE FIRE OR EXPLOSION

Environmental Effects: Cause release of nitrogen compounds (nitrate, nitrite, ammonia) into aquatic environments. Potential effects include algal blooms, reduced oxygen and eutrophication of surface water bodies.

Usage: Amex is used for surface and subsurface blasting associated with quarrying and subsurface blasting related to mine development and mining.

Storage: Ammonium Nitrate is found in mixture form on site, in the form of Amex. Amex is stored in locked seacans located within the explosives berms or storage magazines, as well as temporary use locations during blasting preparation both underground and surface sites. The magazines and explosives berm locations are established and permitted through NRCan or the Ministry of Mines as appropriate.

The explosives storage areas are constructed and located so as to minimize risk to personnel and as permitted by the Ministry of Mines. The expected quantity to be stored on site is 1350 tonnes of Amex. The maximum allowed capacity of the largest container in which the substance is stored is 40,800 kgs.

Spill Response

Personal Protective Equipment for Spill Response:

- Chemically resistant gloves;
- Protective glasses or chemical safety goggles;
- Chemically resistant coveralls or tyvek coveralls; and
- Dust mask if spill is in confined space.

Emergency response for an Ammonium Nitrate Spill

- Isolate and evacuate the spill area if potential for explosion.
- Report spill to Supervisor immediately. Provide location and estimate of spill quantity.
- Supervisor will report the spill immediately to the Environmental Superintendent or Safety Coordinator.
- Mine General Manager will activate Incident Command System and Emergency Response Team if required for response.
  - Based on size, location of spill and potential hazardous conditions/environmental impacts.
- Remove all sources of heat and ignition (there is to be no smoking or use of any flames within the area). Remove all uncontaminated combustible materials or organic compounds from spill area.
- Stop flow if safe to do so.
  - Ventilate space prior to entering, if indoors.
- For spills to land, snow or ice:
  - Protect spill area from storm water runoff and prevent entry into surface waters by constructing a ditch or dike using suitable absorbent materials, soil or other appropriate barriers.
  - Vacuum or sweep the spilled residue using non-metal, non-sparking tools.
  - Avoid shock, friction and contact with grit. Wet spillage with water to prevent dust generation.
  - Place the residue in a plastic container, label as per WHMIS Guidelines and transport to waste management for offsite disposal.
  - Recovered solids, if free from impurities, may be suitable for its intended use. In this case, material is to be placed into suitable containers with lid, and clearly labelled as per WHMIS Guidelines.
- For spills to water:
  - Ammonium nitrate sinks and mixes with water.
  - Isolate/confine the spill from spreading by damming or diversion if feasible.
  - Pump contaminated water to drums, tanks or lined containment berms if possible.
  - Label drums for offsite disposal at an approved waste management facility.
- Remove, bag and label personal protective equipment for offsite disposal.
- Thoroughly wash skin with soap.

Safety Data Sheet

SECTION 1 – IDENTIFICATION

Name, Address, and Telephone of the Responsible Party

Dyno Nobel Inc.
6440 S. Millrock Drive, Suite 150
Salt Lake City, Utah 84121
Phone: 801-364-4800   Fax 801-321-6703
E-Mail: dnna.hse@am.dynonobel.com   www.dynonobel.com

SDS #: 1020
Date: 07/20/2020
Supersedes: 09/10/2018

Product Identifier
Product Name: Superprill
Formula: NH4NO3

Other Means of Identification
Synonyms: Superprill™, Prilled Ammonium Nitrate, Industrial Grade LoDAN, Ammonium Nitrate, Industrial Grade HiDAN, Ammonium Nitrate, Agricultural Grade

Intended Use of the Product
Industrial applications

Emergency Telephone Number
FOR 24 HOUR EMERGENCY, CALL

CHEMTREC (USA)	**800-424-9300**
CANUTEC (CANADA)	**613-996-6666**

SECTION 2 – HAZARD(S) IDENTIFICATION

Classification of the Substance or Mixture
Classification (GHS-US)

Ox. Sol. 3	H272
Eye Irrit. 2A	H319

Label Elements
GHS-US Labeling

Hazard Pictograms (GHS-US) :

GHS03   GHS07

Signal Word (GHS-US) : Warning

Hazard Statements (GHS-US) : H272 - May intensify fire; oxidizer
H319 - Causes serious eye irritation

Precautionary Statements (GHS-US) : P210 - Keep away from heat, sparks, open flames, hot surfaces. - No smoking
P220 - Keep/Store away from combustible materials, clothing, incompatible materials
P221 - Take any precaution to avoid mixing with combustibles, organic material, clothing, incompatible materials
P260 - Do not breathe fume, dust.
P264 - Wash hands, forearms, and other exposed areas thoroughly after handling
P270 - Do not eat, drink or smoke when using this product.
P273 - Avoid release to the environment.
P280 - Wear protective gloves, protective clothing, eye protection
P305+P351+P338 - If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P337+P313 - If eye irritation persists: Get medical advice/attention
P370+P378 - In case of fire: Use water only on AN fires.
P405 - Store locked up.
P501 - Dispose of contents/container according to local, regional, national,

territorial, provincial, and international regulations*
*Do not perform hot work on contaminated equipment.

Other Hazards
Other Hazards: Aquatic Acute 3 H402
H402 – Harmful to aquatic life

SECTION 3 - COMPOSITION/INFORMATION ON INGREDIENTS

Mixture

Name	Product identifier	% (w/w)	Ingredient Classification (GHS-US)
Ammonium nitrate	(CAS No) 6484-52-2	98 - 100	Ox. Sol. 3, H272 Eye Irrit. 2A, H319

Full text of H-phrases: see section 16

SECTION 4 - FIRST AID MEASURES

Description of First Aid Measures
General: Never give anything by mouth to an unconscious person. If you feel unwell, seek medical advice (show the label where possible).
Inhalation: If symptoms occur, go into fresh air and ventilate suspected area. Seek medical attention.
Skin Contact: Remove contaminated clothing. Wash with soap and water followed by rinsing with water. Seek medical attention if irritation develops or persists. Wash contaminated clothing before reuse.
Eye Contact: Rinse cautiously with water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Obtain medical attention if irritation develops or persists.
Ingestion: Rinse mouth. Do NOT induce vomiting. Seek medical attention.

Most Important Symptoms and Effects Both Acute and Delayed
General: Irritation to eyes, skin and respiratory tract.
Inhalation: May cause irritation to the respiratory tract, sneezing, coughing, burning sensation of throat with constricting sensation of the larnyx and difficulty breathing.
Skin Contact: May cause skin irritation.
Eye Contact: Causes serious eye irritation.
Ingestion: Ingestion is likely to be harmful or have adverse effects.
Chronic Symptoms: None known.
Indication of Any Immediate Medical Attention and Special Treatment Needed
If exposed or concerned, get medical advice and attention. If ingested, may cause methemoglobenemia – emergency response should treat appropriately, such as by intravenous administration of methylene blue.

SECTION 5 - FIRE-FIGHTING MEASURES

Extinguishing Media
Suitable Extinguishing Media: Evacuate the area for 1 mile if ammonium nitrate is involved in a fire. Only water shall be used on ammonium nitrate fires. Dry chemical, foams, steam and smothering devices are not effective and can lead to possible explosion of the ammonium nitrate. General extinguishers may be used on fires **not involving the ammonium nitrate** such as conveyors, electrical equipment, tires, bearings, general plant equipment or the like when only minimal amounts of ammonium nitrate are present. For large fires use unmanned monitor nozzles if available.
Unsuitable Extinguishing Media: Dry chemical, carbon dioxide, or regular foam.
Special Hazards Arising From the Substance or Mixture In intense fires, the ammonium nitrate can melt and detonate from confinement or strong shocks. Evacuation of at least 1 mile is recommended if the ammonium nitrate is involved in a fire.
Fire Hazard: May intensify fire; oxidizer. Will accelerate the burning of other combustibles, resulting in more rapid spread of fire.
Explosion Hazard: Heat may build pressure, rupturing closed containers, spreading fire and increasing risk of burns and

injuries. Smothering, contact with organic material, or combustible material may cause an explosive situation.
Reactivity: May cause or intensify fire; oxidizer. May accelerate the burning of other combustible materials. Smothering, contact with organic material, or combustible material may cause an explosive situation.
Advice for Firefighters
Precautions for Firefighting: Evacuate the area for 1 mile if ammonium nitrate is involved in a fire. Only fires which are in the initial or beginning stage or those involving minimal amounts of ammonium nitrate in a manufacturing setting or in an area where ammonium nitrate is stored or in vehicles transporting ammonium nitrate should be attacked using manual fire extinguishing methods (fire extinguishers, hose streams, etc.) that require a human operator. If a fire in an area where ammonium nitrate is stored or in vehicles transporting ammonium nitrate progresses beyond the incipient stage or involves the ammonium nitrate, evacuation is required. Fire fighters downwind from a fire should wear self-contained breathing apparatus. Fire fighters must use standard protective equipment including flame retardant coat, helmet with face shield, gloves and rubber boots.
Hazardous Combustion Products: Nitrogen oxides. Toxic fumes are released. Carbon oxides (CO, CO_2). Ammonia.
Additional Information: If a fire has not reached the ammonium nitrate, cool the ammonium nitrate or container thereof to prevent the fire from reaching it. Ammonium nitrate does not burn by itself and thus needs to be kept separate from combustible materials. Ammonium nitrate is an oxidizer and will significantly increase the burning rate of combustible materials.
When in confinement and in the presence of a strong detonation sources the material can explode when subject to sudden shock, pressure, or high temperatures. Avoid temperatures above 210 C (410 F) which may cause thermal decomposition or explosion, especially in confined or poorly ventilated spaces.
Do not allow run-off from fire fighting to enter drains or water courses.
Reference to Other Sections: Refer to section 9 for flammability properties. Not flammable.

SECTION 6 - ACCIDENTAL RELEASE MEASURES

Personal Precautions, Protective Equipment and Emergency Procedures
General Measures: Handle in accordance with good industrial hygiene and safety practice. Avoid breathing (dust, vapor, mist, gas). Avoid getting in eyes or on skin. Keep away from combustible material.
For Non-Emergency Personnel
Protective Equipment: Use appropriate personal protection equipment (PPE).
Emergency Procedures: Evacuate unnecessary personnel.
For Emergency Personnel
Protective Equipment: Use appropriate personal protection equipment (PPE).
Emergency Procedures: Ventilate area.

Environmental Precautions
Prevent entry to sewers and public waters.

Methods and Material for Containment and Cleaning Up
For Containment: Avoid generation of dust during clean-up of spills. Use a broom for small spills do not mix with other materials.
Methods for Cleaning Up: Collect spillage for possible reuse. Clean up spills immediately and dispose of waste safely. Contact competent authorities after a spill. Do not take up in combustible material such as: saw dust or cellulosic material.
Reference to Other Sections
See heading 8, Exposure Controls and Personal Protection

SECTION 7 - HANDLING AND STORAGE

Precautions for Safe Handling
Additional Hazards When Processed: When heated to decomposition, emits toxic fumes. Smothering, contact with organic material, or combustible material in a fire situation may be an explosive situation. Do not puncture or incinerate container.
Hygiene Measures: Handle in accordance with good industrial hygiene and safety procedures. Wash hands and other exposed areas with mild soap and water before eating, drinking, or smoking and again when leaving work.

Conditions for Safe Storage, Including Any Incompatibilities
Technical Measures: Comply with applicable regulations 29 CFR 1910.109(i).
Storage Conditions: Store in a dry, cool and well-ventilated place. Keep container closed when not in use. Keep/Store away from combustible materials, ignition sources, and incompatible materials.
Incompatible Materials: Strong acids. Strong bases. Strong oxidizers. halogens (F, Cl, Br, I). Chlorine compounds, chlorinated inorganics (potassium, calcium and sodium hypochlorite) and hydrogen peroxides. Organic materials. Combustible materials.

SECTION 8 - EXPOSURE CONTROLS/PERSONAL PROTECTION

Control Parameters

No Occupational Exposure Limits (OELs) have been established for this product or its chemical components.

Exposure Controls

Appropriate Engineering Controls: Ensure all national/local regulations are observed. Ensure adequate ventilation, especially in confined areas.

Personal Protective Equipment: Approved safety glasses. Gloves. If insufficient ventilation: wear respiratory protection. Protective clothing when appropriate as indicated by air monitoring or if engineering controls are insufficient.

Materials for Protective Clothing: Chemically resistant materials and fabrics.

Hand Protection: Wear protective gloves.

Eye Protection: Approved safety glasses

Skin and Body Protection: Not available

Respiratory Protection: Use NIOSH-approved air-purifying or supplied-air respirator where airborne concentrations of vapor or mist are expected to exceed exposure limits.

Other Information: When using, do not eat, drink or smoke.

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

Information on Basic Physical and Chemical Properties

Physical State	:	Solid
Appearance	:	Colorless to off-white prills
Odor	:	Odorless
Odor Threshold	:	Not available
pH	:	Not available
Relative Evaporation Rate (butylacetate=1)	:	Not available
Melting Point	:	170 °C (337°F)
Freezing Point	:	Not available
Boiling Point	:	177 - 210 °C Decomposition (350 - 410°F)
Flash Point	:	Not available
Auto-ignition Temperature	:	Not available
Decomposition Temperature	:	Not available
Flammability (solid, gas)	:	Not flammable
Lower Flammable Limit	:	Not available
Upper Flammable Limit	:	Not available
Vapor Pressure	:	Not available
Relative Vapor Density at 20 °C	:	Not available
Relative Density	:	Not available

Specific Gravity	:	1.72 - 1.00 (Poured bulk density)
Solubility	:	Soluble in water. Water: 192 g/100 ml @ 20 °C (68 °F); 118 g/100 ml @ 0 °C (32 °F)
Partition coefficient: n-octanol/water	:	Not applicable. (inorganic)
Viscosity	:	Not available
Explosion Data – Sensitivity to Mechanical Impact	:	Not sensitive to mechanical impact. May be sensitive to supersonic explosively driven projectile impacts.
Explosion Data – Sensitivity to Static Discharge	:	Not sensitive to static discharge.

SECTION 10 - STABILITY AND REACTIVITY

Reactivity: May cause or intensify fire; oxidizer. May accelerate the burning of other combustible materials. Smothering, contact with organic material, or combustible material may cause an explosive situation.

Chemical Stability: May intensify fire; oxidizer.

Possibility of Hazardous Reactions: Hazardous polymerization will not occur.

Conditions to Avoid: Extremely high temperatures. Overheating. Open flame. Combustible materials. Sources of ignition. Incompatible materials.

Incompatible Materials: Strong acids. Strong bases. Strong oxidizers. Halogens. Chlorine compounds, chlorinated inorganics (potassium, calcium and sodium hypochlorite) and hydrogen peroxides.

Hazardous Decomposition Products: Nitrogen oxides. Toxic vapors. Ammonia. Nitric acid

SECTION 11 - TOXICOLOGICAL INFORMATION

Information on Toxicological Effects – Product
Acute Toxicity: Not classified
LD50 and LC50 Data: Not available

Skin Corrosion/Irritation: Not classified

Serious Eye Damage/Irritation: Causes serious eye irritation.

Respiratory or Skin Sensitization: Not classified

Germ Cell Mutagenicity: Not classified

Teratogenicity: Not available

Carcinogenicity: Not classified

Specific Target Organ Toxicity (Repeated Exposure): Not classified
Reproductive Toxicity: Not classified

Specific Target Organ Toxicity (Single Exposure): Not classified

Aspiration Hazard: Not classified
Symptoms/Injuries After Inhalation: May cause respiratory irritation.
Symptoms/Injuries After Skin Contact: May cause skin irritation.
Symptoms/Injuries After Eye Contact: Causes serious eye irritation.
Symptoms/Injuries After Ingestion: Ingestion is likely to be harmful or have adverse effects.
Chronic Symptoms: None known.
Information on Toxicological Effects - Ingredient(s)
LD50 and LC50 Data:

Ammonium nitrate (6484-52-2)	
LD50 Oral Rat	2217 mg/kg
LC50 Inhalation Rat	> 88.8 mg/l/4h
ATE CLP (oral)	2217.000 mg/kg body weight

SECTION 12: ECOLOGICAL INFORMATION

Toxicity Not classified
Persistence and Degradability

Superprill	
Persistence and Degradability	Not established.

Bioaccumulative Potential

Superprill	
Bioaccumulative Potential	Not established.
Ammonium nitrate (6484-52-2)	
BCF fish 1	(no bioaccumulation expected)
Log Pow	-3.1 (at 25 °C)

Mobility in Soil Not available
Other Adverse Effects
Other Information: Avoid release to the environment.

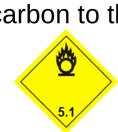
SECTION 13 – DISPOSAL CONSIDERATIONS

Waste Disposal Recommendations: Collect spillage for possible reuse. Dispose of waste material in accordance with all local, regional, national, provincial, territorial and international regulations.
Additional Information: Clean up even minor leaks or spills if possible without unnecessary risk.

SECTION 14 - TRANSPORT INFORMATION

14.1 In Accordance with DOT

Proper Shipping Name : AMMONIUM NITRATE with not more than 0.2% total combustible material, including any organic substance, calculated as carbon to the exclusion of any other added substance
Hazard Class : 5.1
Identification Number : UN1942
Label Codes : 5.1
Packing Group : III
ERG Number : 140



14.2 In Accordance with IMDG

Proper Shipping Name : AMMONIUM NITRATE
Hazard Class : 5.1
Identification Number : UN1942
Packing Group : III
Label Codes : 5.1
EmS-No. (Fire) : F-H
EmS-No. (Spillage) : S-Q

14.3 In Accordance with IATA

Proper Shipping Name : AMMONIUM NITRATE
Packing Group : III
Identification Number : UN1942
Hazard Class : 5
Label Codes : 5.1
ERG Code (IATA) : 5L

14.4 In Accordance with TDG

Proper Shipping Name	:	AMMONIUM NITRATE with not more than 0.2 per cent combustible substances, including any organic substance calculated as carbon, to the exclusion of any other added substance
Packing Group	:	III
Hazard Class	:	5.1
Identification Number	:	UN1942
Label Codes	:	5.1

SECTION 15 - REGULATORY INFORMATION

US Federal Regulations

Superprill	
SARA Section 311/312 Hazard Classes	Immediate (acute) health hazard

Ammonium nitrate (6484-52-2)

Listed on the United States TSCA (Toxic Substances Control Act) inventory

US State Regulations

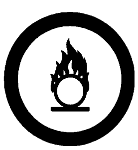
Ammonium nitrate (6484-52-2)

U.S. - Massachusetts - Right To Know List
U.S. - New Jersey - Right to Know Hazardous Substance List
U.S. - Pennsylvania - RTK (Right to Know) - Environmental Hazard List
U.S. - Pennsylvania - RTK (Right to Know) List

Canadian Regulations

Superprill

WHMIS Classification	Class C - Oxidizing Material Class D Division 2 Subdivision B - Toxic material causing other toxic effects



Ammonium nitrate (6484-52-2)

Listed on the Canadian DSL (Domestic Substances List) inventory.

WHMIS Classification	Class C - Oxidizing Material Class D Division 2 Subdivision B - Toxic material causing other toxic effects

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the SDS contains all of the information required by CPR.

SECTION 16: OTHER INFORMATION, INCLUDING DATE OF PREPARATION OR LAST REVISION

Revision date	:	07/20/2020
Other Information	:	This document has been prepared in accordance with the SDS requirements of the OSHA Hazard Communication Standard 29 CFR 1910.1200.

GHS Full Text Phrases:

Eye Irrit. 2A	Serious eye damage/eye irritation Category 2A
Ox. Sol. 3	Oxidizing solids Category 3
H272	May intensify fire; oxidizer

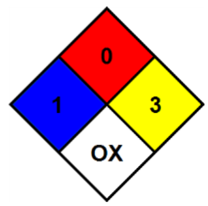
H319	Causes serious eye irritation

NFPA Health Hazard : 1 - Exposure could cause irritation but only minor residual injury even if no treatment is given.

NFPA Fire Hazard : 0 - Materials that will not burn.

NFPA Reactivity : 3 - Capable of detonation or explosive reaction, but requires a strong initiating source or must be heated under confinement before initiation, or reacts explosively with water.

NFPA Specific Hazard : OX - This denotes an oxidizer, a chemical which can greatly increase the rate of combustion/fire.



Party Responsible for the Preparation of This Document

Dyno Nobel Inc.
6440 S. Millrock Drive, Suite 150
Salt Lake City, Utah 84121
Phone: 801-364-4800

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Dyno Nobel SDS

Explosive Materials

Aviation Fuel (Jet-A) Specific Spill Response Plan

Notes: Aviation fuel is a substance listed in Schedule 1 of the E2 regulations. The quantities of Aviation fuel currently stored at the Hope Bay Project do not exceed the Schedule 1 thresholds; however, a Product Specific Emergency Response Plan has been developed for this product based on the environmental and health and safety impacts of a potential spill. If spilled, aviation fuel could be immediately harmful to humans and/or the environment and has the potential to cause pool fires and vapour cloud explosion (dependent on manufacturer specific additives).

CAS No: 8008-20-06 (Kerosene)

UN No: 1223 (Kerosene)

Hazards Identification:

Physical State: Liquid, pale yellow
Odor: Petroleum/solvent
Flash Point: > 38˚C

Emergency Overview: HIGHLY COMBULSTIBLE. FLASH FIRE/EXPLOSION POTENTIAL. MATERIAL IS STATIC ACCUMULATOR.

Potential Acute Health Effects: Highly Explosive when vapour meets the air. Causes combustion and explosion. Hazardous if ingested or inhaled. May cause irritation to the eyes and respiratory tract. Reacts with oxidizing agents. Hazardous decomposition product: Carbon monoxide.

Environmental Effects: Toxic to aquatic organisms, may cause long-term adverse effects in aquatic environments.

Usage: Jet-A is used to fuel aircraft operating at the Hope Bay site (helicopters, airplanes).

Storage: Jet-A is stored in steel fuel tanks or manufactured fuel bladders within the secondary containment berm. Smaller quantities are stored in steel drums within ventilated seacans or within lined containment facilities at the location of use.

The expected quantity to be stored on site is 775 tonnes of Jet-A fuel. The maximum allowed capacity of the largest container in which the substance is stored is 400,000 L.

Spill Response

Personal Protective Equipment for Spill Response:

- Chemical-resistant gloves (e.g., nitrile);
- Protective glasses or chemical safety goggles;
- Chemically resistant coveralls or Tyvek coveralls;

- Half face respirator with organic vapour cartridges or self-contained breathing apparatus; and
- Anti-static clothing.

Emergency response for a Jet-A Spill

- Isolate and evacuate the spill area if potential for explosion or combustion.
- Report spill to Supervisor immediately. Provide location and estimate of spill quantity.
- Supervisor will report the spill immediately to the Environmental Superintendent or Safety Coordinator.
- Mine General Manager will activate Incident Command System and Emergency Response Team if required for response.
  - Based on size, location of spill and potential hazardous conditions/environmental impacts.
- Remove all sources of heat and ignition (there is to be no smoking or use of any flames within the area).
- Stop flow if safe to do so.
  - Low-lying areas can trap explosive vapours.
  - Air quality monitoring will be conducted in enclosed spaces to determine concentration of hazardous vapours prior to initiating spill response efforts.
  - Ventilate space prior to entering, if indoors.
  - Restrict access to area and approach upwind of spill.
- For spills to land, snow or ice:
  - Protect spill area from storm water runoff and prevent entry into surface waters by constructing a ditch or berm using suitable non-combustible absorbent materials (e.g., sand, diatomaceous earth).
  - Do not contain spill if there is any chance of igniting vapours.
  - Cover small spills with non-combustible absorbent materials.
  - Use non-metal, non-sparking tools to collect absorption materials.
  - Place the residue in a steel container, clearly labeled as per WHMIS guidelines. Close tightly.
  - Ground tools and containers when collecting absorption material.
  - Transport to waste management for offsite disposal. Store in ventilated areas away from incompatible materials.
- For spills to water:
  - Jet-A fuel floats on surface of water.

  - Light hydrocarbon with narrow boiling range and low viscosity. Will evaporate or naturally disperse within a day or less in open water (NOAA Office of Response & Restoration, 2019).
  - Do not attempt to contain or remove spills (high explosion potential due to quick evaporation).
  - If Flash Point exceeds the Ambient Temperature by 10˚C or more, use containment booms and remove from the surface by skimming.
  - If Flash Point does not exceed the Ambient Temperature by 10˚C or is less than the Ambient Temperature, use booms as a barrier to protect shorelines and allow the material to evaporate.
  - Use booms to prevent spread of spill. Protect spread to shoreline where fuel can penetrate quickly into porous sediments.
- Remove, bag and label personal protective equipment for offsite disposal.
- Thoroughly wash skin with soap.

Diesel Fuel Specific Spill Response Plan

Notes: Diesel Fuel is a substance listed in Schedule 1 of the E2 regulations, with a threshold of 2500 tonnes. Diesel fuel is used on site to for power and to fuel various pieces of light/heavy equipment. A diesel fuel spill is characterized as the Worst-Case and Alternate Worst-Case Scenario Spill under the E2 Regulations. The details of these spills are presented in section 4.8 of the Plan. CAS No: 68334-30-5 (Diesel)

UN No: UN1202

Hazards Identification:

Physical State: Liquid, clear to yellow
Odor: Petroleum/solvent
Flash Point: >= 40.0˚C

Emergency Overview:

Potential Acute Health Effects: Flammable liquid and vapour. Harmful if swallowed. May be fatal if swallowed and enters airways. Causes skin and serious eye irritation. Harmful if inhaled.

Environmental Effects: Toxic to aquatic life with long lasting effects.

Usage: Diesel is used for power generation and to fuel various pieces of light/heavy equipment operating at site.

Storage: Diesel is stored in steel fuel tanks within secondary containment berm or double walled fuel tanks.

The expected quantity to be stored on site is 30,000,000 L of diesel fuel. The maximum allowed capacity of the largest container in which the substance is stored is 5,000,000 L.

Spill Response

Personal Protective Equipment for Spill Response:

- Chemical-resistant gloves (e.g., nitrile);
- Protective glasses or chemical safety goggles;
- Chemically resistant coveralls or Tyvek coveralls;
- Full face respirator with organic vapour cartridges or self-contained breathing apparatus

Emergency response for a Diesel Spill

- Isolate and evacuate the spill area if potential for explosion or combustion. Stay upwind of spill/leak.
- Eliminate ignition sources.

- Report spill to Supervisor immediately. Provide location and estimate of spill quantity.
- Supervisor will report the spill immediately to the Environmental Superintendent or Safety Coordinator.
- Mine General Manager will activate Incident Command System and Emergency Response Team if required for response.
  - Based on size, location of spill and potential hazardous conditions/environmental impacts.
- Remove all sources of heat and ignition (there is to be no smoking or use of any flames within the area).
- Stop flow if safe to do so.
  - Air quality monitoring will be conducted in enclosed spaces to determine concentration of hazardous vapours prior to initiating spill response efforts.
  - Ventilate space prior to entering, if indoors.
  - Restrict access to area and approach upwind of spill.
- For spills to land, snow or ice:
  - Protect spill area from storm water runoff and prevent entry into surface waters by constructing a ditch or berm using suitable non-combustible absorbent materials (e.g., sand, diatomaceous earth).
  - Cover small spills with non-combustible absorbent materials, appropriate absorbent pads and placing absorbent booms in the path of flow of the spill.
  - Constructing temporary berms from soil or snow at the leading edge of the spill to minimize flow
  - Plastic tarps can be placed over and at the foot of the berm to capture pooling liquid and facilitate recovery
  - Pumping spilled material to empty drums or tanks
  - Excavators and other heavy equipment may be used to excavate contaminated materials
  - Use non-metal, non-sparking tools to collect absorption materials.
  - Place the residue in a steel container, clearly labeled as per WHMIS guidelines. Close tightly.
  - Ground tools/equipment and containers when collecting absorption material.
  - Transport to waste management for offsite disposal. Store in ventilated areas away from incompatible materials.
- For spills to water:
  - Diesel fuel floats on surface of water.

  - Identify the direction and speed of the flow path of the product based on weather conditions and drainage patterns
  - Monitor the spread of the material using a drone or from a helicopter if possible to identify the area of spread
  - Use appropriate absorbent pads, socks and similar materials to recover spilled product
  - Granular sorbent materials are NOT to be used for spill response on water
  - Hydrophobic absorbent booms will be deployed to contain large spills and to facilitate recovery
  - Absorbent booms will be drawn slowly in to encircle the spilled product and absorb it
  - Skimmers will be deployed in open-water areas to remove product from the water surface and boards or plywood may be used in streams or culverts to reduce the flow of spilled product on the surface and limit the area of the spill on the water
  - Pump contaminated water into tanks or storage bladders if possible
- Remove, bag and label personal protective equipment for offsite disposal.
- Thoroughly wash skin with soap.

SECTION 1. IDENTIFICATION

Product name : DIESEL FUEL

Synonyms : Seasonal Diesel, #2 Diesel, #1 Diesel, #2 Heating Oil, #1 Heating Oil, OSX, D50, Arctic Diesel, Farm Diesel, Marine Diesel, Low Sulphur Diesel, LSD, Ultra Low Sulphur Diesel, ULSD, Mining Diesel, Naval Distillate, Dyed Diesel, Marked Diesel, Coloured Diesel, Furnace special, Biodiesel blend, B1, B2, B5, Renewable Diesel blend (RX where X is 2- 50, X is representative of volume %), Diesel Low Cloud (LC), Marine Gas Oil, Marine Gas Oil Dyed

Product code : 103213, 100679, 100654, 100653, 100105, 100992, 100637, 100634, 100631, 100638, 100641, 100635, 100632, 100684, 100683, 100657, 100656, 100655, 100687, 100686, 100685, 100681, 100661, 100659, 100667, 100666, 100665, 100682, 100671, 100669, 100664, 100662, 100680, 100781, 100964, 103204, 103180, 103179, 103193, 103178, 103136, 103135, 103134, 103133, 103132, 103131, 101799, 102907, 102762, 102763, 102755, 102302, 102744, 101801, 100678, 100677, 101802, 100107, 100668, 100658, 100911, 100663, 100652, 100460, 100065, 101796, 101793, 101795, 101792, 101794, 101791, 100768, 100643, 100642, 100103, 101798, 101800, 101797, 101788, 101789, 101787, 102531, 100734, 100733, 100640, 100997, 100995, 100732, 100731, 100994

Manufacturer or supplier's details

Petro-Canada
P.O. Box 2844, 150 - 6th Avenue South-West
Calgary Alberta T2P 3E3
Canada, Telephone: 1-866-786-2671

Emergency telephone number CHEMTREC: 1-800-424-9300 (toll free) or +1 703-527-3887; Suncor Energy: +1 403-296-3000

Recommended use of the chemical and restrictions on use

Recommended use : Diesel fuels are distillate fuels suitable for use in high and medium speed internal combustion engines of the compression ignition type. Mining diesels, marine diesels, MDO and naval distillates may have a higher flash point requirement.

Prepared by : Product Safety

SECTION 2. HAZARDS IDENTIFICATION

Emergency Overview

Appearance	Bright oily liquid.
Colour	Clear to yellow (This product may be dyed red for taxation purposes)

Odour	Mild petroleum oil like.

GHS Classification

Flammable liquids : Category 3

Acute toxicity (Inhalation) : Category 4

Skin irritation : Category 2

Carcinogenicity : Category 2

Specific target organ toxicity - single exposure : Category 3 (Central nervous system)

Specific target organ toxicity - repeated exposure : Category 2 (Liver, thymus, Bone)

Aspiration hazard : Category 1

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : Flammable liquid and vapour.
May be fatal if swallowed and enters airways.
Causes skin irritation.
Harmful if inhaled.
May cause drowsiness or dizziness.
Suspected of causing cancer.
May cause damage to organs (Liver, thymus, Bone) through prolonged or repeated exposure.

Precautionary statements : **Prevention:**
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
Keep container tightly closed.
Ground and bond container and receiving equipment.
Use explosion-proof electrical/ ventilating/ lighting equipment.
Use non-sparking tools.
Take action to prevent static discharges.
Do not breathe dust/ fume/ gas/ mist/ vapours/ spray.
Wash skin thoroughly after handling.
Use only outdoors or in a well-ventilated area.
Wear protective gloves/ protective clothing/ eye protection/ face protection.
Response:

IF SWALLOWED: Immediately call a POISON CENTER/doctor.
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water.
IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/doctor if you feel unwell.
IF exposed or concerned: Get medical advice/ attention.
Do NOT induce vomiting.
If skin irritation occurs: Get medical advice/ attention.
Take off contaminated clothing and wash it before reuse.
In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish.
Storage:
Store in a well-ventilated place. Keep container tightly closed.
Store in a well-ventilated place. Keep cool.
Store locked up.
Disposal:
Dispose of contents/ container to an approved waste disposal plant.

Potential Health Effects

Primary Routes of Entry : Eye contact
Ingestion
Inhalation
Skin contact

Aggravated Medical Condition : None known.

Other hazards

None known.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Mixture

Hazardous components

Chemical name	CAS-No.	Concentration
Kerosine (petroleum), hydrodesulfurized; Kerosine — unspecified	64742-81-0	48 - 100 %
Kerosine (petroleum); Straight run kerosine	8008-20-6	
Fuels, diesel; Gasoil — unspecified	68334-30-5	
Alkanes, C10-20-branched and linear	928771-01-1	0 - 50 %
Fatty acids, C16-18 and C18-unsatd., Me esters	67762-38-3	0 - 20 %

All above concentrations are in percent by weight.

SECTION 4. FIRST AID MEASURES

If inhaled : Move to fresh air.
Artificial respiration and/or oxygen may be necessary.
Seek medical advice.

In case of skin contact : In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing

		and shoes. Wash skin thoroughly with soap and water or use recognized skin cleanser. Wash clothing before reuse. Seek medical advice.
In case of eye contact	:	Remove contact lenses. Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Obtain medical attention.
If swallowed	:	Rinse mouth with water. DO NOT induce vomiting unless directed to do so by a physician or poison control center. Never give anything by mouth to an unconscious person. Seek medical advice.
Most important symptoms and effects, both acute and delayed	:	Harmful if inhaled. Respiratory, skin and eye irritation; nausea; cancer.
Notes to physician	:	Treat symptomatically. For specialist advice physicians should contact the Poisons Information Service.

SECTION 5. FIREFIGHTING MEASURES

Suitable extinguishing media	:	Dry chemical Carbon dioxide (CO_2) Water fog. Foam
Unsuitable extinguishing media	:	Do NOT use water jet.
Specific hazards during firefighting	:	Cool closed containers exposed to fire with water spray.
Hazardous combustion products	:	Carbon oxides (CO, CO_2), nitrogen oxides (NOx), sulphur oxides (SOx), smoke and irritating vapours as products of incomplete combustion.
Further information	:	Prevent fire extinguishing water from contaminating surface water or the ground water system.
Special protective equipment for firefighters	:	Wear self-contained breathing apparatus for firefighting if necessary.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	:	For personal protection see section 8. Ensure adequate ventilation. Evacuate personnel to safe areas. Material can create slippery conditions.
Environmental precautions	:	If the product contaminates rivers and lakes or drains inform respective authorities.
Methods and materials for containment and cleaning up	:	Prevent further leakage or spillage if safe to do so. Remove all sources of ignition. Soak up with inert absorbent material. Non-sparking tools should be used. Ensure adequate ventilation.

Contact the proper local authorities.

SECTION 7. HANDLING AND STORAGE

Advice on safe handling : For personal protection see section 8.
Smoking, eating and drinking should be prohibited in the application area.
Use only with adequate ventilation.
In case of insufficient ventilation, wear suitable respiratory equipment.
Avoid spark promoters. Ground/bond container and equipment. These alone may be insufficient to remove static electricity.
Avoid contact with skin, eyes and clothing.
Do not ingest.
Keep away from heat and sources of ignition.
Keep container closed when not in use.

Conditions for safe storage : Store in original container.
Containers which are opened must be carefully resealed and kept upright to prevent leakage.
Keep in a dry, cool and well-ventilated place.
Keep in properly labelled containers.
To maintain product quality, do not store in heat or direct sunlight.
Ensure the storage containers are grounded/bonded.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

Components	CAS-No.	Value type (Form of exposure)	Control parameters / Permissible concentration	Basis
Kerosine (petroleum), hydrodesulfurized; Kerosine — unspecified	64742-81-0	TWA	200 mg/m3 (As total hydrocarbon vapour)	ACGIH
		TWA	200 mg/m3 (total hydrocarbon vapor)	CA AB OEL
		TWA	525 mg/m3	CA ON OEL
		TWA	200 mg/m3 (As total hydrocarbon vapour)	ACGIH
		TWA	200 mg/m3 (total hydrocarbon vapor)	ACGIH
Kerosine (petroleum); Straight run kerosine	8008-20-6	TWA	200 mg/m3 (total hydrocarbon vapor)	CA BC OEL
		TWA	200 mg/m3 (total hydrocarbon vapor)	CA AB OEL
		TWA	200 mg/m3 (total hydrocarbon	ACGIH

			vapor)	
Fuels, diesel; Gasoil — unspecified	68334-30-5	TWA	100 mg/m3 (total hydrocarbons)	CA AB OEL
		TWA (Vapour and inhalable aerosols)	100 mg/m3 (total hydrocarbons)	CA BC OEL
		TWA (Inhalable fraction and vapor)	100 mg/m3 (total hydrocarbons)	ACGIH

Engineering measures : Adequate ventilation to ensure that Occupational Exposure Limits are not exceeded.
Use only in well-ventilated areas.
Ensure that eyewash station and safety shower are proximal to the work-station location.

Personal protective equipment

Respiratory protection : Concentration in air determines protection needed.
Use respiratory protection unless adequate local exhaust ventilation is provided or exposure assessment demonstrates that exposures are within recommended exposure guidelines.
Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Filter type : organic vapour cartridge or canister may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air-purifying respirators is limited. Use a positive-pressure, air-supplied respirator if there is any potential for uncontrolled release, exposure levels are unknown, or any other circumstances where air-purifying respirators may not provide adequate protection.

Hand protection

Material : neoprene, nitrile, polyvinyl alcohol (PVA), Viton(R). Consult your PPE provider for breakthrough times and the specific glove that is best for you based on your use patterns. It should be realized that eventually any material regardless of their imperviousness, will get permeated by chemicals. Therefore, protective gloves should be regularly checked for wear and tear. At the first signs of hardening and cracks, they should be changed.

Remarks : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.

Eye protection : Wear face-shield and protective suit for abnormal processing problems.

Skin and body protection : Choose body protection in relation to its type, to the concentration and amount of dangerous substances, and to the specific work-place.

Protective measures : Wash contaminated clothing before re-use.

Hygiene measures : Remove and wash contaminated clothing and gloves, including the inside, before re-use.

Wash face, hands and any exposed skin thoroughly after handling.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	Bright oily liquid.
Colour	:	Clear to yellow (This product may be dyed red for taxation purposes)
Odour	:	Mild petroleum oil like.
Odour Threshold	:	No data available
pH	:	No data available
Melting point	:	No data available
Boiling point/boiling range	:	150 - 371 °C (302 - 700 °F)
Decomposition temperature		No data available
Flash point	:	> 40 °C (104 °F) Method: closed cup
Auto-Ignition Temperature	:	204 °C (399 °F)
Evaporation rate	:	No data available
Flammability	:	Flammable in presence of open flames, sparks and heat. Vapours are heavier than air and may travel considerable distance to sources of ignition and flash back. This product can accumulate static charge and ignite.
Upper explosion limit	:	6 %(V)
Lower explosion limit	:	0.7 %(V)
Vapour pressure	:	7.5 mmHg (20 °C / 68 °F)
Relative vapour density	:	4.5
Relative density	:	0.8 - 0.88
Solubility(ies)		
Water solubility	:	insoluble
Partition coefficient: n-octanol/water	:	No data available
Viscosity		
Viscosity, kinematic	:	1.3 - 4.1 cSt (40 °C / 104 °F)

SECTION 10. STABILITY AND REACTIVITY

Reactivity	:	Stable at normal ambient temperature and pressure.
Chemical stability	:	Stable under normal conditions.
Possibility of hazardous reactions	:	Hazardous polymerisation does not occur.
Conditions to avoid	:	Extremes of temperature and direct sunlight.
Incompatible materials	:	Reactive with oxidising agents and acids.
Hazardous decomposition products	:	May release COx, NOx, SOx, smoke and irritating vapours when heated to decomposition.

SECTION 11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure
Eye contact
Ingestion
Inhalation
Skin contact

Acute toxicity

Product:

Acute oral toxicity : Remarks: Based on available data, the classification criteria are not met.

Acute inhalation toxicity : Acute toxicity estimate: 1.5 mg/l
Exposure time: 4 h
Test atmosphere: dust/mist
Method: Calculation method
Assessment: The component/mixture is moderately toxic after short term inhalation.
Remarks: Harmful if inhaled.

Acute dermal toxicity : Assessment: The substance or mixture has no acute dermal toxicity

Components:

Kerosine (petroleum), hydrodesulfurized; Kerosine — unspecified:
Acute oral toxicity : LD50 (Rat): > 5,000 mg/kg,

Acute inhalation toxicity : LC50 (Rat): > 5.2 mg/l
Exposure time: 4 hrs
Test atmosphere: dust/mist

Acute dermal toxicity : LD50 (Rabbit): > 2,000 mg/kg,

Kerosine (petroleum); Straight run kerosine:
Acute oral toxicity : LD50 (Rat): > 5,000 mg/kg,

Acute inhalation toxicity : LC50 (Rat): > 5 mg/l
Exposure time: 4 h
Test atmosphere: dust/mist

Acute dermal toxicity : LD50 (Rabbit): > 2,000 mg/kg,

Fuels, diesel; Gasoil — unspecified:

Acute oral toxicity	:	LD50 (Rat): 7,500 mg/kg,
Acute inhalation toxicity	:	LC50 (Rat): 4.1 mg/l Exposure time: 4 h Test atmosphere: vapour
Acute dermal toxicity	:	LD50 (Mouse): 24,500 mg/kg,

Skin corrosion/irritation

Product:

Remarks: Causes skin irritation.

Serious eye damage/eye irritation

Product:

Remarks: Based on available data, the classification criteria are not met.

Respiratory or skin sensitisation

Product:

Remarks: Based on available data, the classification criteria are not met.

Germ cell mutagenicity

Product:

Germ cell mutagenicity-Assessment	Based on available data, the classification criteria are not met.

Carcinogenicity

Product:

Carcinogenicity - Assessment	Suspected of causing cancer.

Reproductive toxicity

Product:

Reproductive toxicity - Assessment	Based on available data, the classification criteria are not met.

STOT - single exposure

Product:

Target Organs: Central nervous system
Remarks: May cause drowsiness or dizziness.

STOT - repeated exposure

Product:

Target Organs: Liver, thymus, Bone
Remarks: May cause damage to organs through prolonged or repeated exposure.

No data available

Aspiration toxicity

Product:

May be fatal if swallowed and enters airways.

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

Product:

Toxicity to fish	:	Remarks: No data available
Toxicity to daphnia and other aquatic invertebrates	:	Remarks: No data available
Toxicity to algae	:	Remarks: No data available
Toxicity to bacteria	:	Remarks: No data available

Persistence and degradability

Product:

Biodegradability : Remarks: No data available

Bioaccumulative potential

No data available

Mobility in soil

No data available

Other adverse effects

No data available

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues : The product should not be allowed to enter drains, water courses or the soil.
Offer surplus and non-recyclable solutions to a licensed disposal company.
Waste must be classified and labelled prior to recycling or disposal.
Send to a licensed waste management company.

		Dispose of as hazardous waste in compliance with local and national regulations. Dispose of product residue in accordance with the instructions of the person responsible for waste disposal.
Contaminated packaging	:	Contact local or business unit authorities for guidance on disposal of product.

SECTION 14. TRANSPORT INFORMATION

International Regulations

IATA-DGR

UN/ID No.	:	UN 1202
Proper shipping name	:	Diesel fuel
Class	:	3
Packing group	:	III
Labels	:	Class 3 - Flammable Liquid
Packing instruction (cargo aircraft)	:	366

IMDG-Code

UN number	:	UN 1202
Proper shipping name	:	DIESEL FUEL
Class	:	3
Packing group	:	III
Labels	:	3
EmS Code	:	F-E, S-E
Marine pollutant	:	yes

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

National Regulations

TDG

UN number	:	UN 1202
Proper shipping name	:	DIESEL FUEL
Class	:	3
Packing group	:	III
Labels	:	3
ERG Code	:	128
Marine pollutant	:	yes

SECTION 15. REGULATORY INFORMATION

This product has been classified according to the hazard criteria of the Hazardous Products Regulations (HPR) and the SDS contains all of the information required by the HPR.

The components of this product are reported in the following inventories:

DSL On the inventory, or in compliance with the inventory

SECTION 16. OTHER INFORMATION

For Copy of SDS : Internet: www.petro-canada.ca/msds
Canada-wide: telephone: 1-800-668-0220; fax: 1-800-837-1228
For Product Safety Information: 1 905-804-4752

Prepared by : Product Safety

Revision Date : 2022/02/01

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Acetylene Specific Spill Response Plan

Notes: Acetylene is a substance listed in Schedule 1 of the E2 regulations, with a threshold of 4.5 tonnes. Acetylene is used on site for welding on site.

CAS No: 74-86-2 (Acetylene)

UN No: UN1001

Hazards Identification:

Physical State: Dissolved gas, colourless
Odor: Garlic-like
Flash Point: -18˚C
Lower Flammable Limit: 2.4%

Emergency Overview: EXTREMELY FLAMMABLE GAS. CHEMICALLY UNSTABLE. STORED UNDER PRESSURE. CAN CAUSE RAPID SUFFOCATION. IMMEDIATE FIRE AND EXPLOSION HAZARD EXISTS WHEN CONCENTRATIONS EXCEED LOWER FLAMMABILITY LEVEL.

Potential Acute Health Effects: Extremely flammable gas. May react explosively even in absence of air at elevated pressure and/or temperature. Contains gas under pressure. May explode if heated. May form explosive mixtures in air.

Environmental Effects: No known eco-toxicological effects.

Usage: Acetylene is used for welding on site.

Storage: Acetylene is stored in steel compressed gas cylinder secured in cages or racks in seacans.

The expected quantity to be stored on site is 175 tonnes of Acetylene gas. The maximum allowed capacity of the largest container in which the substance is stored is 242 cubic ft.

Spill Response

Personal Protective Equipment for Spill Response:

- Self-contained breathing apparatus when entering confined spaces

Emergency response for an Acetylene Spill:

- Isolate and evacuate the spill area. Suffocation potential.
- Report spill to Supervisor immediately. Provide location and estimate of spill quantity.
- Supervisor will report the spill immediately to the Environmental Superintendent or Safety Coordinator.

- Mine General Manager will activate Incident Command System and Emergency Response Team if required for response.
  - Based on size, location of spill and potential hazardous conditions/environmental impacts.
- Remove all sources of heat and ignition (there is to be no smoking or use of any flames within the area).
- Never enter confined space or other area where flammable gas concentration is > 10% of its lower flammable limit.
- Ventilate area and monitor concentrations.
- Stop flow if safe to do so.

Praxair Material Safety Data Sheet

1. Chemical Product and Company Identification

Product Name:	Acetylene	**Trade Name:**	Acetylene
Product Use:	Metal industry: Welding and cutting of metals.		
Chemical Name:	Acetylene	**Synonym:**	Acetylen, Ethine, Ethyne, Narcylene
Chemical Formula:	C_2H_2	**Chemical Family:**	Alkyne
Telephone:	**Emergencies:** * 1-800-363-0042	**Supplier /Manufacture:**	Praxair Canada Inc. 1 City Centre Drive Suite 1200 Mississauga, ON L5B 1M2
		Phone:	905-803-1600
		Fax:	905-803-1682

**Call emergency numbers 24 hours a day only for spills, leaks, fire, exposure, or accidents involving this product. For routine information, contact your supplier or Praxair sales representative.*

2. Hazards Identification

Emergency Overview

DANGER! **Flammable gas under pressure. Can form explosive mixtures with air. Fusible plugs in top, bottom, or valve melt at 98 - 104 C. Do not discharge at pressures above 103 kPa. May cause dizziness and drowsiness. Self-contained breathing apparatus may be required by rescue workers. At normal temperature and pressure, commercial acetylene is a colourless gas with a distinctive garlic-like odour.**

ROUTES OF EXPOSURE: Inhalation.

EFFECTS OF A SINGLE (ACUTE) OVEREXPOSURE:

INHALATION: Asphyxiant. Effects are due to lack of oxygen. Moderate concentrations may cause headaches, drowsiness, dizziness, excitation, excess salivation, vomiting, and unconciousness. The vapour from a liquid (acetone) release may also cause incoordination and abdominal pain. Lack of oxygen can kill.

SKIN CONTACT: No harm expected. Liquid (acetone) may cause frostbite.

SKIN ABSORPTION: No harm expected. Liquid (acetone) may cause frostbite.

SWALLOWING: An unlikely route of exposure, but frostbite of the lips and mouth may result from contact with the liquid (acetone). If swallowed, the liquid may cause nausea.

EYE CONTACT: Vapour containing acetone may cause irritation. Liquid (acetone) may cause irritation and frosbite.

EFFECTS OF REPEATED (CHRONIC) OVEREXPOSURE:

NOTE: Acetylene cylinders are filled with a porous material containg acetone into which the acetylene is dissolved. ACGIH has established a TLV-TWA of 500 ppm for acetone and a STEL of 750 ppm.

WORKING WITH WELDING AND CUTTING MAY CREATE ADDITIONAL HEALTH HAZARDS. FUMES AND GASES can be dangerous to your health and may cause serious lung disease.* Keep your head out of the fumes. Do not breathe fumes and gases caused by the process. Use enough ventilation, local exhaust, or both to keep fumes and gases from your breathing zone and the general area. The type and amount of fumes and gases depend on the equipment and supplies used. Possibly dangerous materials may be found in fluxes, coatings, gases, metals etc. Obtain a Material Safety Data Sheet (MSDS) for each material used. Air samples can be used to find out what respiratory protection is needed. Short term overexposure to fumes may result in discomfort such as dizziness, nausea, or dryness or irritation of nose, throat, or eyes.

***NOTES TO PHYSICIAN:**

Acute: Gases, fumes, and dusts may cause irritation to the eyes, lungs, nose, and throat. Some toxic gases associated with welding and related processes may cause pulmonary edema, asphyxiation, and death. Acute overexposure may include signs and symptoms such as watery eyes, nose and throat irritation, headache, difficulty breathing frequent coughing, or chest pains.

Chronic: Protracted inhalation of air contaminants may lead to their accumulation in the lungs, a condition which may be seen as dense areas on chest x-rays. The severity of change is proportional to the length of exposure. The changes seen are not necessarily associated with symptoms or signs of reduced lung function or disease. In addition, the changes on x-rays may be caused by non-work related factors such as smoking, etc.

OTHER EFFECTS OF OVEREXPOSURE:

None known.

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE:

Repeated or prolonged exposure is not known to aggravate medical condition.

SIGNIFICANT LABORATORY DATA WITH POSSIBLE RELEVANCE TO HUMAN HEALTH HAZARD EVALUATION:

None

CARCINOGENICITY:

Not listed as carcinogen by OSHA, NTP or IARC.

3. Composition and Information on Ingredients

COMPONENTS	CAS NUMBER	CONCENTRATION % by Mole
Acetylene	74-86-2	>99.9*

*Note: Acetylene cylinders are filled with a porus material containing acetone (CAS 67-64-1)into which the acetylene is dissolved.

4. First Aid Measures

INHALATION:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

SKIN CONTACT:

In case of contact, immediately flush skin with plenty of water. Remove contaminated clothing and shoes. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

SWALLOWING:

If liquid is swallowed, do not induce vomiting. Call a physician.

EYE CONTACT:

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. See a physician, preferably an ophthalmologist, immediately.

NOTES TO PHYSICIAN:

Aspired acetone may cause severe lung damage. If a large quantity of material has been swallowed, stomach contents should be evacuated quickly in a manner which avoids aspiration. Otherwise, treatment should be directed at the control of symptoms and the clinical condition. No specific antidote is known.

5. Fire Fighting Measures

FLAMMABLE : Yes. **IF YES, UNDER WHAT CONDITIONS?** See "Unusual Fire and Explosion Hazards" in this section.

EXTINGUISHING MEDIA: See paragraphs below.

PRODUCTS OF COMBUSTION: These products are carbon oxides (CO, CO2).

PROTECTION OF FIREFIGHTERS:

DANGER! Refer to CGA safety bulletin SB-4, "Handling Acetylene Cyinders in Fire Situations". Evacuate all personnel from danger area. Immediately cool containers with water spray from maximum distance taking care not to extinguish flames. Remove ignition sources if without risk. If flames are accidently extinguished, explosive re-ignition may occur. Use self-contained breathing apparatus. Stop flow of gas if without risk while continuing cooling water spray. Remove all containers from area of fire if without risk. Allow fire to burn out.

SPECIFIC PHYSICAL AND CHEMICAL HAZARDS:

Extremely flammable gas. Forms explosive mixtures with air and oxidizing agents. Container may rupture due to heat of fire. Do not extinguish flames due to possibility of explosive re-ignition. No part of a container should be subjected to temperature higher than 52 C. Most containers are provided with a pressure relief device designed to vent contents when they are exposed to elevated temperature. Contact with copper, silver, or mercury or their alloys or halogens can cause explosion. Vapours form from this product and may travel or be moved by air currents and ignited by pilot lights, other flames, smoking, sparks, heaters, electrical equipment, static discharges, or other ignition sources at locations distant from product handling point. Explosive atmospheres may linger. Before entering area, especially confined areas, check atmosphere with approved device.

SENSITIVITY TO IMPACT:

Avoid impact against container.

SENSITIVITY TO STATIC DISCHARGE:

Possible, See Section 7.

PROTECTIVE EQUIPMENT AND PRECAUTIONS FOR FIREFIGHTERS:

Firefighters should wear self-contained breathing apparatus and full fire-fighting turnout gear.

FLAMMABLE LIMITS IN AIR, % by volume:

LOWER: 2.5 **UPPER:** 100

FLASH POINT: CLOSED CUP: -17.8°C (0°F). (Tag)

AUTOIGNITION TEMPERATURE: 305°C (581°F)

6. Accidental Release Measures

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:

Personal Precautions:

DANGER! **Flammable, high-pressure gas.** Forms explosive mixtures with air. Immediately evacaute all personnel from danger area. Use self-contained breathing apparatus where needed. Remove all sources of ignition if without risk. Reduce gas with fog or fine water spray. Shut off flow if without risk. Ventilate area or move cylinder to a well-ventilated area. Flammable gas may spread from leak. Before entering area, especially confined areas, check atmosphere with an appropriate device.

Environmental Precautions:

Prevent waste from contaminating the surrounding environment. Keep personnel away. Discard any product, residue, disposable container, or liner in an environmentally acceptable manner, in full compliance with federal, provincial, and local regulations. If necessary, call your local supplier for assistance.

7. Handling and Storage

PRECAUTIONS TO BE TAKEN IN HANDLING:

Protect cylinders from damage. Use a suitable hand truck to move cylinders; do not drag, roll, slide, or drop. All piped acetylene systems and associated equipment must be grounded. Electrical equipment must be non-sparking or explosion-proof. Leak check with soapy water; never use a flame. Never use copper piping for acetylene service; use only steel or wrought iron. Open acetylene cylinder valves the minimum amount required for acceptable flow; this will allow you to close valves as quickly as possible in an emergency. Do not open acetylene cylinder valves more than 1½ turns. Never use acetylene at pressures exceeding 103.5 kPa (15 psig). Acetylene cylinders are heavier than other cylinders because they are packed with a porous material and acetone. Never attempt to lift a cylinder by its cap; the cap is intended solely to protect the valve. Never insert an object (e.g., wrench, screwdriver, pry bar) into cap openings; doing so may damage the valve and cause a leak. Use an adjustable strap wrench to remove over-tight or rusted caps. Open valve slowly. If valve is hard to open, discontinue use and contact your supplier. For other precautions in using acetylene, see section 16.

PRECAUTIONS TO BE TAKEN IN STORAGE:

Store and use with adequate ventilation. Separate flammable cylinders from oxygen, chlorine, and other oxidizers by at least 6.1 m or use a barricade of non-combustible material. This barricade should be at least 1.53 m high and have a fire resistance rating of at least ½ hour. Firmly secure cylinders upright to keep them from falling or being knocked over. Screw valve protection cap firmly in place by hand. Post "No Smoking or Open Flames" signs in storage and use areas. There must be no sources of ignition. All electrical equipment in storage areas must be explosion-proof. Storage areas must meet national electric codes for Class 1 hazardous areas. Store only where temperature will not exceed 52 C. Store full and empty cylinders separately. Use a first-in, first-out inventory system to prevent storing full cylinders for long periods.

OTHER HAZARDOUS CONDITIONS OF HANDLING, STORAGE, AND USE:

Flammable high-pressure gas. Use only in a closed system. Use piping and equipment adequately designed to withstand pressures to be encountered. Use only spark-proof tools and explosion-proof equipment. Keep away from heat, sparks, and open flame. ***May form explosive mixtures with air.*** Ground all equipment. ***Gas can cause rapid suffocation due to oxygen deficiency.*** Store and use with adequate ventilation. Close valve after each use; keep closed even when empty. ***Prevent reverse flow.*** *Reverse flow into cylinder may cause rupture. Use a check valve or other protective device in any line or piping from the cylinder.* ***When returning cylinder to supplier,*** *be sure valve is closed, then install valve outlet plug tightly.* ***Never work on a pressurized system.*** *If there is a leak, close the cylinder valve. Vent the system down in a safe and environmentally sound manner in compliance with all federal, provincial, and local laws; then repair the leak.* ***Never place a compressed gas cylinder where it may become part of an electrical circuit.***

RECOMMENDED PUBLICATIONS:

Additional information on storage, handling, and use of this product is provided in **NFPA 55:** ***Standard for the Storage, Use, and Handling of Compressed and Liquefied Gases in Portable Cylinders***, published by the National Fire Protection Association.

See also Praxair publication P-14-153, *Guidelines for Handling Gas Cylinders and Containers*. Obtain from your local supplier.

8. Exposure Controls/Personal Protection

INGREDIENTS	CAS NUMBER	LD_{50} (Species & Routes)	LC_{50} (Rat, 4 hrs.)	Exposure Limits
Acetylene	74-86-2	Not available.	Not available.	Simple asphyxiant.

IMMEDIATELY DANGEROUS TO LIFE AND HEALTH (IDLH):

VENTILATION/ENGINEERING CONTROLS:

LOCAL EXHAUST: Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. Train the worker to keep his head out of the fumes.

MECHANICAL (General): Use a local exhaust system, if necessary, to maintain an adequate supply of oxygen in the worker's breathing zone.

SPECIAL: Use only in a closed system.

OTHER: Use local exhaust ventilation or handle in a ventilated enclosure.

PERSONAL PROTECTION:

RESPIRATORY PROTECTION: Use respirable fume respirator or air supplied respirator when working in confined space or where local exhaust or ventilation does not keep exposure below TLV (acetone) or the applicable TLVs for fumes, gases, and other by-products of welding with acetylene. Select in accordance with the provincial regulations or guidelines. Selection should also be based on the current CSA standards Z94.4, "Selection, care and use of respirators". Respirators should be approved by NIOSH and MSHA

SKIN PROTECTION: Welding gloves recommended.

EYE PROTECTION: Wear safety glasses when handling cylinders.

Select in accordance with the current CSA standard Z94.3, "Industrial Eye and Face Protection", and any provincial regulations, local bylaws or guidelines.

OTHER PROTECTIVE EQUIPMENT: Metatarsal shoes for cylinder handling. Protective clothing where needed. Cuffless trousers should be worn outside the shoes. Select in accordance with the current CSA standard Z195, "Protective Foot Wear", and any provincial regulations, local bylaws or guidelines.

9. Physical and Chemical Properties

PHYSICAL STATE:	Gas.	**FREEZING POINT:**	-82.2°C (-116°F) 6170 KPa abs	**pH:**	Not applicable.
BOILING POINT	-75.2°C (-103.4°F) 6170 KPa abs	**VAPOUR PRESSURE**	4476.8 kPa (@ 20°C)	**MOLECULAR WEIGHT:**	26.04 g/mole
SPECIFIC GRAVITY: LIQUID (Water = 1)	Not applicable.	**SOLUBILITY IN WATER,**	Not applicable.		
SPECIFIC GRAVITY: VAPOUR (air = 1)	0.906	**EVAPORATION RATE** (Butyl Acetate=1):	Not applicable.	**COEFFICIENT OF WATER/OIL DISTRIBUTION:**	Not applicable.
VAPOUR DENSITY:	0.00117 g/ml @ 0 C	**% VOLATILES BY VOLUME:**	100% (v/v).	**ODOUR THRESHOLD:**	657 mg/m3
APPEARANCE & ODOUR:	Colourless.	Odour: Acetylene of 100% purity is odourless, but commercial acetylene has a distinctive garlic-like odour.			

10. Stability and Reactivity

STABILITY:	Unstable.
CONDITIONS OF CHEMICAL INSTABILITY:	Stable as shipped. Avoid use at pressure above 15 psig.
INCOMPATIBILITY (materials to avoid):	Avoid contact with copper, silver, mercury or their alloys, oxidizing agents, acids, halogens, moisture.
HAZARDOUS DECOMPOSITION PRODUCTS:	Thermal decomposition or burning may produce carbon monoxide/carbon dioxide. The welding and cutting process may form reaction products such as carbon monoxide and carbon dioxide.
HAZARDOUS POLYMERIZATION:	Will not occur.
CONDITIONS TO AVOID:	Elevated temperatures and pressures and/or presence of a catalyst.
CONDITIONS OF REACTIVITY:	Fire or explosion mayresult from use at elevated temperatures & pressures or from use with incompatible materials.

11. Toxicological Information

ACUTE DOSE EFFECTS: No known effects from acetylene gas. The welding process may generate hazardous fumes and gases. (See section 8, 10, 15 and 16.)

STUDY RESULTS:

None known.

12. Ecological Information

No adverse ecological effects expected. This product does not contain any Class I or Class II ozone-depleting chemicals. The components of this mixture are not listed as marine pollutants by TDG Regulations.

13. Disposal Considerations

WASTE DISPOSAL METHOD: Do not attempt to dispose of residual or unused quantities. Return cylinder to supplier.

14. Transport Information

TDG/IMO SHIPPING NAME: Acetylene, dissolved

HAZARD CLASS:	CLASS 2.1: Flammable gas.	**IDENTIFICATION #:**	UN1001	**PRODUCT REPORTABLE QUANTITY (PRQ):** Any accidental release in a quantity that could pose a danger to public safety or any sustained release of 10 minutes or more.

SHIPPING LABEL(s): Flammable gas

PLACARD (When Required): Flammable gas

SPECIAL SHIPPING INFORMATION:

Cylinders should be transported in a secure position, in a well-ventilated vehicle. Cylinders transported in an enclosed, non-ventilated compartment of a vehicle can present serious safety hazards.

15. Regulatory Information

The following selected regulatory requirements may apply to this product. Not all such requirements are identified. Users of this product are solely responsible for compliance with all applicable federal, provincial, and local regulations. This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR.

WHMIS (Canada):
CLASS A: Compressed gas.
CLASS B-1: Flammable gas.
CLASS F: Dangerously reactive material.

This product is on the DSL list.

International Regulations:

EINECS: Not available.

DSCL (EEC): This product is not classified according to the EU regulations.

International Lists: No products were found.

16. Other Information

MIXTURES:

When two or more gases, or liquefied gases are mixed, their hazardous properties may combine to create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you produce the mixture. Consult an Industrial Hygienist, or other trained person when you make your safety evaluation of the end product. Remember, gases and liquids have properties which can cause serious injury or death.

HAZARD RATING SYSTEM:

HMIS RATINGS:

HEALTH **2**
FLAMMABILITY **4**
PHYSICAL HAZARD **2**

STANDARD VALVE CONNECTIONS FOR U.S. AND CANADA:

THREADED:	CGA-510, CGA-520, CGA-200
PIN-INDEXED YOKE:	None.
ULTRA-HIGH-INTEGRITY CONNECTION:	None.

Use the proper CGA connections. **DO NOT USE ADAPTERS.** Additional limited-standard connections may apply. See CGA pamphlets V-1 and V-7 listed below.

Ask your supplier about free Praxair safety literature as referred to in this MSDS and on the label for this product. Further information about this product can be found in the following pamphlets published by the Compressed Gas Association, Inc. (CGA), 4221 Walney Road, 5th Floor, Chantilly, VA 20151-2923, Telephone (703) 788-2700, Fax (703) 961-1831, website: www.cganet.com.

AV-1	Safe Handling and Storage of Compressed Gas
G-1	Acetylene
G-1.1	Commodity Specification for Acetylene
G-1.2	Recommendation for Chemical Acetylene Metering
G-1.3	Acetylene Transmission for Chemical Synthesis
P-1	Safe Handling of Compressed Gases in Containers
P-14	Accident Prevention in Oxygen-Rich, Oxygen-Deficient Atmosphere
SB-2	Oxygen-Deficient Atmospheres
V-1	Compressed Gas Cylinder Valve Inlet and Outlet Connections
V-7	Standard Method of Determining Cylinder Valve Outlet Connections for Industrial Gas Mixtures
---	Handbook of Compressed Gases, Fifth Edition

Praxair asks users of this product to study this MSDS and become aware of product hazards and safety information. To promote safe use of this product, a user should (1) notify employees, agents, and contractors of the information in this MSDS and of any other known product hazards and safety information, (2) furnish this information to each purchaser of the product, and (3) ask each purchaser to notify its employees and customers of the product hazards and safety information.

PREPARATION INFORMATION:

DATE:	**Oct 15, 2016**
DEPARTMENT:	**Safety and Environmental Services**
TELEPHONE:	**905-803-1600**

The opinions expressed herein are those of qualified experts within Praxair Canada Inc. We believe that the information contained herein is current as of the date of this Material Safety Data Sheet. Since the use of this information and the conditions of use of the product are not within the control of Praxair Canada Inc., it is the user's obligation to determine the conditions of safe use of the product.

Praxair Canada Inc. requests the users of this product to study this Material Data Sheet (MSDS) and become aware of product hazards and safety information. To promote safe use of this product, a user should (1) notify its employees, agents and contractors of the information on this MSDS and any product hazards and safety nformation, (2) furnish this same information to each of its customers for the product, and (3) request such customers to notify their employees and customers for the product of the same product hazards and safety information.

PRAXAIR

Praxair Canada Inc.
1 City Centre Drive
Suite 1200
Mississauga, ON L5B 1M2

Hydrochloric Acid Specific Spill Response Plan

Notes: Hydrochloric Acid is a substance listed in Schedule 1 of the E2 regulations, with a threshold of 6.8 tonnes. Hydrochloric acid is used within the process plant.

CAS No: 7647-01-0 (Hydrochloric Acid)

UN No: UN1789

Hazard Identification:

Physical State: Liquid, clear to pale yellow
Odor: Pungent

Emergency Overview: MAT BE FATAL IF INHALED. CAUSES RESPIRATORY TRACT, DIGESTIVE TRACT, EYE AND SKIN BURNS

Potential Acute Health Effects: Very toxic by inhalation. Corrosive to eyes, skin, respiratory system and digestive tract. Causes burns. Do not breathe vapor or mist. Do not ingest. Do not get in eyes or on skin or clothing.

Environmental Effects: Toxic to aquatic organisms, may cause long term adverse effects in the aquatic environment.

Usage: Hydrochloric acid is used within the process plant.

Storage: Hydrochloric acid is stored plastic totes inside seacans.

The expected quantity to be stored on site is 140 tonnes of hydrochloric acid. The maximum allowed capacity of the largest container in which the substance is stored is 240 kg.

Spill Response

Personal Protective Equipment for Spill Response:

- Chemical-resistant gloves (e.g., nitrile);
- Protective glasses or chemical safety goggles;
- Chemically resistant coveralls or Tyvek coveralls;
- Self-contained breathing apparatus.

Emergency response for a Hydrochloric Acid Spill

- Isolate and evacuate the spill area.
- Report spill to Supervisor immediately. Provide location and estimate of spill quantity.

- Supervisor will report the spill immediately to the Environmental Superintendent or Safety Coordinator.
- Mine General Manager will activate Incident Command System and Emergency Response Team if required for response.
  - Based on size, location of spill and potential hazardous conditions/environmental impacts.
- Do not touch or walk through spilled material.
- Do not breathe vapor or mist. Provide adequate ventilation.
- Stop flow if safe to do so.
- For spills to land, snow or ice:
  - Protect spill area from storm water runoff and prevent entry into surface waters by constructing a ditch or berm using suitable non-combustible absorbent materials (e.g., sand, diatomaceous earth).
  - Neutralize with soda ash or lime. Use caution neutralization reaction can cause splashes, fumes and yield large amounts of heat resulting in boiling.
  - Dilute with water and mop up or absorb with inert dry material
  - Place in appropriate waste disposal container and seal tightly
  - Keep away from alkalis
  - Transport to waste management for offsite disposal. Store in ventilated areas away from incompatible materials.
- For spills to water:
  - Hydrochloric acid is soluble in water.
  - Do not attempt to contain or remove spills (high explosion potential).
  - Use booms to prevent spread of spill.
- Remove, bag and label personal protective equipment for offsite disposal.
- Thoroughly wash skin with soap.

Hydrochloric Acid,ACS

SECTION 1 : Identification of the substance/mixture and of the supplier

Product name : **Hydrochloric Acid,ACS**

Manufacturer/Supplier Trade name:

Manufacturer/Supplier Article number: **S25358**

Recommended uses of the product and uses restrictions on use:

Manufacturer Details:

AquaPhoenix Scientific
9 Barnhart Drive, Hanover, PA 17331

Supplier Details:

Fisher Science Education
15 Jet View Drive, Rochester, NY 14624

Emergency telephone number:

Fisher Science Education Emergency Telephone No.: 800-535-5053

SECTION 2 : Hazards identification

Classification of the substance or mixture:

Corrosive
Serious eye damage, category 1
Corrosive to metals, category 1
Skin corrosion, category 1B

Irritant
Specific target organ toxicity following single exposure, category 3

Corr. Metals 1
Corr. Skin 1B
Eye Damage 1
STOT. SE 3

Signal word :Danger

Hazard statements:
May be corrosive to metals
Causes severe skin burns and eye damage
May cause respiratory irritation
Precautionary statements:
If medical advice is needed, have product container or label at hand
Keep out of reach of children
Read label before use
Use only outdoors or in a well-ventilated area
Wear protective gloves/protective clothing/eye protection/face protection
Keep only in original container
Do not get in eyes, on skin, or on clothing
Wash skin thoroughly after handling
IF SWALLOWED: Rinse mouth. Do NOT induce vomiting

IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing
Immediately call a POISON CENTER or doctor/physician
Specific treatment (see supplemental first aid instructions on this label)
Wash contaminated clothing before reuse
Absorb spillage to prevent material damage
Store in a well ventilated place. Keep container tightly closed
Store locked up
Store in corrosive resistant stainless steel container with a resistant inner liner
Dispose of contents and container to an approved waste disposal plant

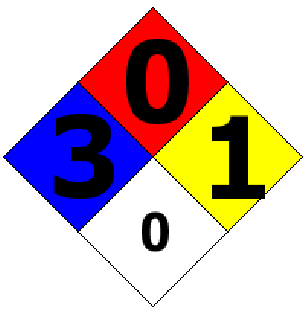
Other Non-GHS Classification:

WHMIS

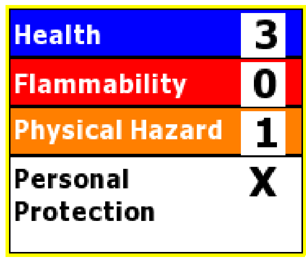
D1A 

E 

NFPA/HMIS



NFPA SCALE (0-4)



HMIS RATINGS (0-4)

SECTION 3 : Composition/information on ingredients

Ingredients:		
CAS 7647-01-0	Hydrochloric Acid, ACS	30-50 %
CAS 7732-18-5	Water	50-70 %
		Percentages are by weight

SECTION 4 : First aid measures

Description of first aid measures

After inhalation: Move exposed individual to fresh air. Loosen clothing as necessary and position individual in a comfortable position.Seek medical attention if irritation or coughing persists.

After skin contact: Wash affected area with soap and water. Immediately remove contaminated clothing and shoes.Rinse thoroughly with plenty of water for at least 15 minutes.Immediately seek medical attention.

After eye contact: Protect unexposed eye. Flush thoroughly with plenty of water for at least 15 minutes.Remove contact lenses while rinsing.Continue rinsing eyes during transport to hospital.

After swallowing: Rinse mouth thoroughly. Do not induce vomiting. Have exposed individual drink sips of water. Immediately seek medical attention.

Most important symptoms and effects, both acute and delayed:

Inhalation may cause irritation to nose and upper respiratory tract, ulceration, coughing, chest tightness and shortness of breath. Higher concentrations cause tachypnoea, pulmonary oedema and suffocation . Ingestion may cause corrosion of lips, mouth, oesophagus and stomach, dysphagia and vomiting.Pain, eye ulceration, conjunctival irritation, cataracts and glaucoma may occur following eye exposure.Erythema and skin irritation, as well as chemical burns to skin and mucous membranes may arise following skin exposure.;Potential sequelae following ingestion of hydrochloric acid include perforation, scarring of the oesophagus or stomach and stricture formation causing dysphagia or gastric outlet obstruction. In some cases, RADS may develop. Respiratory symptoms may take up to 36 hours to develop.Symptoms of burning sensation, cough, wheezing, laryngitis, shortness of breath, spasm, inflammation, edema of the larynx, spasm, inflammation and edema of the bronchi, pneumonitis, pulmonary edema. Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin.

Indication of any immediate medical attention and special treatment needed:

Provide SDS to Physician.Physician should treat symptomatically.

SECTION 5 : Firefighting measures

Extinguishing media

Suitable extinguishing agents: Use water, dry chemical, chemical foam, carbon dioxide, or alcohol-resistant foam.

For safety reasons unsuitable extinguishing agents:

Special hazards arising from the substance or mixture:

Combustion products may include carbon oxides or other toxic vapors.If in contact with metals toxic fumes may be released.

Advice for firefighters:

Protective equipment: Wear protective eyeware, gloves, and clothing. Refer to Section 8. Wear respiratory protection.

Additional information (precautions): Thermal decomposition can produce poisoning chlorine. Hydrochloric acid reacts also with many organic materials with liberation of heat.Avoid inhaling gases, fumes, dust, mist, vapor, and aerosols. Avoid contact with skin, eyes, and clothing.

SECTION 6 : Accidental release measures

Personal precautions, protective equipment and emergency procedures:

Ensure adequate ventilation. Ensure that air-handling systems are operational.

Environmental precautions:

Should not be released into environment. Prevent from reaching drains, sewer, or waterway.

Methods and material for containment and cleaning up:

Always obey local regulations. If necessary use trained response staff or contractor. Evacuate personnel to safe areas. Containerize for disposal. Refer to Section 13. Keep in suitable closed containers for disposal. Soak up with inert absorbent material and dispose of as hazardous waste. Cover spill with soda ash or calcium carbonate. Mix and add water to form slurry.Wear protective eyeware, gloves, and clothing. Refer to Section 8.

Reference to other sections:

SECTION 7 : Handling and storage

Precautions for safe handling:

Prevent formation of aerosols. Never use hot water and never add water to the acid.Do not allow contact between hydrochloric acid, metal, and organics.Follow good hygiene procedures when handling chemical materials. Refer to Section 8. Prevent contact with skin, eyes, and clothing. Follow proper disposal methods. Refer to Section 13. Do not eat, drink, smoke, or use personal products when handling chemical substances. Use only in well ventilated areas.Avoid splashes or spray in enclosed areas.

Conditions for safe storage, including any incompatibilities:

Store in a cool location. Keep away from food and beverages. Protect from freezing and physical damage. Store away from incompatible materials. Provide ventilation for containers. Keep container tightly sealed.Containers for hydrochloric acid must be made from corrosion resistant materials: glass, polyethylene, polypropylene, polyvinyl chloride, carbon steel lined with rubber or ebonite.

SECTION 8 : Exposure controls/personal protection

Control Parameters:
7647-01-0, Hydrochloric Acid, ACGIH: 2 ppm Ceiling
7647-01-0, Hydrochloric Acid, NIOSH: 5 ppm Ceiling; 7 mg/m3 Ceiling

Appropriate Engineering controls: Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapor and mists below the applicable workplace exposure limits (Occupational Exposure Limits-OELs) indicated above. Emergency eye wash fountains and safety showers should be available in the immediate vicinity of handling.

Respiratory protection: Not required under normal conditions of use. Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls. When necessary use NIOSH approved breathing equipment.

Protection of skin: Select glove material impermeable and resistant to the substance. Select glove material based on rates of diffusion and degradation. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Use proper glove removal technique without touching outer surface. Avoid skin contact with used gloves. Wear protective clothing.

Eye protection: Faceshield (8-inch minimum).Tightly fitting safety goggles.

General hygienic measures: Perform routine housekeeping. Wash hands before breaks and immediately after handling the product. Avoid contact with skin, eyes, and clothing. Before rewearing wash contaminated clothing.

SECTION 9 : Physical and chemical properties

Appearance (physical state,color):	Clear, colorless liquid.	**Explosion limit lower**: **Explosion limit upper**:	Non Explosive Non Explosive
Odor:	Pungent odor	**Vapor pressure**:	5.7mmHg @ 0C
Odor threshold:	0.3 – 14.9 mg/m3	**Vapor density**:	1.27 (Air=1)
pH-value:	< 1	**Relative density**:	1.0 - 1.2

Melting/Freezing point:	- 74 C	**Solubilities**:	Miscible
Boiling point/Boiling range:	81.5 - 110 C	**Partition coefficient (n-octanol/water)**:	Not Determined
Flash point (closed cup):	Not Applicable	**Auto/Self-ignition temperature**:	Not Determined
Evaporation rate:	>1.00	**Decomposition temperature**:	Not Determined
Flammability (solid,gaseous):	non combustible	**Viscosity**:	a. Kinematic:Not Determined b. Dynamic: Not Determined
Density: Not Determined **Hydrochloric Acid:**MW is36.46			

SECTION 10 : Stability and reactivity

Reactivity: Reacts violently with bases and is corrosive.
Chemical stability: No decomposition if used and stored according to specifications.
Possible hazardous reactions: Attacks many metals in the presence of water forming flammable explosive gas (hydrogen).Reacts violently with oxidants forming toxic gas (chlorine).
Conditions to avoid: Incompatible materials.
Incompatible materials: Bases, Amines, Alkali metals, Metals, permanganates (potassium permanganate), Fluorine, Metal acetylides, Hexalithium disilicide.
Hazardous decomposition products: Hydrogen chloride gas.Carbon oxides.

SECTION 11 : Toxicological information

Acute Toxicity:		
Inhalation:	7647-01-0	LD50 Rat 3124 ppm/hour
Oral:	7647-01-0	LD50 Rat 238 - 277 mg/kg
Dermal:	7647-01-0	LD50 Rabbit >5010 mg/kg
Chronic Toxicity: No additional information.		
Corrosion Irritation:		
Dermal:	7647-01-0	Skin - rabbit Result: Causes burns.
Ocular:	7647-01-0	Eyes - rabbit Result: Corrosive to eyes
Sensitization:		No additional information.
Single Target Organ (STOT):		7647-01-0: The substance or mixture is classified as specific target organ toxicant, single exposure, category 3 with respiratory tract irritation.
Numerical Measures:		No additional information.
Carcinogenicity:		No additional information.
Mutagenicity:		No additional information.

Reproductive Toxicity:	No additional information.

SECTION 12 : Ecological information

Ecotoxicity

7647-01-0: Toxicity to fish LC50 - Gambusia affinis (Mosquito fish) - 282 mg/l - 96 h (Hydrochloric acid)

Persistence and degradability:
Bioaccumulative potential:
Mobility in soil:
Other adverse effects:

SECTION 13 : Disposal considerations

Waste disposal recommendations:

Do not allow product to reach sewage system or open water.It is the responsibility of the waste generator to properly characterize all waste materials according to applicable regulatory entities (US 40CFR262.11). Contact a licensed professional waste disposal service to dispose of this material. Dispose of empty containers as unused product. Product or containers must not be disposed together with household garbage. Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations. Ensure complete and accurate classification.

SECTION 14 : Transport information

UN-Number

1789

UN proper shipping name

HYDROCHLORIC ACID

Transport hazard class(es)

Class:
8 Corrosive substances

Packing group:II
Environmental hazard:
Transport in bulk:
Special precautions for user:

SECTION 15 : Regulatory information

United States (USA)

SARA Section 311/312 (Specific toxic chemical listings):

Acute

SARA Section 313 (Specific toxic chemical listings):

7647-01-0 Hydrochloric Acid

RCRA (hazardous waste code):

None of the ingredients is listed

TSCA (Toxic Substances Control Act):

All ingredients are listed.

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act):

7647-01-0 Hydrochloric Acid 5000 lbs

Proposition 65 (California):

Chemicals known to cause cancer:

None of the ingredients is listed

Chemicals known to cause reproductive toxicity for females:

None of the ingredients is listed

Chemicals known to cause reproductive toxicity for males:

None of the ingredients is listed

Chemicals known to cause developmental toxicity:

None of the ingredients is listed

Canada

Canadian Domestic Substances List (DSL):

All ingredients are listed.

Canadian NPRI Ingredient Disclosure list (limit 0.1%):

None of the ingredients is listed

Canadian NPRI Ingredient Disclosure list (limit 1%):

7647-01-0 Hydrochloric Acid

SECTION 16 : Other information

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the SDS contains all the information required by the Controlled Products Regulations.Note:. The responsibility to provide a safe workplace remains with the user.The user should consider the health hazards and safety information contained herein as a guide and should take those precautions required in an individual operation to instruct employees and develop work practice procedures for a safe work environment.The information contained herein is, to the best of our knowledge and belief, accurate.However, since the conditions of handling and use are beyond our control, we make no guarantee of results, and assume no liability for damages incurred by the use of this material.It is the responsibility of the user to comply with all applicable laws and regulations applicable to this material.

GHS Full Text Phrases:

Abbreviations and acronyms:

IMDG: International Maritime Code for Dangerous Goods
PNEC: Predicted No-Effect Concentration (REACH)
CFR: Code of Federal Regulations (USA)
SARA: Superfund Amendments and Reauthorization Act (USA)
RCRA: Resource Conservation and Recovery Act (USA)
TSCA: Toxic Substances Control Act (USA)
NPRI: National Pollutant Release Inventory (Canada)
DOT: US Department of Transportation
IATA: International Air Transport Association
GHS: Globally Harmonized System of Classification and Labelling of Chemicals
ACGIH: American Conference of Governmental Industrial Hygienists
CAS: Chemical Abstracts Service (division of the American Chemical Society)
NFPA: National Fire Protection Association (USA)

HMIS: Hazardous Materials Identification System (USA)
WHMIS: Workplace Hazardous Materials Information System (Canada)
DNEL: Derived No-Effect Level (REACH)

Effective date : 01.08.2015
Last updated : 03.20.2015

Additional E2 Regulations Schedule 2 Materials to be Stored Onsite

The hazardous materials to be stored onsite and listed in the E2 Regulations may include the following substances throughout the duration of the project:

- Formalin;
- Unleaded Gasoline;
- Ethyl Mercaptan
- Propane; and
- Nitric acid.

The quantities of these products are not anticipated to meet the thresholds under the E2 Regulations for the development of a product specific spill response plan. However, if at any time the quantities of these materials stored onsite reach the threshold volume identified in these regulations a product specific spill plan will be developed and submitted as an addendum to this Plan.

AGNICO EAGLE
HOPE BAY

HOPE BAY SPILL CONTINGENCY PLAN

HOPE BAY, NUNAVUT

Appendix 2: Spill Response Resources

Mobile Equipment

Any mobile equipment present on site may be used as a resource for spill response or spill clean-up. This includes pick-ups, skid steers, excavators, loaders, dozers, vacuum trucks, haul trucks, and flatbed trucks.

Spill Kit Contents

Each Spill Kit contains:

- 1 roll absorbent or bundle of spill pads;
- 2 plug and dyke kits;
- 1 – 3 m x 4 m tarpaulin;
- 2 pairs of disposable coveralls;
- 4 mini booms;
- 1 bag of corncob and/or peat moss absorbent;
- 1 bag of gravel type fire retardant granular for aviation stations (helipad and airstrip);
- 2 pair of neoprene gloves (i.e., POL [petroleum/oil/lubricants] resistant);
- 2 sets of splash proof POL resistant goggles;
- 1 shovel;
- 10 disposable waste bags and ties; and
- A copy of the First Responder diagram (Figure I at the beginning of this plan).

Spill kits are replenished as needed after use and inspected at least once per quarter. The purpose of the inspection is to evaluate the location of spill kit proximity to associated work activities, inspect the condition of the spill kit, and check that all required contents are available and in good condition. The Environmental Supervisor/Coordinators are required to check the contents quarterly and the results of the inspections are stored locally with other inspection documents.

Aquatic Environment Response Equipment

Response equipment available in the event of a spill to the aquatic environment is stored in ten moveable seacans, with the exception of the boats. This equipment includes:

- 450 feet of 24" solid floatation boom;
- 70 lb, 43 lb, 25 lb, and 17 lb Danforth anchors;
- 8 lb Grapnel Anchors;
- 36" sea anchors;

- Anchor pins;
- Anchor Buoys;
- Anchor lines;
- 150 feet Towline;
- Boom towing bridles;
- 1250 feet of skirted booms (preassembled with tow lines, bridles and floats);
- 200 feet of inflatable Shore Saver booms (with inflation kit);
- 1TDS-118 Drum Skimmer;
- 1 P10E Power Pack;
- 2 Pump;
- 175 L Drum Response Kits c/w lids;
- Disposable coveralls (i.e., Tyvek suits);
- POL (petroleum/oil/lubricants) resistant gloves;
- POL resistant goggles;
- Toolbox c/w assorted tools;
- 45 Gallon containers c/w lids;
- Pails and Rubbermaid tubs;
- 300 foot Nylon rope (3/8);
- Bags of Oclansorb™ Peat Moss or crushed corn cobs;
- Bundles of oil sorbent pads;
- Bundles of universal sorbent pads;
- Oil Sorbent booms;
- Oil snares;
- Universal sorbent booms;
- Bag of Sorbent scraps (spaghetti);
- Containment tanks and berms;
- Plug and dyke kits;
- HAZMAT Disposal Bags and Garbage bags;
- Portable fuel bladders;
- Ice scrapers;
- A net for capturing seabirds/oiled wildlife;

- An 18-foot landing craft boat (with boat safety kit); and
- An 18-foot Zodiac (with boat safety kit and repair kit).

The above aquatic response equipment is considered more than necessary for the potential spills covered under this Plan. Spills to the aquatic environment are limited in potential scale as all fuel storage tanks are located in secondary containment and most are located away from water. The Roberts Bay multiple tank fuel farm berm also has significant excess capacity to contain failure of more than one tank.

As a consequence, spills that may reach water are expected to be limited in size, manageable and recoverable using the aquatic response equipment available on site. If for any reason additional resources are needed, the Materials Manager/Superintendent would immediately begin procuring additional supplies to be flown to site.

Large spills to the marine environment resulting from bulk fuel offloads are addressed through the OPPP/OPEP. As outlined therein, shipping contractors provide all necessary equipment needed to appropriately respond to a fuel-offload spill, with Agnico Eagle supplies serving as additional resources available.

Specialized Response Equipment

A stock of specialized spill response equipment is maintained on site and available for use if a product spill as outlined in a Product Specific Spill Response plan occurs. All of the specialized equipment is maintained in the Mine Rescue Bays which are located in the Mine Ops area. The Health & Safety Manager is responsible for maintaining and ensuring the availability of this equipment. The equipment includes:

- Full body chemical resistant suits (Tyvek);
- Rubber chemical resistant jackets, pants;
- Chemical resistant boots and gloves;
- Splash goggles and full face shields;
- Full and half face respirators with appropriate filters (e.g. organic vapour cartridges);
- Drager Self-contained breathing apparatus;
- Fire retardant coveralls and firefighting bunker gear;
- Drager BG-4 breathing apparatus (not to be used if product has explosive potential);
- Air quality monitors equipped with HCN, CO and O2 sensors;
- Non sparking tools, such as plastic shovels; and
- Sodium hypochlorite solution.

HOPE BAY SPILL CONTINGENCY PLAN

HOPE BAY, NUNAVUT

Appendix 3:
Environmental Resource Maps

Environmental Resource Maps

Shown in the following resource maps are areas of particular vegetation meaningful to the local wildlife and ecosystems which surround the project as well as raptor nests, rare plants and fish habitat. Additional detailed information may be found in baseline and monitoring reports available from the Environmental Superintendent and publically available on the Nunavut Impact Review Board and Nunavut Water Board websites. Information regarding archeological sites that have been identified on the Hope Bay belt is available to the Environmental Superintendent in the event of a spill. At the requirement of the Territorial Archaeologist, the locations of these sites are strictly confidential and information on these locations is only shared on an as needed basis. Spill containment will attempt to minimize impacts to sensitive habitats and archaeological sites.

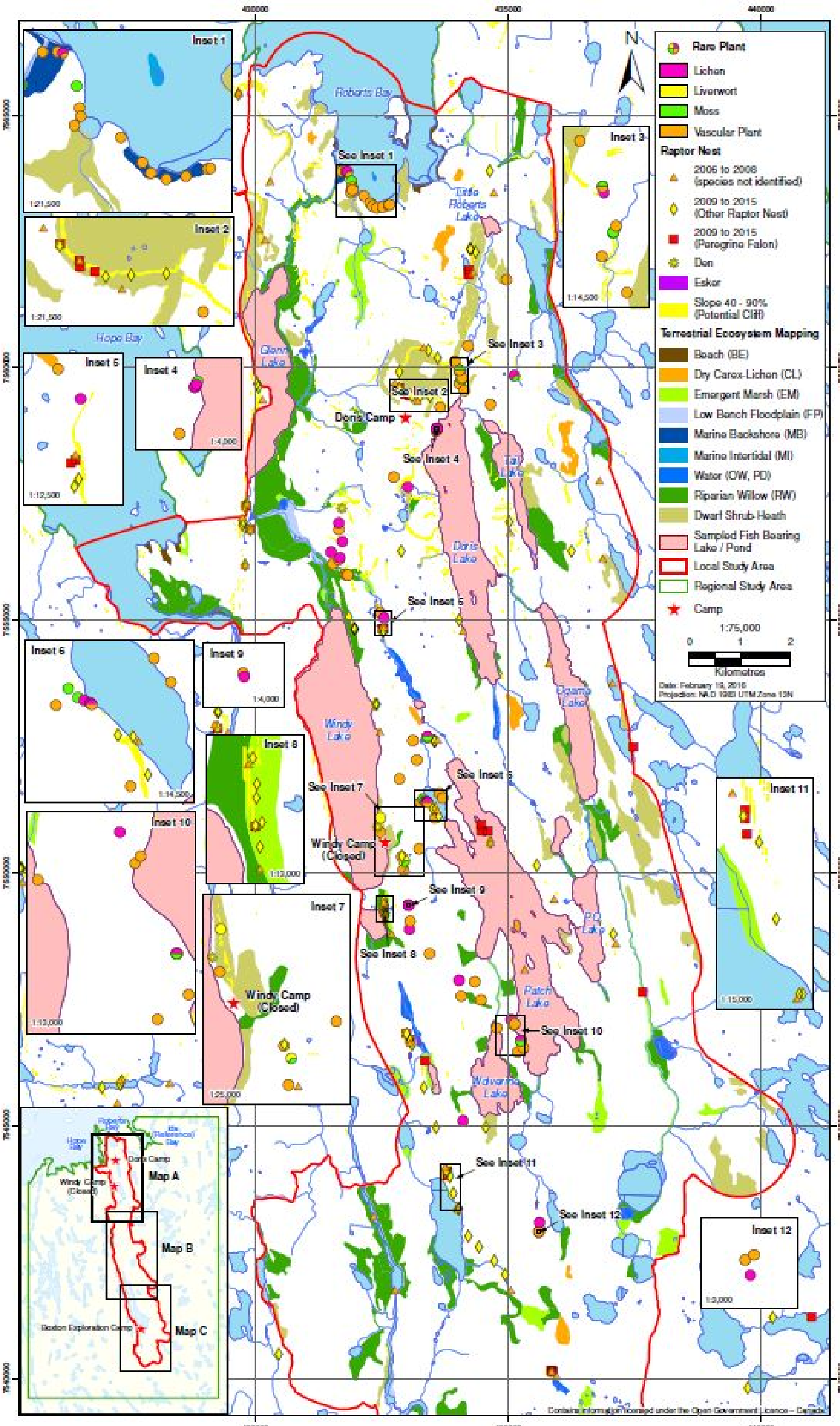


Figure 3.1. Environmental Sensitivity Mapping-Map A

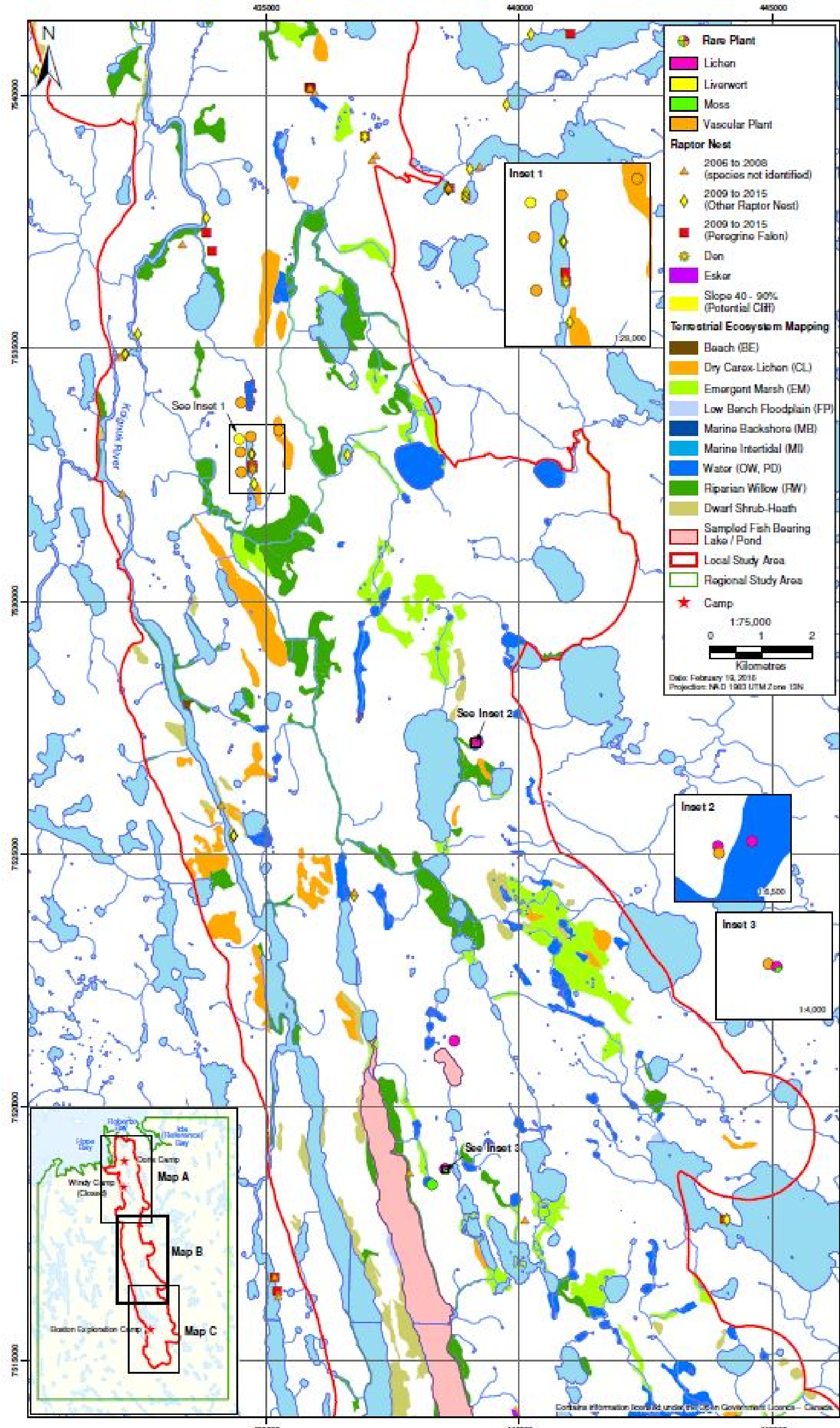


Figure 3.2. Environmental Sensitivity Mapping-Map B

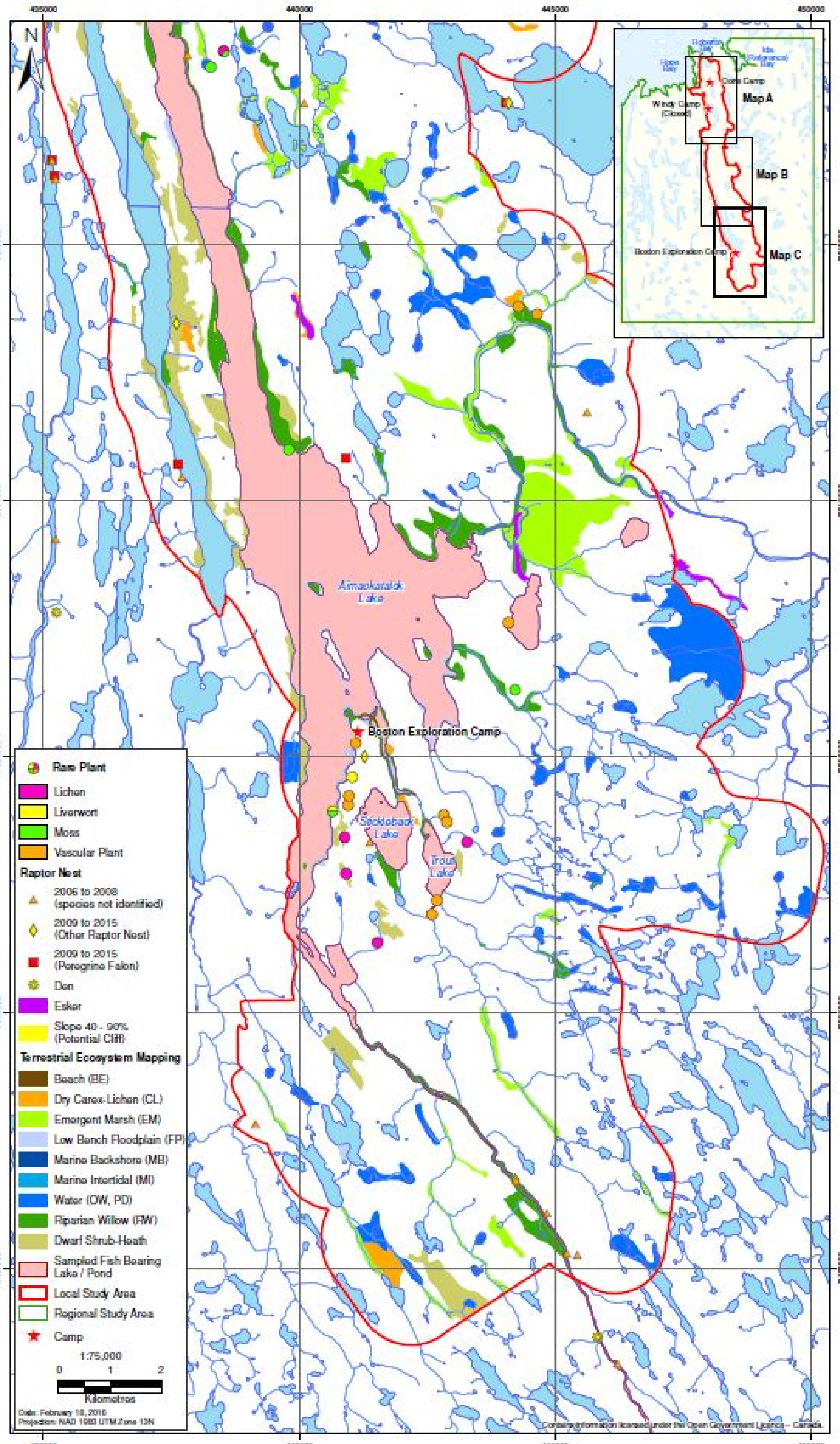


Figure 3.3. Environmental Sensitivity Mapping-Map C

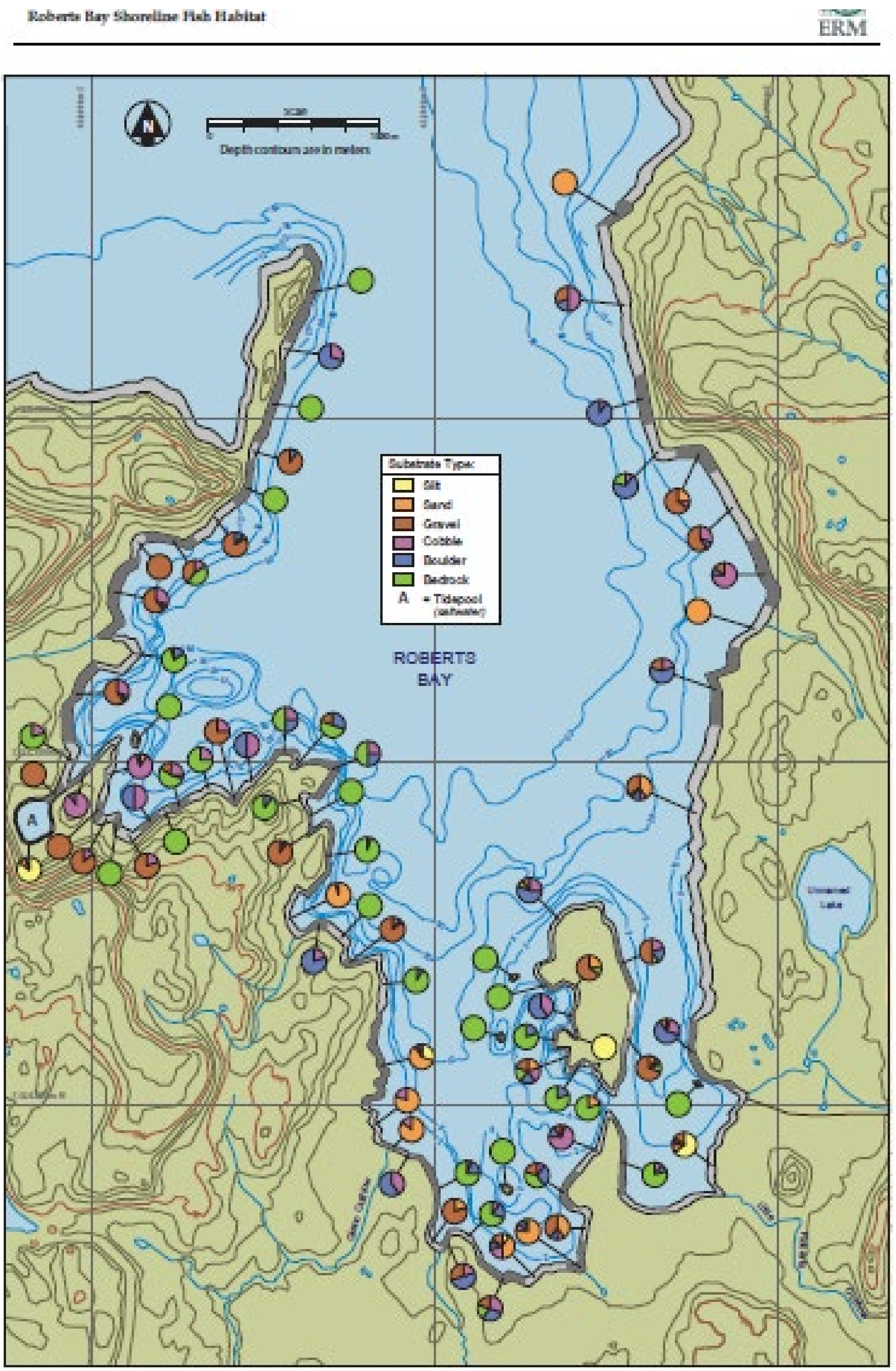


Figure 3.4. Environmental Sensitivity Mapping-Map D

AGNICO EAGLE
HOPE BAY

Hope Bay Spill Contingency Plan

Hope Bay, Nunavut

Appendix 4: Responses to Comments on Previous Plan Versions

Comment Responses and Revision References

This Plan replaces the September 2020 Spill Contingency Plan for the Hope Bay Project. Table 4.1 below outlines the comments received on previous versions of this Plan and Agnico Eagle's responses.

Table 4.1. Comments Received on Previous Versions of this Plan and TMAC's responses

Version	Reviewer	Comment #	Comment	Recommendation	Response
2016	INAC	1	Module A of the Spill Contingency Plan provides details on spill kit contents and aquatic environment response equipment, but the information on mobile equipment (machinery) to be used for spill response is not available.	INAC recommends that the licensee include the list of mobile equipment to be used for spill management, as well as the spill containment equipment on each piece of equipment.	Any mobile equipment present on site may be used as a resource for spill response or spill clean-up. This includes pick-ups, skid steers, excavators, loaders, vacuum trucks, haul trucks, and flatbed trucks. This has been made clear in revised text in Module A.
2016	INAC	2	Section 2.5.1 of the spill contingency plan states that spill response kits will be available within 200 m of any areas where chemicals are stored and used. Aquatic spill response kits are available in moveable containers. The spill response kit locations are described as being easily accessible, but it is not clear if there will be adequate signage to identify them. As well, the modules at the end of the plan include pictures on which chemical storage locations are circled, but there is no indication where to find the spill kits beside them. The Guidelines for Spill Contingency Planning recommend including a plan with many features including storage locations of hazardous materials and locations of spill response kits.	INAC recommends that spill kit locations be identified on the ground and, on a site map or indicated in the pictures included in the plan. Default storage locations for the mobile aquatic response spill kits should be included so that a person consulting the plan would quickly know where to look for them.	Default spill kit locations, including the mobile aquatic response spill kits, have been now indicated on the site photographs provided in the site-specific modules.
2016	INAC	3	The section on spill response actions (2.3) outlines actions to be taken in event of different spill scenarios. Two of the scenarios for spills in water outline actions to be taken in event of a hydrocarbon spill, but do not speak to what should be done if other materials are spilled. These are sub-sections 2.3.5, spills under ice, and mitigation of impacts to birds. Some of the materials listed as on site including sodium cyanide would not disperse in the same way as petroleum products and would require different action responses.	INAC recommends that the licensee include action responses for materials that might sink or dissolve in water for spills under ice and mitigation of impacts to birds.	Information addressing spill sunder ice of substances that sink and dissolve is now presented in Sections 2.3.6 and 2.3.7, respectively. Mitigation of impacts to birds is addressed under 2.3.10.1.

Version	Reviewer	Comment #	Comment	Recommendation	Response
2016	INAC	4	Table 1 of Section 1.2 includes regulations and guidelines governing the spill contingency plan. Other regulations are referenced in the text and included in Section 7 of the plan.	INAC suggests that other material to be considered might include: - Federal Transportation of Dangerous Goods Act and regulations; and - NWT Used Oil and Waste Fuel Management Regulations	Waste material generated during spill response is managed as per the Hazardous Waste Management, Non-Hazardous Waste Management Plan, and/or the Landfarm Management Plan as indicated in Section 2.4 of the Plan. TMAC's Hazardous Waste Management Plan includes consideration of/reference to the Federal Transportation of Dangerous Goods Act and regulations and NWT Used Oil and Waste Fuel Management Regulations, as well as many other materials which may apply to management and disposal of spill response wastes, such as GN's Environmental Guideline for Used Oil and Waste Fuel.
2016	ECCC	1	Reference: Page 18 of the revised Spill Contingency Plan, EC #2 Comment: As noted in the table ECCC requested that TMAC undertake and incorporate hazardous substance identification and risk assessment into the Spill Contingency Plan in order to provide the required basis for accident scenario characterization and response planning.	It is expected that the risk assessment process will incorporate consideration of the likelihood of various spills and their potential consequences, which will determine appropriate mitigation/response strategies according to the resulting matrix rankings.	TMAC has provided further clarification of the risk assessment process to be undertaken for all work areas in the revised Plan, in Section 4.
2016	ECCC	2	Reference: Pages 18-19 of the revised Spill Contingency Plan, EC #4 Comment: ECCC reiterates recommendation EC #4 which requests that TMAC document and provide information on worst case accident scenarios for each hazardous product stored and handled onsite.	While the TMAC has indicated that the appropriate sections of the SCP “will continue to be refined in future revisions to capture additional scenarios as operational activities evolve and corrective actions/lessons learned are developed through incident investigations” ECCC is of the opinion that by identifying worst case accident scenarios now, TMAC will be better placed to determine actual required response capacities and develop adequate preparedness and response plans.	During the 2016 revision of the Plan, and based on ECCC's recommendation # 4 cited in the 2016 Plan, TMAC identified worse case scenarios and appropriate responses and included this information in the 2016 SCP as Section 4 "Spill Response Management Issues and Contingencies". TMAC's text indicating that worst case scenarios and responses 'will continue to be refined in future' was an acknowledgement of the continual improvement process loop employed at the Hope Bay Project including the risk assessment process, and recognition that additional scenarios may be identified and added to this Plan in future as a result.
2017	KIA	1 (KIA-6)	The Spill Contingency Plan provides a solid outline of reporting and mitigation measures in the event of a spill. Although specific mitigation of impacts to wildlife, including birds, and sensitive habitats is outlined, there is no specific detail associated with a spill into fish habitat. It is noted that no chemicals are stored with 31 m of water, but there are no specific response actions protective of fish, as is outlined for other wildlife in the ‘environmentally Sensitive Species’ section. Environmental Resource Maps are provided in Module C, but the focus is on vegetation and terrestrial features.	TMAC should include additional maps and detail be provided for freshwater and marine fish habitat, so that sensitive features can be avoided, and if a spill were to occur near or in water, that the sensitivity of the habitat would be easily found and appropriate mitigation measures taken.	Fish are addressed and protected under the Plan by the management actions addressing spills to water. Fish habitat (sites which have been sampled for fish and within which fish have been found) are also indicated on the Environmental Resource Maps presented in Module C. TMAC has also included a fish habitat map of Roberts Bay in the revised Plan to allow identification of sensitive intertidal and shallow subtidal habitat for avoidance where possible.

Version	Reviewer	Comment #	Comment	Recommendation	Response
2017	KIA	2 (KIA-7)	The Spill Contingency Plan states in section 1.4, “In the event that a spill requires activation of the Emergency Response Plan, the Environmental Coordinator will provide guidance to the Surface Manager regarding implementing response actions according to this plan and evaluating priorities for protection of sensitive habitats/species and archeological features at risk.” A decision tree for use by the Surface Manager/Incident Commander or Environmental Coordinator has not been provided for the reviewer to evaluate how sensitive habitats/species and archeological features are prioritized in the event of potential impact to multiple priority areas.	TMAC should include a decision tree outlining how various sensitive or high value locations are prioritized. This will ensure of these locations are prioritized in the event of a spill or unplanned discharge in a manner satisfactory to KIA.	A prioritization hierarchy has been proposed for the environmental sensitivities and is now included in Section 2.3.10.
2017	KIA	3 (KIA-8)	In Section 2.3.8, the Plan states, “TMAC and previous companies operating on the Hope Bay site have conducted numerous ecological surveys to identify [environmentally sensitive habitats or archeological sites] at risk, with the focus of identifying those areas immediately surrounding Project infrastructure which are at greatest risk of impact from a spill. In the event that a spill enters the natural environment, the Environmental Coordinator will use maps identifying these sensitive areas to prioritize the protection of these resources.” In the event of an unplanned spill or discharge, these sites will only become a mitigation priority after the Environmental Coordinator has had a chance to review the pertinent maps and provide guidance to the response team. A delay in First Responders becoming aware of these priority locations may limit the effectiveness of mitigation measures, permit more significant adverse impacts than necessary, or even damage those locations through the application of mitigation measures. We understand that, Environmental Resource Maps outlining archeological sites are kept confidential by TMAC. However, the need to keep the locations of these sites confidential must be weighed against the risk of potential spills and unplanned discharges.	TMAC should ensure that the Environmental Coordinator has a-priori knowledge of high priority environmentally sensitive habitats and archeological sites and how to respond in these areas and provide all first responders with instruction on the locations of high priority environmentally sensitive habitats and archeological sites so that First Responders are immediately aware of them in the event of a spill or unplanned discharge. This would allow these locations to be prioritized and/or avoided when applying mitigation measures.	TMAC wishes to clarify that environmentally sensitive habitat maps are included in the Plan, which is available to all staff including the Environmental Coordinator. These maps identify locations of sensitive habitat, raptor nests, den sites, and fish habitat. Only archaeological site locations are kept confidential, at the requirement of the GN's Territorial Archaeologist. However, the Environmental Coordinator has ready access to archaeological site maps. of all locations which may be designated high priority.

Version	Reviewer	Comment #	Comment	Recommendation	Response
2017	KIA	4 (KIA-9)	In Section 3.4 the Plan states, "Monitoring activities may be conducted to assess the impacts of the spill and the effectiveness of associated cleanup/remediation efforts in the event a spill cannot be completely removed." The KIA notes that spills reaching watercourses or waterbodies will eventually disperse as a result of natural hydrology such that they are "completely removed" from the environment even if impacts have occurred. The language included in the Plan does not require monitoring in the event of a spill or unplanned discharge to water nor other habitat types. The KIA's right to compensation for damages to their lands and waters makes prompt and effective monitoring important to both TMAC and the KIA in the event of a spill or unplanned discharge.	TMAC should include triggers which require monitoring activities, and provide details of the type of monitoring that will be undertaken as part of adaptive management to spills and unplanned discharges in the Plan. This discussion should be specific to the type of spill, volume, mobility of the spilled material and proximity to various habitat features. Triggered monitoring should be implemented as quickly as possible such that it would characterize the impact of a spill to the receiving environment as well as the effectiveness of mitigation.	TMAC has provided more detail on spill related monitoring in Section 3.4.
2017	KIA	5 (KIA-10)	TMAC specifies in Module B that the Windy Camp is "no longer occupied". TMAC further specifies that "Fuel storage at Windy Camp is limited to one tank (double-walled Tidy Tank) containing a maximum of 1240L of diesel fuel." This tank is located more than 31 m from any waterbody and has been placed in "a secondary portable berm capable of containing the full volume of this tank in the event that the double-walled system failed". However, no schedule for regular inspections of the tank or secondary containment has been included. A breach in the double-walled Tidy Tank may persist within the secondary containment for an unknown period of time placing the receiving environment and wildlife at potential risk.	TMAC should include the frequency fuel storage structures will be inspected at the Windy Camp, and increase the capacity of the secondary portable berm to 110% the total volume of the 1240L Tidy Tank.	TMAC has clarified in the revised Plan that the tank at Windy is a double-walled enviro tank (i.e. it possesses 110% secondary containment in its design and construction), and is also located inside of tertiary containment, with a capacity > 110 % of the volume of the tank. Although this tank is located at Windy camp, it is there to support Doris activities (it is the fuel supply tank for the potable water pump used to collect all potable water for Doris Camp), as such it is inspected on a regular basis as required under the Doris Water Licence (Part I Items 2 and 4).
2017	CIRNAC	8		Section 2.4.1 of the Hope Bay Spill Contingency Plan indicates that spill response kits will be available near (within 200 m) areas where chemicals are stored and used on site, on fuel transfer vehicles, in moveable containers, and that additional kits will be added as project activities evolve and new locations of chemical storage and use are identified. Reference is made to Module B for a list of supplies in each spill kit and aquatic spill response container. This reference is incorrect – contents of spill kits and the aquatic spill response container are provided in Appendix 2: Spill	Corrected in this version of the Plan.

Version	Reviewer	Comment #	Comment	Recommendation	Response
				Response Resources. CIRNAC recommends this error be corrected to eliminate confusion.	
2017	CIRNAC	9		Sections 2.3.12 and 2.2.13 of the Hope Bay Spill Contingency Plan make reference to substances that will sink or dissolve if spilled under ice, indicating that response to these substances will be decided on a case-by-case basis, with consultation with regulatory agencies and remediation specialists as necessary. CIRNAC recommends that the plan should include an indication of whether these categories of materials are present on site, what they are, as well as where and how they are stored and/or utilized.	TMAC keeps on file Safety Data Sheets (SDS) for all chemicals and materials on-site. The information provided in the SDS and by the manufacturer define what they are, as well as where and how they are stored and/or utilized. SDS are made available to all employees on site and help define spill response activities for any material, including any substances that will sink or dissolve if spilled under ice.
2017	CIRNAC	10		Appendix 2 of the Hope Bay Project Spill Contingency Plan provides information on spill response resources including mobile equipment, spill kit contents, and aquatic environment response equipment, however no mention is made of specialized equipment and material to cleanup/handle spills, for example, the respirators/self-contained breathing apparatus, fire retardant clothing, sodium or calcium hypochlorite solution, etc. identified in Appendix 1 as required to clean up/neutralize spilled sodium cyanide. CIRNAC recommends Appendix 2 should be enhanced to include all equipment and material referenced in the plan for spill response and the Proponent ensures the equipment is available on site.	Appendix 2 in this version of the Plan has been revised to include specialized equipment required for spill response.
2017	CIRNAC	15	Multiple references (e.g. in Section 2.2.6, 2.2.24 and 4.5.1) incorrectly state that Product Specific Spill Response Plans are provided in Module A	Ensure the proper reference (Appendix 1: Hazardous Materials and Product Specific Spill Response Plans) is used to eliminate confusion	References to appendices corrected in this version of the Plan.
2018	CIRNAC	CIRNAC-3	In reviewing the 2017 Annual Report, CIRNAC commented that a table of key government contacts was presented in the Hope Bay Project Spill Contingency Plan which required an update. This contact information has not been updated to the recommended phone number in the 2019 revision.	CIRNAC recommends that the contact numbers for the inspector be updated. Candice Peterson is now responsible for this file. She is based out of Cambridge Bay, her phone number is 867-983-5115, and her fax number is 867-982-4307.	During the upcoming annual review and update of the Spill Contingency Plan, TMAC will update the Inspector contact information, as well as any other key government contacts, as required to ensure they are current.
2018	CIRNAC	CIRNAC-6	Continuous monitoring and timely reporting of spills incidents is required by regulations and project Term and Condition. The Term and Condition 20 states that: “The Proponent shall ensure spill kits are at hand at the Roberts Bay oil handling facility at all times, and that appropriate containment measures are used in the event of a spill”. The Term and Condition 32 requires that: “Prior to the commencement of	CIRNAC recommends that TMAC Resources Inc.: • Consider including details of all spills (minor and major/reportable) in the Annual Report. Minimum details should include numbers, quantities, material spilled, impacted media, reasons/causes, and corrective measures implemented (both short term and long term).	TMAC tracks all unauthorized discharges and spills on site, regardless if they are externally reportable or not and identifies any observable trends. Based on those results, root cause analysis and corrective actions are recorded, tracked and implemented. CIRNAC is welcome to review information with TMAC staff during any of their multiple annual site inspections. See Section 3 of this plan.

Version	Reviewer	Comment #	Comment	Recommendation	Response
			operation the Proponent shall have a complete Environment, Health and Safety Management System in place which includes: Emergency Response and Spill Contingency Plan; Occupational Health and Safety Plan; Monitoring and Follow-up Plan; and Auditing and Continuous Improvement Plan". General comments in Section 6.2 regarding the 2017 Annual Report state: "An information summary should be included in the annual report on these minor spills such as numbers, quantities, impacted media, reasons/causes, and corrective measures implemented (both short term and long term). As one of the objectives stated in the Hope Bay Project Spill Contingency Plan is to "Implement a process to evaluate and continuously improve site spill response procedures", discussion should be provided regarding lessons learned related to spill response and improvement measures implemented." The objectives for monitoring spills and discharges are designed to prevent negative impacts to the environment (e.g., water, soil, vegetation, wildlife, air, etc.) associated with project activities, prevent injuries and health impacts to workers and other people associated with project activities; ensure adequate spill response capacity and emergency response planning is in place and ensure adequate oversight of project activities is occurring. In the 2018 Annual Report, 15 spills were reported to have met the reporting threshold of the Nunavut Spill Contingency Planning and Reporting Regulations and were reported to regulatory agencies. An unquantified number of spills termed minor in nature are noted. It is notable that: • The overall number of reportable spills increased from 2017 (11) to 2018 (15). • The overall number of total spills including minor spills is not reported and there is no provision of quantities, details of the 'minor' spills. • Eight of 15 reportable spills were reported one day after the spill occurred. • The total quantity of hazardous materials spilled to the environment is more than 25,000 L and is a greater volume than that of the previous year. • The March 2019 Spill Contingency Plan does not include continuous improvement management processes addressing prevention.	• Identify corrective measures to address the timing for reporting of reportable spills. All reportable spills have to be reported within 24 hours as required by the Spill Contingency and Reporting regulation R-068-93 (Government of Nunavut, clauses 9(2) and 11(2)). • Consider adding the following testing and review elements to the Spill Contingency Plan to promote continuous improvement, as best management practice: • Document all spill incidents (major/reportable and minor/non-reportable) and undertake periodic review of trends and lessons learned. Analyze previous year's data of reportable and non-reportable spills to identify trends. • Plan, undertake and document an annual spill drill / simulation exercise. The incorporation of this element into the existing management plan(s) will provide a mechanism to learn and improve from accidents and malfunctions. • Revise Spill Contingency Plan to include requirements for evaluation and continuous improvement.	TMAC would like to clarify that only two of the 15 spills were reported outside of the 24 hour reporting window. TMAC strives to provide adequate reporting within the 24 hour reporting period and will aim to ensure all spills are reported as per the Spill Contingency and Reporting regulation R-068-93 (Government of Nunavut, clauses 9(2) and 11(2)). An annual tabletop exercise is conducted prior to the sealift fuel transfer simulating a spill to land or water. The exercise tests TMAC's Incident Command System and the implementation of the Spill Contingency Plan, Oil Pollution Prevention Plan and the Oil Pollution Emergency Plan in response to a spill scenario at the Roberts Bay oil handling facility as required by Transport Canada. See Section 5.1 of this plan.

Version	Reviewer	Comment #	Comment	Recommendation	Response
2018	CIRNAC	CIRNAC-7	Sections 2.3.12 and 2.2.13 of the Hope Bay Project Spill Contingency Plan (December 2017) make reference to substances that will sink or dissolve if spilled under ice, indicating that response to these substances will be decided on a case-by-case basis, with consultation with regulatory agencies and remediation specialists as necessary. CIRNAC recommended that at a minimum, the plan should include an indication of whether these categories of materials are present on site currently, if so identify them and indicate where they are stored and how they are utilized. TMAC Resources Inc. provided a response and referred to these substances in Table 4.2 (Pg. 27) of the updated Spill Contingency Plan (March, 2019). Therefore this issue has been resolved. Appendix 2 of the Hope Bay Project Spill Contingency Plan provides information on spill response resources including mobile equipment, spill kit contents, and aquatic environment response equipment, however no mention is made of specialized equipment and material to cleanup/handle spills, for example, the respirators/self-contained breathing apparatus, fire retardant clothing, sodium or calcium hypochlorite solution, etc. identified in Appendix 1 as required to clean up/neutralize spilled sodium cyanide. CIRNAC recommended that Appendix 2 should be enhanced to include all equipment and material referenced in the plan for spill response. TMAC Resources Inc. listed the specialized response equipment in the Spill Contingency Plan, March, 2019 (Pg. 13). This issue is resolved. Format and reference errors were identified for the updated Spill Contingency Plan (March, 2019): Hope Bay Project Spill Contingency Plan (March 2019) Section 1.2 Title of Table 1.1 references the Incinerator Management Plan Correct Title of Table 1.1 Table 1.1 Regulation / Guideline Include updated regulation:	CIRNAC recommends that TMAC Resources Inc.: • Correct the Format and Reference errors indicated in the table above. • Review and add new relevant documents pertaining to spills including: • “A Guide to Spill Contingency Planning and Reporting” dated 2018 June, Nunavut Department of Environment; and • Environmental Emergency Regulations, 2019 published in the Canada Gazette March 6, 2019, coming into force August 24, 2019, Environment and Climate Change Canada	TMAC agrees to update and correct the formatting and reference errors in the next annual update of the Spill Contingency Plan.
2018	KIA	KIA-NIRB-21 KIA-NWB-3	There is a discrepancy in the spill amount-reporting threshold for “miscellaneous products, substances, or organisms” that needs to be resolved. The table of Immediately Reportable Spills (p. iv) refers to the “NU Spill Contingency Planning and Reporting Regulations”, a document on the GN DOE website that was created by the GNWT for the GNWT’s use in 1998. These regulations specify a 50 L or 50 kg reporting threshold. However, Section 3.3 of the Plan also implies that the Immediately Reportable Spills Table follows the current GNWT ENR	The KIA recommends that TMAC confirm spill-reporting thresholds with the GN and GNWT, and to update the information presented in the Immediately Reportable Spills, if needed.	TMAC will investigate to determine the correct reportable quantity and include in the next update of the Spill Contingency Plan if required. Use of the GNWT ENR “Report a Spill” website confirmed with the Inspector. This plan has been updated to reflect these thresholds (Section 3.3).

Version	Reviewer	Comment #	Comment	Recommendation	Response
			"Report a spill" website, which states that this limit is ≥ 5L or 5kg. Unless there is a typo on the GNWT website, the more conservative values should be used in TMAC's Spill Contingency Plan. In the Mar 2019 Hope Bay Spill Contingency Plan, there is a table showing Immediately Reportable Spills following "Schedule B of the NU Spill Contingency Planning and Reporting Regulations". This document is available on the GN DOE website – it is a 1998 consolidation of the 1993 regulations created by the GNWT. In Schedule B of this document, the immediately reportable amount of "miscellaneous products or substances, excluding PCB mixtures" is 50 L or 50 kg, which are the values listed in the Plan. However, the Plan also references the GNWT ENR "Report a spill" website within Section 3.3 when discussing the Immediately Reportable Spills Table. On this website, the reportable quantities for spills of "miscellaneous products, substances or organisms" are ≥ 5 L or 5 kg. These values are 10x lower than those listed in the Regulations, suggesting that the Hope Bay Spill Contingency Plan, or the website itself, contains a typo. It seems more likely that the values on the website are correct, and that those in the Plan are incorrect, based on precedents seen in other projects. Note also that the cited website link in Section 3.3 is broken. The current URL is: https://www.enr.gov.nt.ca/en/services/report-spill The correct spill amount threshold for miscellaneous substances needs to be resolved with regulators. The Immediately Reportable Spills table in the Hope Bay Spill Contingency Plan should then be updated, if necessary.		
2018	KIA	KIA-NIRB-22 KIA-NWB-4	The Plan states that a marine spill report will be submitted to a Transport Canada (TC) Marine Safety Inspector if required. There is no further information regarding these reporting requirements; and the table showing Key Government Contacts does not include the TC Inspector's contact information. In addition, the CIRNAC Inspector's phone number in the Key Government Contacts table is different from the number listed in the Type A/B Water License conditions within the Conformity Tables.	The KIA requests additional information about spill reporting requirements for Transport Canada, and that contact information be included in the Plan for TC's Marine Safety Inspector. The KIA also recommends that TMAC confirm the correct contact information for the CIRNAC Inspector and update the table of Key Government Contacts, if needed.	TMAC will ensure the correct contact information for the CIRNAC inspector is up to date with key Government Contacts in the next annual update of the Spill Contingency Plan.
			Section 3.3 of the Hope Bay Spill Contingency Plan states that in the event that a spill has occurred to the marine	TMAC's response is partially satisfactory. They will confirm and include the correct contact information for the CIRNAC	Contact information for the Marine Safety Inspector and the situation(s) in which the Inspector would be contacted are

Version	Reviewer	Comment #	Comment	Recommendation	Response
			environment, a written report will be submitted within 24 hours to the Canadian Coast Guard, and a copy of this report will be submitted to a Transport Canada Marine Safety Inspector "if required". There are no further details regarding the situation(s) in which a TC Marine Safety Inspector will need to be notified. There is also no contact information for the TC Marine Safety Inspector within the table of Key Government Contacts on p. iii of the Plan. The Conformity Tables within Modules A, B, C, and D include conditions of the Type A and B Water Licenses that the Spill Contingency Plan is intended to address. Among these conditions is the reporting of any unauthorized deposits or foreseeable unauthorized depots of waste and/or discharges of effluent to "the Inspector at (867) 975-4295" (in addition to the 24-Hour NT-NU Spill Reporting Line and the KIA). However, the phone number listed in Key Government Contacts (p. iii of the Plan) for the CIRNAC Inspector is (867) 983-5115. Please confirm which phone number is correct and update the list of key contacts, if needed.	inspector in the next update of the Spill Contingency Plan. However, TMAC did not address the KIA's comment regarding marine spills and reporting requirements to a Transport Canada Marine Safety Inspector. Request to TMAC: Please include contact information for the Marine Safety Inspector in the list of Key Government Contacts and indicate the situation(s) in which the Marine Safety Inspector needs to be notified in the next update of the Spill Contingency Plan.	detailed in the Hope Bay Ocean Pollution Prevention Plan/Oil Pollution Emergency Plan (OPPP/OPEP). The OPPP/OPEP is the main document of reference for spill control actions in a marine environment and is directly referenced in section 2.2.8 – Spill in a Marine Environment of the Spill Contingency Plan.
2018	KIA	KIA-NIRB-23 KIA-NWB-5	It is difficult to judge from the plates in Modules A and D whether TMAC is complying with their own policy of making spill kits available within 200 m of fuel and chemical storage locations. TMAC should ensure that spill kits are available as described. Section 2.4.1 of the Hope Bay Spill Contingency Plan states that spill response kits will be available near (within 200 m) any areas where chemicals are stored and used on site, including near all bulk fuel berms and smaller fuel tanks. In addition, all active construction areas where equipment is operating will have a spill kit located within 200 m. Modules A through D within the Plan describe the specific conditions of Doris, Windy, Madrid, and Boston operations relevant to spill response, including chemical storage volumes and locations, and photographs of the sites. Plate A.4 shows the Reagent Berm at Doris, and an Explosive Berm is indicated to the right, outside of the photo. It is unclear whether the spill kit located at the Reagent Berm is also intended to serve spill incidents at the Explosive Berm, and it is also unknown whether the Explosive Berm is located	The KIA recommends that updated photos or site diagrams, with appropriate scale indicators, be included in the next version of the Hope Bay Spill Contingency Plan.	TMAC will ensure updated site diagrams will be included in the next annual update of the Spill Contingency Plan. Please refer to Modules A through D of this Plan.

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			within 200 m of the Reagent Berm (and spill kit). Furthermore, the lack of scale, and possible forced perspective, of Plate D.1 (Boston Camp) makes it difficult for a reviewer to determine whether the spill kit in the middle-left is located within 200 m of the chemical storage locations to the farthest left of the photo. It would be useful to have updated photos or site diagrams, for all Hope Bay project locations, that encompass all infrastructure and activities and have a scale to assess distances. These would allow for a more comprehensive review of TMAC's spill response plan.		
2018	KIA	KIA-NIRB-24 KIA-NWB-6	The Jet-A Specific Spill Response Plan needs more information and subsequent steps for emergency response to a spill to water. Currently, the plan is limited to advising responders not to attempt to contain or remove spills, and to use booms to prevent spread. Even if TMAC staff are not responsible for cleaning up a Jet-A spill, there should be further information about who to contact for proper treatment. TMAC has developed a Product Specific Spill Response Plan for Jet-A fuel because spills of this substance could be immediately harmful to humans and/or the environment and has the potential to cause pool fires and vapour cloud explosion. Within the Jet-A plan, the instructions for spills to water include three bullet points: • Jet-A fuel floats on surface of water. • Do not attempt to contain or remove spills (high explosion potential). • Use booms to prevent spread of spill. • The subsequent generic steps regarding Jet-A fuel spills are to properly dispose of PPE and to thoroughly wash skin with soap. This is the end of the Jet-A spill response plan. Further details are needed regarding Jet-A spills to water. It is perhaps implied (though this should be clarified) that no Hope Bay Project staff within the Spill Emergency Incident Command System (Figure III, p. vii) is qualified to clean up Jet-A spills to water. If this is the case, information about who should be contacted, and who will be responsible for clean-up, should be included in the Plan.	The KIA requests that additional information regarding spills to water be included in the Jet-A Specific Spill Response Plan, such as the party(ies) responsible for cleanup/ treatment.	TMAC will provide additional information to the Aviation Fuel (Jet-A) Specific Spill Response Plan. Additional information has been provided in the Jet-A Specific Spill Response Plan with rationale for response to a spill on water. Refer to Appendix 1 of this Plan. Note, multiple spill response resources direct that attempts to recover spills of Jet-A to water should not be attempted due to volatility and explosive potential of the material, and the fact that evaporation of the product occurs within hours to days makes recovery of this product by conventional skimming methods difficult to accomplish.

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2018	KIA	KIA-NIRB-25 KIA-NWB-7	TMAC's revisions to the Spill Contingency Plan in response to the previous KIA comment #2 are incomplete. There are ambiguities between Section 2.2.16 and the Environmental Resource Maps provided in Appendix 3, which would prevent a clear understanding of priorities in the event of a spill. In response to previous KIA review comment KIA-7, TMAC proposed a prioritization hierarchy for environmental sensitivities. (Note that there is a typo in TMAC's response on p. 24 – it should refer to Section 2.2.16 rather than 2.3.10.) The proposed hierarchy of protection will attempt to favour: 1. Waterbodies; 2. Sensitive habitat types; 3. Archaeological sites; 4. Rare plants; and 5. Active raptor nest or wildlife den. In addition, for spills in water, prioritization will attempt to avoid vegetated and finer substrate shoreline areas (sand, gravel, cobble). TMAC's proposed hierarchy is not detailed enough in comparison to the Environmental Sensitivity Maps A-C, which include rare plants, raptor nests, and wildlife dens. Are the "sensitive habitat types", indicated as the second highest priority, the other features on these maps, i.e., eskers, slopes of 40-90% (possible cliffs), or certain TEM classes? For example, would the TEM class of Dry Carex-Lichen be prioritized over others because this is important forage for caribou? Furthermore, the Environmental Resource Maps in Appendix 3 may not be at a size, scale, or resolution that is useful for emergency spill response. For example, Figure 3.1 (Map A) is very difficult to read; the need for 12 insets may indicate that larger scale maps are needed to cover the study area in sufficient detail. Map A also shows that Hope Bay is within the study area; however, only Roberts Bay was mapped for shoreline fish habitat values (Figure 3.4, Map D).	The KIA requests that the proposed prioritization hierarchy in Section 2.2.16 of the Spill Contingency Plan be revised to a level of detail that is compatible with the Environmental Sensitivity Mapping for this project. The KIA also requests that Environmental Sensitivity Maps be provided to Project personnel in a larger format and at higher resolution, such that they are useful for emergency spill response.	TMAC would like to take the opportunity to re-visit the response hierarchy to reflect operational experience. TMAC's first priority in any spill incident is to stop the source of the spill (if not already accomplished at the time discovered), then to prevent the spread and contain the spill and then to assess the best method to remove as much of the spilled substance as possible taking into consideration numerous factors including but not limited to land, water, topography, substrate depth, location and season. Safety of personnel is the paramount consideration in all efforts and workplans. Based on the review of Appendix 3 and experience to date, TMAC will re-visit the Environmental Sensitivity Mapping to account for the abiotic and biotic factors that practically guide spill response at Hope Bay. KIA will be engaged on this matter and the potential timing of the next update in the plan.

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2018	KIA	KIA-NIRB-26 KIA-NWB-8	TMAC has made some revisions to the Spill Contingency Plan regarding spill-related monitoring. However, the wording is weak and does not reflect a commitment by TMAC to conduct monitoring activities. In response to previous KIA review comment KIA-9, TMAC responded that more details on spill related monitoring have been included in Section 3.4 of the Spill Contingency Plan. However, the revisions to Section 3.4 do not fully address the KIA's concerns. While TMAC has deleted the phrase "completely removed" and has added more information about monitoring triggers and locations for spills to water, the wording in this section still needs to be stronger. The current wording throughout Section 3.4 is that "monitoring may be triggered". TMAC should commit to conducting monitoring activities for spills that potentially have negative environmental impacts, and that are unlikely to be (completely) recovered, whether or land or in water. While monitoring for all spills may not be feasible, especially for small spills with little expected impact, TMAC could develop spill thresholds for various substances or situations for which "monitoring will be triggered".	The KIA recommends that TMAC use stronger wording within Section 3.4 of the Spill Contingency Plan, i.e. "monitoring will be triggered" rather than "monitoring may be triggered" for various spill response scenarios.	TMAC is committed to the application of the appropriate spill prevention, response, monitoring and restoration activities outlined in the Spill Contingency Plan. TMAC believes that it is not practical to establish specific thresholds for various spill response scenarios as there are many, and monitoring and restoration activities would need to be determined on a case-by-case basis. Where deemed appropriate, monitoring and restoration programs deemed would be developed in consultation with the CIRNAC Inspector and the KIA.
			Without a strong commitment from TMAC to monitor the potential effects of spilled substances that cannot be recovered, there is no guarantee that monitoring will occur at all. The KIA's right to compensation for damages to their lands and waters makes prompt and effective monitoring important to both TMAC and the KIA in the event of a spill or unplanned discharge.	TMAC's response is partially satisfactory. Please see detailed KIA review comments for KIA-NWB-9 below.	Please see detailed response as part of KIA-NWB-9 below.

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2018	KIA	KIA-NIRB-27 KIA-NWB-9	Conditions for triggering of monitoring of spills into water is unclear. TMAC states that "monitoring may be triggered in the event of spills to water of substances that dissolve or sink where substance recovery unlikely" and that "monitoring may also be triggered in the event of externally reportable spills to land for which recovery of spilled material is unlikely or may be incomplete". In Appendix 4, under Comment #4 (KIA-9), the KIA requested that "TMAC should include triggers which require monitoring activities, and provide details of the type of monitoring that will be undertaken as part of adaptive management to spills and unplanned discharges…the discussion should be specific to the type of spill, volume, mobility of the spilled material and proximity to various habitat features. Triggered monitoring should be implemented as quickly as possible".	Please remove the discretionary language in Section 3.4 to so that monitoring is required for (i) all spills to water of substances that dissolve or sink which are unlikely to be recovered and (ii) all externally reportable spills to land of substances unlikely to be fully recovered. Please specify under what conditions monitoring will be triggered for spills (i) and (ii) (e.g., type of spill, volume, mobility, proximity to sensitive environmental features), what parameters will be collected, and how soon after a spill triggered monitoring will be implemented.	TMAC is committed to the application of the appropriate spill prevention, response, monitoring and restoration activities outlined in the Spill Contingency Plan. TMAC believes that it is not practical to establish specific thresholds for various spill response scenarios as there are many, and monitoring and restoration activities would need to be determined on a case-by-case basis. Where deemed appropriate, monitoring and restoration programs would be developed in consultation with the CIRNAC Inspector and the KIA.
			TMAC responds that it "has provided more detail on spill related monitoring in Section 3.4". We do not believe TMAC has satisfactorily responded to our original concern regarding monitoring spills. We are concerned with the use of discretionary language in the guidelines for monitoring spills under Section 3.4 ("may be triggered"). Furthermore, it is not clear what conditions will actually trigger monitoring under the two scenarios presented in this section (e.g., type of spill? volume? mobility? proximity to sensitive environmental features?). TMAC also has not indicated how soon after a spill triggered monitoring would be implemented, or what parameters will be collected.	TMAC's response is the same as for KIA-NWB-8, which is partially satisfactory. The proponent states that "where deemed appropriate, monitoring and restoration programs would be developed in consultation with the CIRNAC Inspector and the KIA." As evidenced by comments KIA-NWB-8 and -9, the KIA believes that monitoring and restoration programs should be developed prior to spill events as part of spill response planning and preparedness and to show an understanding of the potential effects of spills on land and in water. These programs can then be adapted, in a timely manner, to each spill response scenario on a case-by-case basis. We appreciate that TMAC's monitoring and restoration programs will be developed in consultation with the KIA; however, we recommend that consultation about spill response and triggered monitoring occur as soon as possible. KIA acknowledges that spill response varies depending on numerous factors (including type of substance, location of spill, volume, proximity to sensitive environmental features etc.), all spills need to be monitored to help determine what response is appropriate. Furthermore, in the case of spills to water and land that are unlikely to be recovered, it is paramount that monitoring be conducted to track whether these spills cause any adverse environmental effects, so that effective mitigation measures can be implemented. Consequently, the discretionary language in the guidelines for monitoring spills under Section 3.4 should be removed and	TMAC appreciates KIA's intent to understand spill preparedness however TMAC does not feel predetermining every possible scenario, response, follow up monitoring, including parameters to be measured, and reclamation actions, is practical or effective. If TMAC were to attempt to address these requests it would result in an extremely voluminous document with thousands of iterations and combinations that account for every possible factor at Hope Bay. TMAC has explored this approach in the past and determined it would be unreasonable to maintain but more importantly, unnecessary. Including these details up front in the management plan is not the intent of the Spill Contingency Plan. The Spill Contingency Plan was developed for the efficient and effective management of activities at site by ensuring the people responsible have the information required to make informed decisions that consider key factors. TMAC has evaluated this approach as being more effective than predetermined responses to a copious amount of scenarios. That said, TMAC would welcome discussing this matter further with the KIA to understand if there are opportunities for improvement that TMAC can incorporate into its approach to spill response.

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				replaced with wording stating that monitoring is required for all spills described under (i) and (ii) in our prior recommendation. The KIA also requests clarification about situations in which TMAC would deem it appropriate to develop appropriate monitoring and restoration programs in consultation with the CIRNAC Inspector and the KIA (e.g., compared to when it would be inappropriate to do so).	
2019	KIA	KIA-NIRB-28 KIA-NWB-10	Photograph does not indicate location of spill kit at Patch Laydown Facility. Plate B.2 shows a photograph of the Patch Laydown Facility. The caption indicates that the red circle is for the fuel storage location and the yellow star is for the spill kit location. However, no red circles or yellow stars are shown on the photograph.	Please clarify whether any fuel storage and spill kit locations exist at the Patch Laydown Facility.	Fuel and chemical storage facilities have been removed from the Patch Laydown Facility. Plate B.2 been removed in this version of the Plan.
2019	KIA	KIA-NIRB-29 KIA-NWB-11	No mitigation measures are stated for settlement of tanks. Eight fuel tanks at the Boston site are situated on a lined fuel berm on the permafrost. TMAC indicates that there are concerns that the permafrost may degrade over time due to thin areas of the crush pad, which could cause settlement of the tanks, making them unstable and prone to tipping. TMAC states that regular monitoring of the fuel tanks for differential settlement occurs during seasonal visits, annual geotechnical inspections, and as needed. However, TMAC does not discuss what mitigation measures are in place should settlement of the tanks be detected.	Please explain what management action is taken if settlement of the fuel tanks at the Boston site is detected during routine monitoring.	If settlement of the fuel tanks at the Boston site are detected beyond an acceptable limit, TMAC will discontinue the use of the tank(s) that are effected by settlement and engage the Engineer of Record (SRK Consulting) for guidance and recommendations for correcting the settlement issue. TMAC will continue to monitor permafrost and physical stability of site infrastructure on an ongoing basis and will take a proactive approach to risks identified.

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2020	KIA	KIA-NWB-33	The discretionary language KIA identified in the 2018 Annual Report relating to monitoring of spills remains in the 2019 Annual Report. Under section 3.4 of Appendix H, TMAC states that "monitoring activities may be conducted to assess the impacts of the spill and the effectiveness of associated cleanup/ remediation efforts in the event spill material cannot be removed" (p. 20) and "monitoring may be triggered in the event of spills to water of substances that dissolve or sink or where substance recovery is unlikely" (p. 21) and "monitoring may also be triggered in the event of externally reportable spills to land for which recovery of spilled material is unlikely or may be incomplete" (p. 21). In Appendix 4, in response to our previous comments, TMAC indicates that it is not reasonable or necessary to predetermine "every possible scenario, response, follow up monitoring" because such an approach "would result in an extremely voluminous document with thousands of iterations and combinations that account for every possible factor at Hope Bay" (p. 43). We are not suggesting that every possible step for monitoring should be detailed in the Spill Contingency Plan, but we are requesting that monitoring be required for (i) every spill that cannot be removed, (ii) spills to water of substances that dissolve or sink or where substance recovery is unlikely, and (iii) externally reportable spills to land for which recovery is unlikely or incomplete. Specific details on what the required monitoring would entail could then be determined on a case by case basis, depending on the nature of the spill. We do not think such an approach would be unduly time-consuming or cumbersome, but rather, would provide an effective and efficient framework for ensuring monitoring of spills that are not fully or partially recoverable is conducted, so that ultimately no adverse effects to the environment occur, and long-term liabilities on IOL are avoided.	Please remove the discretionary language in section 3.4 and replace with wording that monitoring is required for all spills detailed in (i) to (iii) above.	TMAC acknowledges that any required environmental monitoring would be evaluated on a case by case basis in situations of reportable spills that cannot be removed or fully recovered; or, involve a substance spilled to water that dissolves, sinks or where substance recovery is unlikely. As part of regulated spill reporting and follow up, specific details on the spill and any follow-up monitoring would be detailed in the 30 day spill report submitted to the Government of Nunavut with copy to the KIA. Spill response and monitoring is determined on a case by case basis, depending on the nature of the spill and the KIA has the opportunity to inspect spill locations with their routine site inspections.

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2021	KIA	KIA-NWB-6	In 2020 the discharge location of the Roberts Bay Discharge System changed. The subsea diffuser now extends 1.4 km into Roberts Bay and the Marine Outfall Berm now extends from the shoreline to approximately the 20 m bathymetric contour. It is recommended that TMAC update Section A4 of Module A: Doris to reflect the recent changes to the Roberts Bay Discharge System.	It is recommended that TMAC update the description of the Roberts Bay Discharge System in Module A of the Spill Contingency Plan to reflect recent changes to the discharge location.	The new location will be included in the next revision of the plan and submitted in the 2021 annual report.
2021	ECCC	**3.(1)**	Did the responsible person submit a SCH 2 Notice of Substance within 90 days of either of the following situations: The **SCH 2 Notice** must be submitted via the SWIM database **within 90 days** of meeting the threshold for quantity and/or container capacity of an E2 substance and re-submitted every 5 years thereafter **(s.13)**		Schedule 2 was submitted by TMAC on June 23, 2020; however, because the substances on site met the E2 concentration and substance thresholds on August 24, 2019, Schedule 2 was due on Nov. 22, 2019.

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		3.(1)	The total quantity of an E2 substance stored at the facility is equal to or greater than the Schedule 1 threshold Total includes quantities inside & outside of the container system at the facility; If the quantity exceeds the threshold limit they must submit a SCH 2 Notice.	*Table A.1* - The E2-regulated substances listed in this table are diesel fuel, ammonium nitrate, HCl, calcium chloride, acetylene, and propane; the quantities and max. container system capacities of calcium chloride, acetylene and propane do not meet the reporting thresholds. - It appears as if this list of chemicals is only presented in this table, and therefore, somewhat hidden - I really like the way the location and substance information is presented in this table; however, **although the max. expected quantity stored at each storage location is listed, the max. expected quantity stored overall is not. Both types of information are important, and should be included in this plan.** - According to the information submitted in Schedule 2, the total expected quantity of ammonium nitrate (solid) on site was 1197.4 T; however, the information presented in **Appendix I indicates that 1350 T is on site. Likewise, the submitted info. for the max. capacity of the largest container system is 0.5 T, whereas, the info. in Appendix I appears to indicate that it is 40.8 T, which is a considerable difference.** - Similarly, the values in Appendix I for the **max. capacity of the largest container system of diesel fuel appears to be different from the 5000 T submitted in Schedule 2.** . The annotated photographs are helpful.	Updated Modules (A-D) to include an additional table presenting the total quantities for each chemical substance at the facility Schedule 2 will be updated The 5000 T listed in Schedule 2 is the containment capacity of the 5,000,000 L diesel tanks. 5,000,000 L is the maximum quantity stored in the tank.

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		3.(1)	(b) Any quantity of an E2 substance is stored within a container system at the facility that has a maximum capacity equal to or greater than the Schedule 1 threshold for that E2 substance If the maximum capacity of the container system equals or exceeds the SCH 1 threshold limit they must submit a SCH 2 Notice even if the quantity of the E2 substance w/i the container is below the threshold limit;The maximum capacity means the full physical capacity, including any capacity beyond the safe-fill limit.	Diesel fuel	Diesel fuel is stored at a capacity greater than the Schedule 1 threshold for that E2 substance.

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		3.(2)	Do any of the following exclusions apply to the total quantity calculations at the facility: a) Quantities located at a facility for less than 72 hrs; b) Quantities that are in a container system with a capacity less than 0.03t; c) Quantities of the substance that are found in slag, waste rock, tailings, solid residues, ores and ore concentrates d) Quantities of propane w/i a container system with a max capacity of 10t that is located 360m from all points along the boundary of the facility; e) Quantities of anhydrous ammonia, ammonia hydroxide & ammonia solution that are located at a farming operation for on-site use as an agricultural nutrient. Do any substance exclusions apply? Refer to Exclusions Table in the Appendix If there are substances that are stored at the facility for less than 72 hours, ask for the records showing the date/arrival time/ departure time/quantities? Regarding exclusions, refer to the Exclusions Table in the Appendix.	There was no information indicating that any exclusions applied to the chemicals identified in this E2 Plan. I proceeded on the assumption that exclusions were applied prior to the creation of this document; thus, only chemicals to which exclusions did not apply were identified in it.	Exclusions under the E2 Regulation were not considered when tabulating the chemicals stored. Text has been updated in Modules.

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		3.(5)	Has there been any change to the following information submitted under the SCH 2 Notice: (a) Information respecting the facility or head office of the facility (address, company contacts, facility name); (b) An increase by 10% or more of reported maximum quantity of the E2 substance; (c) An increase by 10% or more of the reported maximum capacity of the container system in which the E2 substance is stored The SCH2 information must be updated via the SWIM database within 60 days of any change.	Amended Schedule 2 notices submitted on June 8, 2021 and June 30, 2021; unknown if these were submitted within 60 days of the change(s).	Agnico confirms this was submitted within 60 days, as required by the Regulations.

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		4.(1)	Did the responsible person prepare an E2 plan with respect to an E2 substance under the following circumstances: (a) Some or all of the E2 substance is not contained within a container system and the maximum expected quantity equals or exceeds the SCH 1 threshold limit OR (b) The E2 substance is contained within a container system and the maximum expected quantity equals or exceeds the SCH 1 threshold AND The E2 substance is in a container system that has a maximum capacity, which equals or exceeds the SCH 1 threshold A facility must develop and implement an E2 plan if one or more substances are present AND either: Some or all of the substance is uncontained, and its maximum expected quantity equals or exceeds the SCH1 threshold quantity; OR BOTH the maximum expected quantity on-site equals or exceeds the SCH 1 threshold and is contained in a container system AND the container system's maximum capacity equals or exceeds the SCH1 threshold quantity.	*Table A.1* - I like the way the location and substance information is presented in this table; however, it is unclear from this information what the <u>total expected quantity</u> is, nor what is the <u>maximum (i.e., 100%) capacity of the largest container system.</u> - It is unclear if any of these tanks are connected; if so, the connected tanks (if not able to be segregated) would constitute one container system. - Although the max. expected quantity stored at each storage location is listed, the max. expected quantity stored overall is not. Both types of information are important, and should be included in this plan. - I like that the substances listed in this table include all the substances on site, not just the E2-regulated ones (diesel fuel, ammonium nitrate, propane, HCl). *Appendix I* - There are a lot of hazardous chemicals stored on site, and it is concerning that the list of these substances is not included in this plan until Appendix 1. - It's unclear if the "largest container" is the largest container or the largest container system.	Updated each Module to include a table presenting the total expected quantity at each Site. For the Maximum Expected Quantity Stored at each location, a foot note is included with the quantity details. The tanks are not interconnected and do not constitute a container system. Module A2 has been updated. Updated each Module to include a table presenting the total expected quantity at each Site. Updated table in Module A2 to indicate largest container is not a container system.

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		4.(2)	A description of the properties and characteristics of the substance and the maximum expected quantity of the substance at the facility;
			
			pH, boiling point, density, gas/liquid/solid, incompatibility, reactivity; Usually contained in a safety data sheet or other specific sources.
				Appendix 1
				- Sodium cyanide, ammonium nitrate, diesel, Jet-A aviation fuel
				  ○ There **are no SDS included in this document,** nor is the information from those SDS (i.e., boiling point, density) included in this document.
				- *Ammonium Nitrate*
				  ○ There is a discrepancy between the total expected quantity indicated in Appendix 1 (1350 T) and the value submitted in Schedule 2 (1197.4 T).
				- *Diesel*
				  ○ Using different units in the same sentence can be problematic.
				- *Jet-A Aviation Fuel*
				  ○ Contrary to what was indicated, this chemical (i..e, kerosene) is not currently listed as a substance in Schedule 1 of the E2 Regulations.
				
				Modules A2, B2, and C2 – indicate the quantities of the chemicals and different locations
				It's **unclear if the quantities listed in the tables are the 100% maximum capacity of the container system, the safe fill zone capacity, or the quantity that is normally stored in those containers**
					Updated Appendix 1 to include SDS
					
					Updated each Module to include a table presenting the total expected quantity at each Site. For the Maximum Expected Quantity Stored at each location, a foot note is included with the quantity details.

		4.(2)	**(b)** a description of the commercial, manufacturing, processing or other activity involving the substance that takes place at the facility; Is there a description of what the substance is used for on-site (is it stored, produced, reacted or used)? If the substance is used within a larger system, the facility may choose to represent the system in a figure/diagram.	Appendix 1	Appendix 1 contains the Hazardous Materials details and Product Specific Emergency Response Plans.

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		4.(2)-	**(c)** a description of the facility and of the area surrounding the facility that may be affected by an environmental emergency referred to in paragraph (d), including any hospitals, schools, residential, commercial or industrial buildings and any highways, public transit infrastructure, parks, forests, wildlife habitats, water sources or water bodies; Plan/map/table or adequate description of facility and surrounding area; Other sensitive receptors to be considered: childcare, long-term care and senior facilities; public camping and wetlands;	*1.5 Project Description* - facility description, location, climate - *Module A* = water sources, WTP - Photo plates in modules A, B, C, D - *Appendix 3* = sensitive information **- There is no information specifying the area, *if any*, that may be affected by an environmental emergency – i.e., discussion of presence/absence of sensitive receptors.**	Section 1.5 has been updated to include details regarding the project area and the absence of sensitive receptors. Section 4.8 has been updated to include discussion on sensitive receptors for the Worst-Case Scenario and the Alternate Worst Case Scenario.

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		4.(2)	**(d)** an identification of any environmental emergency that could reasonably be expected to occur at the facility and that would likely cause harm to the environment or constitute a danger to human life or health, including the environmental emergency referred to in paragraph (e) and, if applicable, the environmental emergency that is more likely to occur than the environmental emergency referred to in paragraph (e) and that would have the longest impact distance outside the boundary of the facility; Has every environmental emergency that could reasonably be expected to occur and have impacts (harm to environment, human life or health) been identified for each E2 regulated substance at the facility? Has the **Worst Case Scenario (WCS)** environmental emergency (release of the max quantity that could be contained in the largest container system and/or the release of the max expected quantity that is not in a container system on-site) been identified for each E2 regulated substance at the facility? If any, has the **Alternate Worst-Case Scenario** environmental emergency (scenario that may most realistically happen with the longest impact distance outside the boundary of the facility) been identified for each E2 regulated substance at the facility? Have impact zones with distances to potential consequences been identified for every scenario?	*S. 4 – Spill Management and Mitigation* - s. 4.1 - Three causes of a spill from a chemical storage tank or other containment identified. - s. 4.2 - Three causes of a spill during transfer identified. - s. 4.3 - Three causes of a spill during transfer identified. - s. 4.4 - Two causes of spills from equipment identified. - No scenario identified in s. 4.5. - **A risk analysis that depicts the probability and consequences of identified scenarios is recommended to be included. This matrix would ID all scenarios and score the risk.** *Appendix I* - **There are no specified causes of spills (i.e., identified scenarios) in Appendix I.** - I like the thought process in s. 4.1.1. - **The worst case scenario and alternate worst case scenarios were not identified as such.** - **The potentially affected members of the public were not identified - is this because there are none, or because it was overlooked?**	Section 4.8 has been updated to include a risk analysis. Section 4.8 has been updated to include the Worst-Case Scenario, the Alternate Worst-Case Scenario and an Alternate Scenario.

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		4.(2)	**(e)** an identification of the harm to the environment or danger to human life or health that would likely result from an environmental emergency involving the release of Has the harm been identified under the following Worst Case Scenarios for each E2 substance located on-site? Look for a map demonstrating impact zones.	The worst case scenario was not identified in *s. 4*, nor elsewhere in the document; **therefore, neither was *the harm* resulting from that scenario.**	Section 4.8 has been updated to include the Worst-Case Scenario, the Alternate Worst-Case Scenario and an Alternate Scenario.
		4.(2)	(i) the maximum quantity of the substance that could be contained in the container system that has the largest maximum capacity, if a quantity of the substance is in a container system, and WCS involving the release of the maximum quantity that could be contained in the largest container system on-site	Same comment as above, but the non-site specific environmental effects were touched upon in *Appendix 1.*	
			(ii) the maximum expected quantity of the substance that will not be in a container system, if a quantity of the substance is not in a container system; WCS involving the release of the maximum quantity that could be contained in the largest container system on-site	WCS involving the release of the maximum quantity that is not contained within a container system on-site. - Same comment as above, but the non site-specific environmental effects were touched upon in the *Ammonium Nitrate Specific Spill Response Plan in Appendix 1.*	
		4.(2)	**(f)** an identification of the harm to the environment or danger to human life or health that would likely result from the environmental emergency identified under paragraph (d), if any, that is more likely to occur than the environmental emergency referred to in paragraph (e) and would have the longest impact distance outside the boundary of the facility; Has the harm been identified in the **Alternate Worst-Case Scenario** for each E2 substance located on-site, if any? Look for a map demonstrating impact zones.	No AWC scenario was identified in Section 4 or in Appendix 1; **therefore, *the harm* from this scenario was not identified either.** - It is possible that NO AWC exists, which is fine; however, **this possibility needs to be stated. The potentially affected members of the public were not identified** - is this because there are none, or because it was overlooked?	Section 3.3 has been updated with more detail regarding the external reporting protocol.

		4.(2)	**(g)** a description of the measures to be taken to prevent and prepare for the environmental emergencies identified under paragraph (d) and the measures that will be taken to respond to and recover from such emergencies if they were to occur; **PREVENTION:** Mitigation measures such as spill containment around tanks (dykes/catch basins); Concrete blocks used for collision protection, walls, shut-off valves, detectors, alarms; Standard Operating Procedures; Regular Maintenance and Inspection Programs i.e. checking pipes for corrosion, awareness of equipment lifespan; Management systems for process design and operation, training and facility operation. **PREPAREDNESS**: Prediction of environmental emergencies and their harm to the environment or their danger to human life and health; Consultation with first responders; Training of staff and on-site responders; Availability of resources and equipment; communication with neighbours; Testing and updating the plan annually; **RESPONSE:** activation of plan; rapid assessment of the emergency and potential impacts; proper notification to first responders and affected public; communication systems between stakeholders; evacuating and accounting for personnel and members of the public present at the facility; adequate reporting; **RECOVERY:** pre-planning for the restoration of any part of the environment that is damaged during an emergency; adequate finances available for restoration; availability of restoration equipment; work with outside resources to support recovery i.e., emergency response contractor;	PREVENTION: - s. 4.1.1 & s. 4.3.1 - secondary containment and spill containment, weekly inspections of all containment structures - s. 4.4.1 - spill trays - s. 4.6.1 - No chemicals are stored within 31 m of water; containment, etc. PREPAREDNESS: - s. 4.2.1 - Traffic ROW procedures for transport, comm. equipment, procedures - s. 4.3.1 - SOPs for safe use and handling, storage - 4.4.1 - 4.5.1 - Training, PPE, chemicals reviewed annually - 4.7.1 - Due to its location, all the required spill response resources and trained personnel are available on site. GOOD section. - s. 5(1) - Spill response simulation exercises RESPONSE: - Section 2, Appendix 1 (NOT listed in the cross-reference table) - s. 2.2.15 – Perhaps using words such as “appropriate" unless there is additional info. or clarification. - s. 2.2.16 - the appropriate response for small spills was indicated, but what about large spills? RECOVER: - s. 3.4	Section 2.3.14 has been updated. Section 2.3.16 has been updated.

Version	Reviewer	Comment #	Comment	Recommendation	Response
		4.(2)	**(h)** a list of the position titles of the persons who will make decisions and take a leadership role in the event of an environmental emergency and a description of their roles and responsibilities; Interview the people involved in emergency management and ensure that each one named is aware of their responsibility; and their alternatives.		
		4.(2)	**(i)** a list of the environmental emergency training that has been or will be provided to prepare personnel at the facility who will respond in the event that an environmental emergency identified under paragraph (d) occurs; Has the training required for each position/person identified above been outlined? Ensure that the training has been taken or ask for the date on which they will take place. Good overview, and nice and concise.	- The training was identified for potential and designated first responders, **but what about for the personnel identified in sections 2.2.1-2.2.8. Require more specifics about how each role's specified training is achieved, or refer to another document (e.g., internal computer software).** - Although the purpose of the training was identified (e.g., the fuel offloading training, response to fire, explosive, or toxic incidents, and appropriate handling, storage, and disposal of chemicals), **the types of training (specific training sessions) were not.** - Is there a Is there a spreadsheet or checklist available that lists the required training, and the status of all employees? Who is responsible to ensure that this is done? It's fine if this information is located in other documents, but it must be referenced in this one. **- There is no indication about how often training is provided or how often recertification is required, only that it is provided.**	Section 5 has been updated with additional details on training.

Version	Reviewer	Comment #	Comment	Recommendation	Response
		4.(2)	**(j)** a list of the emergency response equipment that is necessary for the measures described in paragraph (g) and the equipment's location; Ensure that the emergency response equipment referred to in paragraph g) is at the right location and usable. Is there a list of emergency response equipment and the equipment's location – the location may be depicted on a site map. Is the list of equipment complete and adequate - specific to the nature of the hazard. Was training provided on how to use the equipment?	*2.4.1 – On Site Resources* *Appendix 2* - Very good. - I like that the OPPP/OPEP was considered and referenced **- Where is the specialized response equipment stored? Is there someone designated to maintain and ensure the availability of the emergency equipment** *Modules A, B, C, D* - The photo plates with the clearly marked spill kit locations are good; however, there is **no information indicating where *in that facility* the spill kit is located**	Appendix 2 has been updated with additional details regarding the spill kit maintenance and storage. Spill kits are clearly identified in the facilities.

Version	Reviewer	Comment #	Comment	Recommendation	Response
		4.(2)	**(k)** a description of the measures that will be taken by a responsible person or by a responsible person and local authorities, acting jointly, to communicate with the members of the public who may be adversely affected by the environmental emergency referred to in paragraph (f) to inform them, before the environmental emergency occurs, of Ask specific questions about the authorities that will be contacted and by what means. Was public notification made under the alternate worst-case scenario (most likely) where the impact distance is outside the boundary of the facility? (If predicted impacts do not extend beyond the boundary of the facility, prior notification of the public is not required.) Have all members of the public been notified within the calculated impact zone? How were they identified? The method of notification is not specified by the Regulations, some options include: public meetings, flyers, posters, stickers, websites, newsletters, open house meetings, safety day, door-to-door direct contact, partnering with a local community awareness and emergency response group.		

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			(i) the possibility that the environmental emergency could occur, (ii) the potential effects of the environmental emergency on the environment and on human life or health, taking into account the factors referred to in paragraphs (a) to (c), and (iii) the measures that will be taken by the responsible person to protect the environment and human life or health, and the means by which the responsible person will communicate with them, in the event that the environmental emergency occurs; Have members of the public been informed of the type of environmental emergency that could occur, the potential effects, the protective measures taken and how the facility will communicate with them in the event of an emergency? Notification must be provided to the public BEFORE an environmental emergency occurs – it is recommended that this action be completed as part of the implementation/ bringing into effect of the plan	. - The info. in *Section 2.2.8* refers to the requirement in s. 4(2)(l), not this clause. - **I could not find any information in this plan about an environmental emergency scenario designated under s. 4(2)(f), which may explain why there is no information meeting the s. 4(2)(k) requirements; however, since its existence, or lack thereof is not referenced, it's impossible to know if this is an oversight or not.**	Section 4.8 has been updated to include the Worst-Case Scenario, the Alternate Worst-Case Scenario and an Alternate Scenario.

Version	Reviewer	Comment #	Comment	Recommendation	Response
		4.(2)	**(l)** a description of the measures that will be taken by a responsible person or by a responsible person and local authorities, acting jointly, to, in the event that an environmental emergency involving the release of a substance occurs, communicate with the members of the public who may be adversely affected to provide them, during and after its occurrence, with information and guidance concerning the actions that could be taken by them to reduce the potential harm to the environment and danger to human life or health, including an explanation of how those actions may help to reduce the harm or danger; Is there a description of how the public will be notified as soon as possible of an emergency situation and by what method (siren, automated phone message, media release, police/fire services, etc); Is there a description of how the public will receive communications during and after an environmental emergency? Have members of the public been informed of what to do in the event of an emergency, i.e., shelter in place; wait for instructions by local authorities, etc;	*Section 2.2.8* - I really liked the information in this subsection, but there was **no info. about *how* the communication will happen**. - There is **no description of the measures to be taken** - i.e., how communication would occur, what info. would be relayed. - The potentially affected members of the public were not identified in this plan, which may be the cause of this omission in this paragraph. *Section 3.3* - There is **no description of the measures that will be taken**, only that the Mine General Manager will work with the Communications Delegate to provide notification to the public during and after the event. - However, **this is the only place in this document that refers to members of the public and their vicinity to the mine** (closest community is located >120 km away).	Section 2.3.8 has been updated to include additional details around communication methods. Product Specific Spill Response Plans are detailed in Appendix 1.
		4.(2)	**(m)** the position title of the person who will communicate with the members of the public referred to in paragraphs(k)&(l); Position title of the person who will communicate with the members of the public. *Section 2.2.8*		
		4.(2)	**(n)** a description of the consultations that a responsible person had with local authorities, if any, with respect to the measures referred to in paragraph (k) and (l); and Local authorities are not required to participate in the plan development or simulation exercises, although it is strongly encouraged by ECCC.	The comments in *Appendix 4* do not relate to the communication provisions in paragraphs s. 4(2)(k) and s. 4(2)(k).	

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		4.(2)	**(o)** a plan of the facility showing the location of any substances in relation to the physical features of the facility. Plan/map of the facility depicting the location of the E2 substances at the facility.	*Plate A.3* is the only photograph in which certain chemicals were identified to be in a specific building. - Are the tables and the photographs meant to be used in conjunction with each other? **The storage locations are indicated by red circles, but they are *not* labelled.** Emergency responders would not know which chemicals were stored in specific buildings	The modules have been updated with labels for all storage locations.
		5	Did the responsible person submit a **Schedule 3 Notice: Preparation of Plan** within 6 months of meeting or exceeding BOTH the substance quantity and container capacity thresholds OR only the quantity threshold for a substance that is not in a container system A **SCH3 Notice** must be submitted via the SWIM database within 6 months of meeting the threshold for quantity (when not contained) or quantity & container capacity of an E2 substance (when contained).	Schedule 3 was submitted on June 23, 2020, which was later than the Feb. 24, 2020 reporting deadline.	Agnico will meet all regulatory deadlines going forward.

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		6	Did the responsible person bring the plan into effect within 12 months of meeting/exceeding BOTH the substance quantity and container capacity thresholds OR only the quantity threshold for a substance that is not in a container system AND submit the **Schedule 4 Notice: Bringing Into Effect of an E2 Plan** A **SCH4 Notice** must be submitted via the SWIM database within 12 months of meeting the threshold for quantity or quantity & container capacity of an E2 substance. This requirement is to ensure readiness to respond in the event of an emergency, which means that any prevention measures and preparedness (except exercises, which are due in following year) have been implemented. Recommended approach to assess the implementation of the plan: 4 (2) (h): Interview the people involved in emergency management and ensure that each one named is aware of their responsibility; 4 (2) (i): Ensure that the training has been taken or ask for the date on which it will take place. 4 (2) (j): Ensure that the emergency response equipment referred to in paragraph g) is at the right location and usable. 4 (2) (k): Ask specific questions about the authorities that will be contacted and by what means. Enforcement received a legal opinion regarding this section. Consult with enforcement leads/programs and potentially legal services if required regarding enforceability.	According to Schedule 4, the E2 Plan was brought into effect on March 31, 2020; Schedule 4 was submitted on June 23, 2020	

Version	Reviewer	Comment #	Comment	Recommendation	Response
		7.(1)	**(a)** Was an **Annual Simulation exercise** conducted within one year of the plan being brought into effect and annually thereafter (excluding the year of the full-scale exercise)? Did the exercise simulate a response to an environmental emergency identified according to 4(2)(d) that involved the release of one Schedule 1 substance from **EACH** of the hazard categories (A,C,E,F,I,O) present at the facility? The Annual Simulation is administrative in nature; Examples to fulfill requirements include Drills, Table Top Exercises, Functional Exercises Notices are not required for the annual simulations but **records must be kept at the facility for 7 yrs (s.21)** starting on the day on which they are prepared.		
		7.(1)	**(b)** Was a **Full-Scale Simulation exercise** completed within 5 years of the E2 plan being brought into effect and every 5 years thereafter? Was a **SCH 5 Notice: Full-Scale Exercise of E2 Plan Conducted** submitted following the completion of the full-scale exercise and within 5 years of the plan being brought into effect, and every 5 years thereafter? The full-scale simulation is an action-based exercise requiring the deployment of personnel, resources and equipment; only one SCH 1 substance at the facility is required to be part of the full-scale exercise and can be from any of the 6 hazard categories; full-scale exercise pertains to WCS or Alternate Scenarios identified in the plan.		

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		7.(2)	With respect to the annual simulations, has the facility cycled through a different environmental emergency each year until all the environmental emergencies identified under the plan have been tested? Once the facility has cycled through all the possible environmental emergencies identified under the plan, the expectation is for them to repeat the cycle again and again and so on. A different substance from each hazard category needs to be the subject of the annual simulation exercise.		
		7.(3)	The annual simulation is not required during the year of the full-scale exercise.		
		8	Was a record prepared after each simulation exercise (annual and full-scale) outlining the date, summary of activity and result of the exercise? Annual simulation records must be kept at the facility for a period of 7 years and available for inspection upon request.	Annual simulation records must be kept at the facility for a period of 7 years and available for inspection upon request.	
		9	Was a **SCH 5 Notice: Full-Scale Exercise Conducted** submitted for the full-scale exercise within 5 years of the plan being brought into effect and every 5 years thereafter? The **SCH 5 Notice** must be submitted via the SWIM database within 5 years of the implementation of the plan and every 5 years thereafter **(s.14)** The full-scale simulation records must be kept at the facility for a period of 7 years.	A Schedule 5 has not been submitted to the E2 database, but the reporting deadline for this facility is **March 31, 2025** (within 5 years after the implementation of the E2 Plan).	Agnico will submit Schedule 5 by the regulatory deadline.

Version	Reviewer	Comment #	Comment	Recommendation	Response
		10	Was the E2 plan reviewed and updated (if required) once per year and did they keep a record of the date of review with the plan as required? Records of plan updates must be kept at the facility for a period of 7 years.	According to this document, it was published in March 2021. There is no review or amendment page included in this document, so either it is missing or this is the original version of the E2 Plan.	The Hope Bay Spill Contingency Plan is the E2 Plan. It is reviewed and updated annually. The plan includes a revision section to keep track of annual changes.
		11	Is the plan readily available at the facility where the substance is located AND is the plan readily available to those individuals who are to carry out the plan? Is the plan readily accessible in the event of an emergency? Things to consider: Was the plan provided to local authorities (eg. the fire dept.)? Is the plan accessible via a company wide network system? Is there a hardcopy of the plan located at the facility in the event that it cannot be accessed via a network system, i.e. in a lockbox located near the entrance to the property?		
		15	Has the total quantity of the E2 substance located at the facility become less than the threshold amount for a period of one year or more? Has the regulated container capacity been below the E2 threshold quantity for a period of one year or more? If yes to either situation, a **SCH 6 Notice: Change in Quantity or Capacity** must be submitted via the SWIM database no later than 60 days after the one year time period has expired; Situational Examples: they stop storing the E2 substance at the facility or they reduce the capacity of the storage container system to below the E2 threshold quantity.	A schedule 6 has not been submitted in the E2 database.	A change in circumstance (Schedule 6) has not occurred at Hope Bay.

Version	Reviewer	Comment #	Comment	Recommendation	Response
		16	Has operations at the facility stopped for a period of more than one year for any purpose other than maintenance? If yes, a **SCH 7 Notice: Cessation of Operations** must be submitted via the SWIM database at least 30 days before operations cease or as soon as feasible in the case of extraordinary circumstances i.e. fire, major accident, natural disaster, etc.		
		17	Has there been a transfer of ownership at the facility? If yes, a **SCH 7 Notice: Transfer of Ownership** must be submitted via the SWIM database on or before the date of transfer An amended Schedule 2 was submitted on June 8, 2021 in order to change the address and contact information for the Facility and Head Office subsequent to Agnico Eagle Mines Ltd. becoming the new parent company of TMAC Resources Inc. A Schedule 7 was not submitted.		

		18	Has there been any release of an E2 substance at the facility? If yes, was verbal and/or written notification provided and to whom was it provided? For the purposes of these Regulations, paragraph 201(1)(a) of CEPA relating to verbal and written notification of an environmental emergency, only applies to an environmental emergency involving the release or anticipated release of an E2 substance, in any quantity, that • has or may have immediate or long-term harmful effect on the environment; • constitutes or may constitute a danger to the environment; OR • constitutes or may constitute a danger in Canada to human life/health. When assessing reported release incidents, EOs should consider the following criteria for the provision of the written report: 1) Accidental release of a SCH 1 substance (in the threshold concentration) in an unplanned or uncontrolled manner; and the 2) Release resulted or may result in-impacts or the potential for consequences exist, examples include: impact to water and air; impact to habitat and wildlife i.e., migratory bird staging area or fish habitat; and/or 3) Release results or may result in a site evacuation or shelter in-place response at the facility or outside the facility; and/or 4) Release resulted in an injury on or off-site;		

Version	Reviewer	Comment #	Comment	Recommendation	Response
			The Written Report must be provided to the Regional Director, Enforcement Branch in the region that the environmental emergency occurs through the E2 Regulations reporting application accessible through SWIM. This written report must be submitted as soon as is reasonably possible after an incident.		
		19	Was all the information submitted under a Notice or any written report accompanied by a signed certification stating that the information is accurate? Submissions online require a mandatory online certification. If the information is submitted on paper (must justify why they could not use electronic submission), then the following applies: If certification is provided by an authorized representative, they must provide their name, telephone number and email address.		

HOPE BAY SPILL CONTINGENCY PLAN

HOPE BAY, NUNAVUT

Appendix 5:
E2 and MDMER Cross-reference Tables

E2 Regulations Cross-Reference Table

Environmental Emergency Regulations, 2019: SOR/2019-15
Cross-reference Table Hope Bay Project Facility, E2 ID# 2-4032, E2 Substance Diesel Fuel

EER Reference	Information required	Location of information in this emergency plan
4 (2) (a)	a description of the properties and characteristics of the substance and the maximum expected quantity of the substance at the facility	Maximum expected quantity – Hope Bay Spill Contingency Plan Module A Section A2, Module B Section B2, Module C Section C2 and Module D Section D2 Substance properties – Appendix 1
4 (2) (b)	a description of the commercial manufacturing, processing or other activity involving the substance that takes place at the facility	Hope Bay Spill Contingency Plan Appendix 1
4 (2) (c)	a description of the facility and of the area surrounding the facility that may be affected by an environmental emergency referred to in paragraph (d), including any hospitals, schools, residential, commercial or industrial buildings and any highways, public transit infrastructure, parks, forests, wildlife habitats, water sources or water bodies;	Hope Bay Spill Contingency Plan Section 1.5, Module A, Appendix 1, Appendix 3
4 (2) (d)	an identification of any environmental emergency that could reasonably be expected to occur at the facility and that would likely cause harm to the environment or constitute a danger to human life or health, including the environmental emergency referred to in paragraph (e) and if applicable, the environmental emergency that is more likely to occur than the environmental emergency referred to in paragraph (e) and that would have the longest impact distance outside the boundary of the facility	Hope Bay Spill Contingency Plan Section 4.8
4 (2) (e) (i)	an identification of the harm to the environment or danger to human life or health that would likely result from an environmental emergency involving the release of the maximum quantity of the substance that could be contained in the container system that has the largest maximum capacity, if a quantity of the substance is in a container system, and	Hope Bay Spill Contingency Plan Section 4.8
4 (2) (e) (ii)	an identification of the harm to the environment or danger to human life or health that would likely result from an environmental emergency involving the release of the maximum expected quantity of the substance that will not be in a container system, if a quantity of the substance is not in a container system	Hope Bay Spill Contingency Plan Section 4.8, Appendix 1
4 (2) (f)	an identification of the harm of the environment or danger to human life or health that would likely result from the environmental emergency identified under paragraph (d), if any, that is more likely to occur than the environmental emergency referred to in paragraph (e) and would have the longest impact distance outside the boundary of the facility;	Hope Bay Spill Contingency Plan Section 4, Appendix 1
4 (2) (g)	a description of the measures to be taken to prevent and prepare for the environmental emergencies identified under paragraph (d) and the measures that will be taken to respond to and recover from such emergencies if they were to occur	Hope Bay Spill Contingency Plan Section 2, Section 3.4 and Section 3.5, Appendix 1
4 (2) (h)	a list of the position titles of the persons who will make decisions and take a leadership role in the event of an environmental emergency and a description of their roles and responsibilities	Hope Bay Spill Contingency Plan Section 2.3
4 (2) (i)	a list of the environmental emergency training that has been or will be provided to prepare personnel at the facility who will respond in the event that an environmental emergency identified under paragraph (d) occurs	Hope Bay Spill Contingency Plan Section 5
4 (2) (j)	a list of the emergency response equipment that is necessary for the measures described in paragraph (g) and the equipment's location	Hope Bay Spill Contingency Plan Appendix 2, Equipment locations shown in Module A Plate A.1 to A.4, Module B Plate B.1 to B.2, Module C Plate C.1 to C.4, Module D Plate D.1 to D.3
4 (2) (k) (i)	a description of the measures that will be taken by a responsible person or by a responsible person and local authorities, acting jointly, to communicate with the members of the public who may be adversely affected by the environmental emergency referred to in paragraph (f) to inform them, before the environmental emergency occurs, of the possibility that the environmental emergency could occur	Hope Bay Spill Contingency Plan Section 2.2.8

EER Reference	Information required	Location of information in this emergency plan
4 (2) (k) (ii)	a description of the measures that will be taken by a responsible person or by a responsible person and local authorities, acting jointly, to communicate with the members of the public who may be adversely affected by the environmental emergency referred to in paragraph (f) to inform them, before the environmental emergency occurs, of the potential effects of the environmental emergency on the environment and on human life or health, taking into account the factors referred to in paragraphs (a) to (c), and	Hope Bay Spill Contingency Plan Section 3.3
4 (2) (k) (iii)	a description of the measures that will be taken by a responsible person or by a responsible person and local authorities, acting jointly, to communicate with the members of the public who may be adversely affected by the environmental emergency referred to in paragraph (f) to inform them, before the environmental emergency occurs, of the measures that will be taken by the responsible person to protect the environment and human life or health, and the means by which the responsible person will communicate with them, in the event that the environmental emergency occurs;	Hope Bay Spill Contingency Plan Section 1.5 and Section 3.3
4 (2) (l)	a description of the measures that will be taken by a responsible person or by a responsible person and local authorities, acting jointly, to, in the event that an environmental emergency involving the release of a substance occurs, communicate with the members of the public who may be adversely affected to provide them, during and after its occurrence, with information and guidance concerning the actions that could be taken by them to reduce the potential harm to the environment and danger to human life or health, including an explanation of how those actions may help to reduce the harm or danger;	Hope Bay Spill Contingency Plan Section 1.5 and Section 3.3
4 (2) (m)	the position title of the person who will communicate with the members of the public referred to in paragraphs (k) and (l);	Hope Bay Spill Contingency Plan Section 3.3
4 (2) (n)	a description of the consultations that a responsible person had with local authorities, if any, with respect to the measures referred to in paragraph (k) and (l); and	Hope Bay Spill Contingency Plan Appendix 4
4 (2) (o)	a plan of the facility showing the locations of any substances in relation to the physical features of the facility	Hope Bay Spill Contingency Plan Module A Plate A.1 to A.4, Module B Plate B.1 to B.2, Module C Plate C.1 to C.4, Module D Plate D.1 to D.3

MDMER Cross-Reference Table

MDMER Cross-reference table for section 30(1) to 30(5)
Hope Bay Project Facility, FDP RBD-1

MDMER Reference	Information required	Location of information in this emergency plan
s. 30(1)	The owner or operator of a mine shall prepare an emergency response plan that describes the measures to be taken in respect of a deleterious substance within the meaning of subsection 34(1) of the Act to prevent any unauthorized deposit of such a substance or to mitigate the effects of such a deposit.	Hope Bay Spill Contingency Plan
s. 30(2)	The emergency response plan shall include the following elements:	
s. 30(2)(a)	the identification of any unauthorized deposit that can reasonably be expected to occur at the mine and that can reasonably be expected to result in damage or danger to fish habitat or fish or the use by man of fish, and the identification of the damage or danger;	Hope Bay Spill Contingency Plan Section 4
s. 30(2)(b)	a description of the measures to be used to prevent, prepare for, respond to and recover from a deposit identified under paragraph (a);	Hope Bay Spill Contingency Plan Section 2, Section 4, Module A Section A5
s. 30(2)(c)	a list of the individuals who are to implement the plan in the event of an unauthorized deposit, and a description of their roles and responsibilities;	Hope Bay Spill Contingency Plan Section 2
s. 30(2)(d)	the identification of the emergency response training required for each of the individuals listed under paragraph (c);	Hope Bay Spill Contingency Plan Section 5
s. 30(2)(e)	a list of the emergency response equipment included as part of the plan, and the equipment's location; and	Hope Bay Spill Contingency Plan Appendix 2. Equipment locations shown in Modules A through D.
s. 30(2)(f)	alerting and notification procedures including the measures to be taken to notify members of the public who may be adversely affected by a deposit identified under paragraph (a).	Hope Bay Spill Contingency Plan Section 3.3
s. 30(3)	The owner or operator shall complete the emergency response plan and have it available for inspection no later than 60 days after the mine becomes subject to this section.	Hope Bay Spill Contingency Plan
s. 30(4)	The owner or operator shall update and test the emergency response plan at least once each year to ensure that the plan continues to meet the requirements of subsection (2).	Hope Bay Spill Contingency Plan Section 5
s. 30(4.1)	The owner or operator of a mine shall, each time the emergency response plan is tested, record the following information and keep the record for at least five years: (a) a summary of the test (b) the test results; and any modifications that are made to the plan as a consequence of the test.	Hope Bay Spill Contingency Plan Section 5
s. 30(4.2)	The owner or operator of a mine shall ensure that a copy of the most recent version of the emergency response plan is kept at the mine in a location that is readily available to the individuals who are responsible for implementing the plan.	Hope Bay Spill Contingency Plan Available on Public server, posted in main camp hallway, copy maintained in main conference room (assembly point for Incident Command Group) and Geo-Hub conference room (alternate assembly point)
s. 30(5)	If a mine has not been subject to the requirements of this section for more than one year, a new emergency response plan shall be prepared and completed no later than 60 days after the day on which the mine again becomes subject to this section.	NA

HOPE BAY PROJECT, WASTE ROCK, ORE AND MINE BACKFILL MANAGEMENT PLAN

HOPE BAY, NUNAVUT

MARCH 2022

Hope Bay Project, Waste Rock, Ore and Mine Backfill Management Plan

Plain Language Overview:

This Plan describes how rock that is brought to the ground surface during mining and mine backfill materials are handled to minimize impacts to water quality. The rock brought to surface from the underground mine includes ore (rock that contains economic quantities of gold) and waste rock (rock that does not contain economic quantities of gold). When ore is brought out of the mine, it is placed in stock piles until it is processed to extract the gold. As much waste rock as possible is left underground to fill voids created by mining and thus stabilize the ground. However, some of the waste rock may be brought to surface during mining and temporarily stockpiled separate from the ore. The rock will be taken back underground on an ongoing basis as underground void space becomes available however where suitable some may be used for construction.

Mine backfill is required for structural purposes and includes waste rock from the underground mine (all mines), rock extracted from quarries on surface (Madrid North and Boston) and/or detoxified tailings from the mill (Doris, Madrid North and Boston). Detoxified tailings are classified as potentially acid generating (PAG). Rock quarried on surface is used for construction or underground backfill. All quarry rock geochemically characterized as having a high risk for acid rock drainage (ARD) will be used as mine backfill only. All backfill is placed on the waste rock stockpile prior to transfer underground.

A secondary objective of the plan is to implement a monitoring program that will support mitigative action, as required, in the event that unanticipated changes to water quality are observed in drainage from the surface stockpiles or underground.

Hope Bay, Nunavut

Publication Date: March 2022

Hope Bay Project
c/o #18 Yellowknife Airport
100 McMillan Drive
Yellowknife, NT X1A 3T2
Phone: 867-873-4767
Fax: 867-766-8667

Revisions

Revision #	Date	Section	Changes Summary	Author	Approver
1	2010		Approved Plan under 2AM-DOH1323	SRK	HBML
2	April 2015	Throughout	TMAC as current licensee for the Hope Bay region.	SRK	TMAC
		Throughout	Addition of Pad T for waste rock storage		
		Sec 3.3	Introduction of the low salt drilling procedure		
		Throughout	Update classification of Gabbro as Low NP basalt		
3	June 2015	Throughout	Changes to document structure for operational suitability and efficiency	TMAC with contributions from SRK	TMAC
		Sec 1	Addition of Glossary and list of List of Acronyms, related TMAC documents, revised Plan Management responsibilities		
		Sec 2	Revised waste rock classification and segregation		
		Module A	Concordance with 2AM-DOH1323, revised Mine development plan to include placement of waste rock on Pad T, Ore storage on Pad U		
4	August 2016	Sec 2.4	Limiting backfill of ANFO spill impacted material to permafrost zones of the underground mine	TMAC with contributions from SRK	TMAC
		Sec 2.6	Limiting backfill of hydrocarbon impacted material to permafrost zones of the underground mine		
		Sec 2.1 and Sec 3.2	Monitoring of the available mine void space and backfill volumes being placed underground		
		Sec 2.3	New section pertaining to detoxified tailings		
		Sec 2.1	Inclusion of monitoring for Total Cyanide as part of the surface water monitoring program		
		Sec 5	References updated		
		Sec 2.1.1	Removal of segregation into mineralized and non-mineralized		
			Approved Plan under 2AM-DOH1323 Amendment No.1		

Revision #	Date	Section	Changes Summary	Author	Approver
5	December 2017	Throughout	Replaces the plan for waste rock from Doris (Phase 1). Now includes waste rock from Madrid North, Madrid South and Boston (Phase 2) and Doris.	TMAC with contributions from SRK	TMAC
		Sec 1.2	Change in overall management of waste rock explained		
6	January 2019	Throughout	Updates to conform to amended water license and use of waste rock for construction	TMAC with contributions from SRK	TMAC
7	March 15 2019	Sec 2.3.1 Sec 3.1.5	Sec 2.3.1 references Sec 2.1.1 which does not exist. Sec 3.1.5 indicates a composite at TL7a (detox solids), but this is only done for TL6. TL7a is a monthly discrete sample.	TMAC	TMAC
8	March 18 2019	Throughout	Appendix A updated as per comments received from CIRNAC and other typos addressed as per comments from ECC and CIRNAC	TMAC	TMAC
9	March 2022	Sec 1.6 Sec 2.2.4, 2.3.1, 3.1	Updated Roles and Responsibilities Updates for inclusion of Cemented Rockfill as backfill	AEM	AEM

Conformity Table

Licence	Part	Item	Topic	Report Section
2AM-DOH1335 Amendment No.2	D	11	Construction Summary Report	Sec 3.3
		18	Quarry rock monitoring	Sec 3.1.6
		2	Rock for construction	Sec 3.2 and Sec 4.2
		12	Use of waste rock for construction	Sec 3.2
		19	Surface seepage collection	Sec 2.1.1
	F	13,14,15,	Waste rock and quarry monitoring and management	Sec 2.1, Sec 3.1, Sec 3.2 and Sec 3.3
		19j	Use of detoxified tails as backfill in permafrost	Table 1-3 and Sec 2.2
		15	Manage underground backfill and placement	Table 1-3, Table 3-2, and Sec 3.1
		12	Waste rock segregation	Sec 3.2 and Appendix A
	I	5d, 5e	Monthly volumes	Table 1-3 , Sec 3.1 and Table 3-2
	I	6b	tonnage of tails placed underground	Table 1-3, Sec 3.1, Table 3-1 and Table 3-2
	Provisions in Schedule B		Annual reporting	Sec 3.3
	Provisions in Schedule D		Waste Rock, Quarry and Detoxified Tailings Monitoring report	Sec 3.1, Sec 3.2, Sec 3.3 and Sec 4.3
2AM-BOS1835	D	1	Waste rock and quarry monitoring and management	Sec 2.1, Sec 3.1, Sec 3.2 and Sec 3.3
		2	Rock for construction	Sec 3.2 and Sec 4.2
		11	Construction Summary Report	Sec 3.3
		18	Surface seepage collection	Sec 2.1.1
		20	Quarry rock monitoring	Sec 3.1.6
	F	13	Waste rock segregation	Sec 3.2 and Appendix A
		14	Waste rock and quarry monitoring and management	Sec 3.1.6, Sec 2.1, Sec 3.1, Sec 3.2 and Sec 3.3
		16	Manage underground backfill and placement	Table 1-3, Table 3-2, and Sec 3.1
		23	Use of waste rock for construction	Sec 3.2 and Appendix A
	I	6b	tonnage of detoxified tailings placed underground	Table 1-3, Sec 3.1, Table 3-1 and Table 3-2
		5f	Monthly Tonnes of Waste Rock	Table 1-3 , Sec 3.1 and Table 3-2
	Provisions in Schedule B		Annual reporting	Sec 3.3
	Provisions in Schedule D		Waste Rock, Quarry and Detoxified Tailings Monitoring report	Sec 3.1, Sec 3.2, Sec 3.3 and Sec 4.3
2BB-MAE1727 Amendment No.2	G	1,4	Construction Summary Report	Sec 3.3
		5	Quarry rock monitoring	Sec 3.1.6

Licence	Part	Item	Topic	Report Section
		13	Rock for construction	Sec 3.2 and Sec 4.2
		13	Use of waste rock for construction	Sec 3.2
		5	Waste rock and quarry monitoring and management	Sec 2.1, Sec 3.1, Sec 3.2 and Sec 3.3
	E	13	Surface seepage collection	Sec 2.1.1
	B	2	Annual reporting	Sec 3.3

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Glossary

Term	Definition
ABA	Acid base accounting
Agnico	Agnico Eagle Mines Limited
ANFO	Ammonium nitrate – fuel oil mixture
AP	Acid potential
ARD	Acid rock drainage
EC	Electrical conductivity
FOS	Factor of safety
GPS	Global positioning system
HBML	Hope Bay Mining Ltd.
ICP-MS	Inductively coupled plasma – mass spectrometry
ML	Metal leaching
NiAsS	Sulphide mineral gersdorffite
Non-PAG	Non-potentially acid generating
NP	Neutralization potential
NWB	Nunavut Water Board
ORP	Oxidation-reduction potential
PAG	Potentially acid generating
PCP	Pollution control pond
pH	Hydrogen ion concentration
QMP	Quarry Management Plan
SNP	Surveillance Network Program
TDS	Total dissolved solids
TIA	Tailings Impoundment Area
TIC	Total inorganic carbon
TMAC	TMAC Resources Inc.

1 Introduction”

The Plan is intended primarily for use by Agnico Eagle Mines Limited (Agnico) and its contractors to ensure that best practices for minimizing potential environmental impacts and potential environmental liabilities associated with waste rock, ore and mine backfill storage are understood and managed.

The document outlines Agnico’s approach to waste rock, ore and mine backfill management as it pertains to all Agnico Hope Bay developments. The Plan is structured in a manner such that one document pertaining to waste rock, ore and mine backfill management is approved and implemented across all Agnico’s Hope Bay project sites, while still addressing site- and licence-specific needs.

1.1 Objectives

The objective of the Plan is to provide guidance and procedures required to deposit, manage and monitor waste rock, ore and mine backfill stored on-site in accordance with the current mine and closure plans for Doris, Madrid North, Madrid South and Boston and licences associated with development of the Hope Bay Project.

A secondary objective of the plan is to implement a monitoring plan that will support mitigative action, as required, in the unanticipated event that deleterious water quality is observed in drainage from the surface stockpiles or underground.

The third objective is to outline the process for establishing suitable waste rock for use in the construction of pads, roads or other construction uses consistent with the flexibility authorized under Agnico- Hope Bay’s Type A and B licences. Waste rock that is determined suitable for construction is not considered waste rock once utilized as such.

1.2 Scope of the Plan

The design of the management plan is consistent with Agnico– Hope Bay’s current mine and closure plans. Specifically:

- Waste rock brought to surface will ultimately be placed as structural backfill in an underground mine. At closure, no waste rock will remain on surface, except for rock that has been characterised as suitable and utilized for construction of surface infrastructure.
- The waste rock will not be segregated on surface based on geological management units.
- The management and monitoring of detoxified tailings from the both Doris and Boston processing plants.
- Management of quarry rock that is placed on the waste rock stockpile for its intended use as mine backfill.
- The geochemical requirements to demonstrate the geochemical suitability of waste rock for use as construction material.

Furthermore, this plan:

- Superceds TMAC's *Waste Rock and Ore Management Plan, Hope Bay Project, Nunavut* (TMAC 2019) dated March 2019, which was approved under 2AM-DOH1335.
- Supercedes TMAC's *Waste Rock and Ore Management Plan, Hope Bay Project, Nunavut* (TMAC 2016) dated August 2016, which was approved under 2AM-DOH1323 Amendment No.1 Water Licence.
- Updates and supercedes the *Overview of Madrid North and Madrid South Bulk Sample ML/ARD Characterization Programs and Conceptual Waste Rock Management Plan*, dated December 2014 (SRK 2014) as required under the Madrid Advanced Exploration Project 2BB-MAE1727 Water Licence.
- Does not address the waste rock and ore currently on surface at Boston camp as part of underground exploration carried out in 1996/97. The management plan for these materials is documented in the *Water and Ore/Waste Rock Management Plan for the Boston Site, Hope Bay Project, Nunavut* (TMAC 2017a) dated January 2017 as part of the Boston Advanced Exploration Project 2BB-BOS1727 Water Licence.
- Supersedes TMAC's Waste Rock, Ore and Mine Backfill Management Plan (December 2017) which was submitted and reviewed for permitting of the Phase 2 Madrid-Boston Project.

1.3 Background

The Hope Bay Project is a gold mining and milling undertaking of Agnico. The Project is located 705 km northeast of Yellowknife and 153 km southwest of Cambridge Bay in Nunavut Territory, and is situated east of Bathurst Inlet. The Project comprises three distinct areas of known mineralization plus extensive exploration potential and targets. The three areas that host mineral resources are Doris, Madrid, and Boston.

In 2010 and 2011, approximately 2,670 m of lateral and 76 m of vertical underground development were completed at the Doris Mine by HBML. This development resulted in production of approximately 183,000 t of waste rock, including 86% non-mineralized and 14% mineralized waste rock. Additionally, 329 m of ore development occurred resulting in the production of 9,400 t of ore (HBML 2012).

Throughout this period, HBML placed the rock according to the approved interim management plans described in Revision 01 of the Waste Rock Management Plan (SRK 2010), which included segregation of mineralized and non-mineralized waste rock within the footprint of the Temporary Waste Rock Pad (on Pad I; Pads F and G were temporarily used as laydown areas), and placement of ore on Pads Q and H/J). HBML's waste rock program included segregation of waste rock based on lithology and sulphide content to create a stockpile of waste rock with low risk of ML/ARD. The segregation program was designed to meet the objectives of the HBML mine plan and closure objectives, specifically using the segregated stockpile of low risk ML/ARD waste rock as construction material and/or leaving this stockpile on surface at closure.

No underground development occurred during 2012-2014. TMAC re-opened the Doris mine in 2015 and constructed Pad I for waste rock storage. Consistent with TMAC's mine plan (TMAC 2015) and revised waste rock management plan (SRK 2015), waste rock was not segregated on Pad I and a new pad (Pad T) was constructed. Pad T is currently the main Temporary Waste Rock pad and ore is being stockpiled around the perimeter of Pad T according to the approved Revision 4 of the Waste Rock and Ore Management Plan (TMAC 2016).

Waste rock stockpile material are maintained, including volumes of:

- Waste rock placed on the stockpile, according to deposit;
- Detoxified tailings placed on the stockpile;
- Quarry rock placed on the pad, according to source Quarry;
- Backfill, as either rock or detoxified tailings, returned to the mine; and
- Voids created in the mine.

1.4 Relevant Legislation and Guidance

The following table lists federal and territorial regulations governing the management of waste rock and ore and associated guidelines.

Table 1-1. Regulations and guidelines pertinent to the Hope Bay Project, Waste Rock, Ore and Mine Backfill Management Plan

Regulation	Year	Governing Body	Relevance
Nunavut Waters Regulation (NWB 2013)	2013	Nunavut Water Board (NWB)	License for mining and milling undertaking to use water and deposit of waste in relation to the construction, operation, closure and reclamation.
Mine Health and Safety Act and Regulations (WSCC 2011)	2011	Workers' Safety and Compensation Commission (WSCC)	Waste rock pile design and operations safety requirements. Designs to be approved by Chief Inspector.
Guideline	**Year**	**Issued by**	**Relevance**
Prediction Manual for Drainage Chemistry for Sulphidic Geologic Materials, Report 1.20.1 (MEND 2009)	2009	Mine Environmental Neutral Drainage (MEND)	Guidance on determining the type, magnitude, location and timing of measures required to prevent significant environmental impacts by drainage from disturbed rock.
Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest Territories (MVLWB/AANDC 2013)	2013	Aboriginal Affairs and Northern Development Canada (AANDC) and the Mackenzie Valley Land and Water Boards (MVLWB)	Guidance on closure and reclamation expectations.

1.5 Related Documents

Table 1-2 provides a list of documents to be considered in conjunction with this Plan.

Table 1-2. List of documents related to the Hope Bay Project, Waste Rock, Ore and Mine Backfill Management Plan

Document Title	Year	Relevance
Hope Bay Project Boston Water Management Plan (TMAC 2017b)	2017	Identifies water management areas, facilities and procedures
Hope Bay Project, Quarry Management and Monitoring Plan (AEM 2022a)	2022	Describes management of rock for all Phase 1 and Phase 2 quarries, including identification of quarry rock suitable for use as construction material and/or mine backfill. Monitoring programs for quarry rock is outlined.
Hope Bay Spill Contingency Plan (AEM 2022b)	2022	Spill response procedure
Air Quality Management Plan (TMAC 2017c)	2017	Outlines how fugitive dust, associated with blasting, hauling and end dumping is managed and monitored.
Hope Bay, Explosives Management Plan (TMAC 2017d)	2017	Contingency procedure for disposal of spilled ANFO
Kinetic Testing of Waste Rock and Ore from the Doris Deposits, Hope Bay (SRK 2015b) and Supporting Data (SRK 2015c)	2015	Geochemical characterization of waste rock, ore, quarry rock and detoxified tailings. Source term estimates for rock stockpiles and underground mines containing backfill.
Static Testing and Mineralogical Characterization of Waste Rock and Ore from the Doris Deposit, Hope Bay (SRK 2015d) and Supporting Data (SRK 2015e)	2015	
Doris Madrid Water Management Plan (AEM 2022c)	2022	Identifies water management areas, facilities, procedures and SNP monitoring for contact water from surface stockpiles and underground mine.
Groundwater Management Plan (AEM 2022d)	2022	Identifies underground sump water monitoring procedures.

1.6 Plan Management

This Plan is reviewed annually and updated as necessary. Revisions to the Plan will be submitted as necessary to address future water licence conditions. Personnel responsible for implementing and updating the Plan identified in Table 1-3.

Table 1-3. Roles and Responsibilities

Role	Responsibility
Mine General Manager	• Overall responsibility for implementation of this management plan • Provide the on-site resources to operate, manage, and maintain waste rock and ore management infrastructure such as pads, stockpiles and ponds • Ensure underground practices are continually improved to reduce brine and blast residues in waste rock • Provide input on modifications to handling and operational procedures to improve operational performance
Geotechnical Engineer (alternate: Mining engineer)	• Conduct regular inspections of the pads, stockpiles and containment ponds to determine compliance with the plans, regarding, slopes, volumes, safety berms, snow removal etc • Provide deposition plan and guidance to Mill Operations Supervisor • Facilitate Geotechnical Inspection, when required • Update and manage design and deposition plan
Environmental Superintendent	• Updating the Plan; • Providing the necessary resources for completing the water sampling programs; • Coordinate: - Waste Rock and Quarry Monitoring Report; and - Monthly Monitoring Report.
Environment Coordinator	• Ensure water sampling programs are completed as needed; • Keeping records of onsite analysis, observations, photographs, and laboratory analysis; • Conduct or facilitate seep sampling program on surface and underground as required; and • Conduct monthly and annual regulatory reporting as required
Mine Geologist	• Execute construction qualification sampling program to identify the material as non-PAG.; • Inspect the working face on a regular basis to confirm geology • Instruct the mucking crew regarding waste rock and ore placement on surface
Underground Supervisor	• Ensure removal waste rock and placement ore in the intended and designated location • Ensure removal of detoxified tailings from surface to underground
Construction Supervisor	• Ensure use of waste rock confirmed as non-PAG material for construction • Provide quantities of waste rock used for construction to mine engineer monthly
Mine Engineer	• Record quantity of material sent to each of the stockpiles in daily record • Record quantity, source and destination of backfill material sent to underground in daily record

	• Provide waste rock and backfill movement totals to Environment Superintendent monthly • Provide long term material balance to Geotechnical Engineer for planning, design and compliance purposes • Provide monthly topographic survey of the waste pile to the Geotechnical Engineer
Mill Operations Supervisor	• Coordinate the removal of Detoxified tailings with Underground Supervisor to ensure timely removal to underground • Follow and ensure compliance with deposition plan including snow removal for the Doris Ore and Waste pads • Provide guidance to Underground Supervisor for the removal of waste rock and placement of ore at surface
Site Services Supervisor	• Ensure placement of waste rock and removal of ore in the intended and designated location for the Madrid area • Ensures snow removal at the Madrid Waste Rock Management area

2 Waste Rock, Ore and Backfill Management Issues

2.1 Waste Rock Stockpile – Metal Leaching and Acid Rock Drainage (ML/ARD) Potential

The mine plans for all Hope Bay mines includes placement of structural backfill in the underground. Backfill material types include waste rock, detoxified tailings and/or quarry rock, depending on the specific mine (Table 2.1). On surface, all backfill materials will be placed on the waste rock stockpile prior to placement in the underground stopes. At closure, there will be no waste rock and detoxified tailings remaining on surface pads.

Contact water chemistry from waste rock stockpile materials will be a result of metal leaching and/or acid rock drainage (ML/ARD) due to the weathering of sulphide minerals. Due to the high carbonate content of rock at Hope Bay, the risk of ARD for the waste rock stockpile is low however, neutral pH drainage issues can occur, depending on the mine, as discussed below.

Table 2.1. Sources of structural backfill

Mine	Backfill Source
Doris	• Doris waste rock • Detoxified tailings from Doris processing plant
Madrid North	• Madrid North waste rock • Doris waste rock • Madrid South waste rock • Detoxified tailings from Doris processing plant • Quarry rock
Madrid South	• Madrid South waste rock
Boston	• Boston waste rock • Detoxified tailings • Quarry rock (including all rock from Quarry AD)

2.2 Geochemical Characterization of Mine Backfill

This section discusses the geochemistry of waste rock, quarry rock and detoxified tailings. For context, the geochemistry of ore is also presented. Contact water from the temporary waste rock stockpile pad is projected to remain pH neutral. At closure, there will be no materials on the waste rock stockpile as all material will be placed as backfill underground.

2.2.1 Waste Rock

The geochemistry of waste rock varies according to geological deposit and is therefore discussed according to each mine. The geochemical characterization program for waste rock is documented in SRK (2015b, 2015c, 2015d, 2015e, 2017a, 2017b and 2017c). The results of operational monitoring of Doris waste rock are also documented (e.g. SRK 2017j). This section presents a summary of the geochemistry of waste rock from each mine.

Doris

The baseline geochemical characterization program indicated that the majority of the samples were classified as non-potentially acid generating (non-PAG). Most of the samples classified as PAG or uncertain were classified as ore or as a mixture of ore and waste rock. Diabase and some of the hornfelsed basalt had low sulphide, NP and TIC content, and were classified as PAG or uncertain on the basis of low NP/TIC ratios, but contained such low concentrations of sulphide that buffering by silicate minerals is likely to be sufficient to maintain neutral pH conditions in these rocks. The risk of ARD/ML from Doris waste rock is low and demonstrated by operational monitoring of waste rock and associated seepage (e.g. SRK 2017j).

Madrid North

The most volumetrically significant waste rock lithology is mafic metavolcanics (1)[1]. The ore is also hosted in the mafic metavolcanics (1). Mafic volcanics with sediments (1oj, 1aj or 1aj), intermediate volcanics (2p, 2pg), sedimentary units (5) and the deformation zone (13a) are volumetrically less significant waste lithologies that are projected to be intersected by the mine workings based on the geological logging. Additional volumetrically minor units include mafic volcanics with sediments (1oj, 1aj), intermediate volcanics (2p, 2pg), early gabbro (7a), late mafic intrusive rocks (10b), diabase (11c) and quartz veins (12q).

The waste rock sample set was typically characterized by low sulphur levels, with 90% of samples having total sulphur contents less than 0.43%. Carbonate minerals were generally ubiquitous and abundant. Ferroan dolomite was the dominant carbonate mineral though calcite was the dominant carbonate mineral in selected rock types. Median levels of NP and TIC for mafic metavolcanics is greater than 240kg$CaCO_3$/t. All other rock types except mafic intrusives and diabase, had median NP and TIC levels greater than 100 kg $CaCO_3$/t.

Samples of ore contained the highest median total sulphur levels, which included rock types mafic metavolcanics (1 ore and 1 ore/waste), mixed mafic metavolcanics (1 mixed) and mixed sedimentary units (5 mixed). These gold-bearing samples had median values of NP and TIC of 120 and 140 $CaCO_3$/t, respectively.

The acid-base accounts ($TIC_{(Ca+Mg)}$/AP) resulted in more than 95% of samples classified as non-PAG, where $TIC_{(Ca+Mg)}$ is the effective TIC and addresses the potential overestimation of neutralization potential due to the presence of NP-neutral iron carbonates. The rock types classified as PAG (sedimentary units and early gabbro) are projected to represent less than 4% of the volume of waste rock. Kinetic test work indicates arsenic, antimony, cobalt, molybdenum and nickel leaching are potential issues at neutral to alkaline pH values.

[1] Denotes TMAC lithological codes

Madrid South

The most volumetrically significant rock types for the Madrid South deposit include mafic to ultramafic metavolcanics (1), intermediate volcanics (2), and late porphyry granitoids (9). Less significant rock types characterized include quartz veining (12q), which is associated with gold mineralization, intermediate to felsic volcanics (3ao), early gabbro intrusives (7), late gabbro intrusive (10a), late mafic dykes (10b), and carbonate vein (12c).

The waste rock and ore samples were characterized by low sulphur content, with 95% of samples containing less than 0.5% total sulphur. Levels of NP and TIC were high (median values for all rock types greater than 75 kg$CaCO_3$/t). All samples were classified as non-PAG.

The potential for ARD from Madrid South waste rock is low. Neutral pH metal leaching from the relatively small proportion of samples that contain higher sulphur concentrations is of concern, specifically related to arsenic and, to a lesser extent, cobalt, copper, nickel, molybdenum and uranium.

Boston

The most volumetrically significant waste rock lithologies are mafic metavolcanics (1) and sedimentary units (5). The ore is hosted in quartz veins (12q), mafic metavolcanics with sediments (1oj) and mafic metavolcanics (1). Mafic metavolcanics with sediments (1oj), late intermediate dyke (9n) and late gabbro (10a) are volumetrically less significant waste lithologies.

Sulphur levels for Boston (75th percentiles of 0.38%) were higher than Doris, Madrid North, and Madrid South (0.26, 0.28 and 0.11%, respectively). NP and TIC values were high (median values for all rock types greater than 85 kg $CaCO_3$/t).

The risk of ARD for Boston is low, with approximately 95% of the overall sample set classified as non-PAG. Boston ore samples were characterized by higher levels of total sulphur compared to waste. The humidity cell tests data indicated that arsenic leaching is related to solid-phase arsenic content, and arsenic, antimony, cobalt and nickel leaching are potential issues at neutral to alkaline pH values. Compared to the other Hope Bay deposits, arsenic content for mafic metavolcanics from Boston were higher than Madrid South and generally comparable to Madrid North.

2.2.2 Quarry Rock

Quarry rock typically has a low risk for ARD/ML and is suitable for use as construction material. It is anticipated that the majority of quarry rock backfill will have a low risk for ARD/ML. Quarries containing PAG rock that would be developed (e.g. Quarry AD where the Boston mill pad will be developed) will be used as mine backfill only. The *Hope Bay Quarry Management Plan* outlines management of quarry rock (AEM 2022a).

2.2.3 Detoxified Tailings

Detoxified tailings have high sulphide content and are classified as PAG (SRK 2015f and 2017d). Kinetic testing indicated that sulphate, cobalt, manganese, nickel and selenium leaching at neutral to alkaline pH conditions. The projected onset to acidity for detoxified tailings is 20 years (SRK 2015f). The residence time of detoxified tailings on surface will be less than this period, therefore drainage from detoxified tailings is expected to be neutral to alkaline pH during operations.

2.2.4 Management Response

Backfill Materials Management on Surface

Backfill material types include waste rock, detoxified tailings and/or quarry rock, depending on the specific mine (Table 2-1). On surface, all backfill materials will be placed on the waste rock stockpile prior to placement in the underground stopes. Backfill use and available mine void space will continuously be monitored to ensure that all backfill materials can be placed underground as proposed. At closure, there will be no mineralized waste rock and detoxified tailings on surface. The current LOM of Doris also includes Cemented rockfill (CRF) for the DCN area. Although this does not significantly affect the waste material balance, the CRF will be tracked separately from the regular backfill (waste rock only). The management of each backfill type is discussed below.

Waste Rock

All mineralized waste rock from Doris, Madrid South, Madrid North and Boston will be placed as backfill in the underground stopes Waste rock on surface will be placed on the waste rock stockpile pad.

Quarry Rock

Waste rock volumes from Doris and Madrid South are sufficient to meet structural backfill requirements, however Madrid North and Boston require imported sources. Once all mine waste rock has been exhausted, quarry rock will be developed and used for structural backfill underground.

As stated in the *Hope Bay Quarry Management and Monitoring Plan* (AEM 2022a), all quarry rock classified as PAG will be placed on the waste rock stockpile for placement as underground backfill. This includes all quarry rock from Quarry AD during the construction of the mill pad at Boston. The rock will be stockpiled in the waste rock storage area prior to placement underground.

Detoxified Tailings

Detoxified tailings from the Doris processing plant are transferred underground in the Doris mine as they are generated. Later in the mine life, detoxified tailings from the Doris processing plant will be placed as backfill in the Madrid North mine. Detoxified tailings from the Boston processing plant will be placed as mine backfill in the Boston mine. Once all mine waste rock has been exhausted, detoxified tailings will be mixed with quarry rock during this period.

Detoxified tailings will be filtered in the plant with free water recirculated as a closed loop within the facility. Once filtered, the dry “filter cake”, which has a saturation of about 80%, has no free water. The dry filter cake can be handled with conventional earthmoving equipment. This filter cake will be trucked from the filter belt stockpile within the plant to underground workings or the waste rock storage area as needed. It will be placed immediately adjacent to, or on top of, waste rock material that is designated for backhaul to the mine as underground backfill. As waste rock material is loaded for use as underground backfill, detoxified tailings (when available) will be included in appropriate proportions to ensure the structural backfill requirements continue to be met. These tailings will be moved underground into voids that will remain frozen within permafrost. Due to the inherent moisture content in the material there will be no requirement for dust suppression.

Designated Surface Facilities and Water Management

All seepage and runoff from the waste rock stockpile pads are directed to downstream lined collection ponds and managed according to the water management plans (TMAC 2017b, AEM 2022c). Contact Water Ponds are monitored as part of the Surveillance Network Program (SNP) monitoring network.

Doris

The permitted surface facilities in the Doris camp and processing plant area are shown in Figure 2.1. The site is currently divided into a series of adjoining rock pads that provide a foundation for all of the facilities in this area. The pads on the eastern half of this area (Pads D, F, G, H/J, I, Q and T) are located within the Pollution Containment System, which drains to a Pollution Control Pond (PCP) at the southern edge of the pad complex and collection sumps located at the southeast corner of the pad area. The processing plant is located on Pad D. Pad U has a dedicated PCP as it is located adjacent to the existing Pollution Containment System. Pad T is the current main Temporary Waste Rock Pad. Pads I, F and G have been and may continue to be utilized for temporary waste rock storage. Water collected at the PCPs and collections sumps is discharged to the Doris Tailings Impoundment Area (TIA).

Madrid North

The proposed surface facilities for Madrid North mine and concentrator plant are shown on Figure 2.2. The concentrator will process the Madrid North ore through a flotation circuit. The resulting flotation tailings will be pumped via pipeline and deposited in the Doris TIA. The Madrid North Contact Water Pond (CWP) will capture contact water from the Madrid North concentrator area, ore stockpile, and waste rock stockpile. The Madrid North (CWP) will be dewatered to the Doris TIA.

Madrid South

Madrid South surface facilities are shown on Figure 2.3. The Madrid South Primary CWP captures contact water within the Madrid South ore stockpile and waste rock stockpile. The Madrid South Primary CWP will be dewatered to the Doris TIA. All ore from Madrid South will be trucked to Doris for processing.

Boston

Waste rock and ore stockpile contact water at the Boston mine site will be collected in two CWPs (Figure 2.4). CWP #1 will collect runoff from the waste rock pile. The outflow from contact water pond #1 will be a pumping station directing contact water to CWP #2, and ultimately the Boston water treatment plant. CWP #2 will capture runoff from the infrastructure pads containing the process plant, ore stockpile and camp. Excess water from CWP #2 will flow over a spillway into the connected surge pond. The surge pond will be a lined facility, which will have a pipeline directly to water treatment plant.

Volume Tracking and Mine Void Space

Backfill volumes will be tracked together with the mine plan, which contains available mine void space at any given time in the mine life. This record indicates progress towards ensuring that all mine waste is placed underground prior to the completion of mining. Backfill volume tracking will include tracking of waste rock, detoxified tailings and quarry rock placement underground.

Monitoring

All monitoring of backfill materials temporarily stored on the waste rock stockpile pad is discussed in Section 3.1.

2.3 Underground Mine Backfill - Metal Leaching and Acid Rock Drainage (ML/ARD) Potential

Section 2.1 summarizes the geochemical properties of all backfill materials.

Mining of the Doris, Madrid North and Madrid South deposits is within permafrost but selected areas of the mine will intersect talik resulting in intercepted groundwater. The Boston mine is entirely within permafrost and accordingly, there will be no management of source load (water chemistry) resulting from mine backfill.

SRK (2017e) presents operational source term drainage chemistry estimates for the underground mine backfill based on the interaction of mine backfill with intercepted groundwater. At closure, all mine workings will be allowed to flood. When the mine is reflooded, all backfill will be either submerged or within permafrost, and therefore not oxidizing. The reflooded mine backfill source terms represent pore water chemistry in the mine "pool" or flooded portion of the mine workings when the water level is first allowed to recover, and oxidation products that have accumulated on the backfill material are released into the porewater. These source loads are considered backfill contact water and do not include the water chemistry of groundwater. The site-wide water and load balance combines the loads from mine backfill and groundwater sources (SRK 2017f). The source terms indicate that for operations and closure, backfill contact water chemistry at each mine will be pH neutral.

2.3.1 Management Response

Backfill

The mine plans for all Hope Bay mines includes progressive placement of structural backfill in the underground during operations. Backfill material types include waste rock used for rockfill and cemented rockfill , detoxified tailings and/or quarry rock, depending on the specific mine. At closure, there will be no waste rock or detoxified tailings remaining on surface.

Water Management

The management of groundwater is presented in the Hope Bay Groundwater Management Plan (AEM 2022d). A synopsis for each mine is presented.

Doris, Madrid North and Madrid South

Intercepted groundwater will be collected in underground sumps and pumped to surface, from where it will be discharged to the marine mixing box in Roberts Bay.

Boston

The Boston Mine will be completely within permafrost, and no groundwater interception is anticipated (SRK, 2017g). The management of any unplanned groundwater interception is presented in the Hope Bay Groundwater Management Plan (AEM 2022d).

Monitoring

The monitoring of mine backfill and underground mine drainage is discussed in Section 3.1.

2.4 Ore Stockpile - Metal Leaching and Acid Rock Drainage (ML/ARD) Potential

The material from the stopes is classified as ore and will be processed in the mill. The ML/ARD potential of ore from each deposit is summarized in Section 2.1. This material tends to have a higher sulphide content and lower NP and TIC. Ore is more likely to be classified as uncertain or PAG. However, there is sufficient NP present that the development of acidic conditions is unlikely to occur during the short time that this material will be stockpiled on surface.

2.4.1 Management Response

Ore is temporarily stockpiled on surface prior to being processed in the mill to extract the gold. The ore stockpiles locations and associated water management are discussion in Section 2.1.1 (Designated Surface Facilities and Water Management).

There are no separate monitoring requirements for the ore stockpile.

2.5 Nutrient Release from Explosives

The majority of waste rock is blasted using a bulk form of ammonium nitrate and fuel oil mixture (ANFO). Nutrients may be released during mining from ANFO residue on rocks, packaging or ANFO spills. ANFO can be highly water soluble, with runoff able to release ammonia, nitrate and nitrite to the receiving environment.

2.5.1 Management Response

Surface Water Management

Water flows and seepage from waste rock and ore piles are captured in a series of ponds designed to prevent direct discharge of potentially contaminated water to the environment. All waste rock and ANFO-contaminated material will routinely be placed underground throughout operations and completely at closure.

Drainage collected in the Doris and Madrid ponds are transferred to the Doris Tailings Impoundment Area (TIA) whereas drainage in the Boston ponds will be transferred to the surge pond for treatment to the Boston water treatment plant.

Groundwater Management

Material from clean-up of ANFO spills will only be placed in permafrost areas of the mine to limit mobility of nutrients.

Minimization of Residual ANFO during Detonation

Any wet holes will be evident at the time of drilling and during the cleaning of each blast hole. The blaster, being responsible for the loading and firing of the holes, begins the loading process by checking the actual depth of each hole and records unusual conditions, such as water in the blast-holes. The inadvertent loading of ANFO into a wet blast hole could result in residual from an incomplete detonation of the product. In the event a wet hole is encountered, one of two charging methods is employed to ensure complete detonation of the explosives:

- The hole is dewatered using compressed air. This is common on the bottom (lifter) holes in underground mining.
- If the hole cannot be dewatered, or if it is seeping water, the hole will be loaded with an alternative explosive that is effective under wet conditions.

After blasting, the blaster is required by regulations to inspect the blasted area, make note of blast holes that may have experienced incomplete detonation, and mark those locations with paint. Information from the blaster's inspection will be noted in the daily operations shift log and will be communicated to all underground supervision personnel.

Material considered un-detonated or high in ANFO residue, which will contain potentially elevated level of nutrients (primarily ammonia), will be used for backfill of permafrost areas of the mine.

Minimization of ANFO Spills

To minimize the risk of spills during loading, the loader hose is pushed to the end of the hole and is slowly withdrawn as the ANFO is blown into the hole, thereby filling the hole. Once the end of the loading hose is near the top (collar) of the hole, the loader is stopped to prevent spillage of ANFO.

In the unlikely event that a spill of ANFO occurs during charging of the blast holes, the ANFO will be cleaned-up immediately upon the completion of all loading operations, in accordance with the Spill Contingency Plan (AEM 2022b). Spilled ANFO will be reused where possible, or deposited in a designated areas for use in backfill of permafrost areas of the mine only.

2.6 Underground Brine Water

Water is used as a lubricant for drilling, as a means of cleaning off the face and walls for geological mapping, and for dust suppression in the underground mine. Salt may be added to the make-up water to lower the freeze point and thereby keep the water supply lines from freezing. This water is called underground brine water. Any excess brine water that ends up at the mine face is pumped to a settling sump and is recycled for use at the face. However, some of the water is absorbed by the blasted rock, which is hauled to the surface stockpiles.

Excessive use of salt can result in impacts to the structural integrity of infrastructure components arising from ground thaw, increased or alternative requirements for wastewater treatment and disposal, increased challenges associated with waste rock and tailings disposal and stabilization, and limitations on using the waste rock for construction.

Agnico has procedures for reducing the concentration and amount of brine that is used in the underground mine. These procedures are outlined below. The *Hope Bay Groundwater Management Plan* (AEM 2022d) provides details on the collection and fate of underground sump water management.

2.6.1 Management Response

Agnico Hope Bay follows a Low Salt Underground Brine Water Use Procedure to minimize the amount of calcium chloride use in the mine, and therefore minimize the amount of salt that is entrained in waste rock and ore. The procedure includes:

- locating brine mixing tanks in the mine or within an enclosure to control temperatures, and thereby limit the amount of salt used in the brine;
- using hose nozzle atomizers and/or foggers to reduce the amount of water used for dust suppression; and
- recycling brine water during drilling activities, bolt inflation, and washing activities.

2.7 Fuel and Lubricants

Any fuel or lubricant spills, including leaks from mobile equipment, have the potential to become mixed with the waste rock; and therefore, effect the quality of water entrained in the waste rock. Therefore, prevention and management of spills is particularly important for ensuring that the waste rock can be used for construction activities outside of the Pollution Containment System.

2.7.1 Management Response

If re-fuelling of mobile equipment is required in the mining or waste deposition areas, it will be conducted at a location and time that will ensure that any spill of fuel or lubricants will be effectively contained and clean-up can be easily accomplished.

Every operator is required to inspect their light or heavy equipment at the beginning of every shift. In the event that leaks are detected, the vehicle will be taken out of service and must be repaired prior to resuming use.

In the unlikely event that a spill occurs, clean-up of the spilled material will be initiated immediately as per the requirements specified in the Spill Contingency Plan.

Hydrocarbon contaminated rock will be placed in a designated area of the mineralized waste rock piles, for use in backfill of permafrost areas of the mine only.

2.8 Dust

Fugitive dust can arise from blasting, haul traffic and end dumping. Fugitive dust poses a potential risk to human and ecological health through both ingestion and deposition.

2.8.1 Management Response

The Air Quality Management Plan (TMAC 2017c) outlines procedures for managing fugitive dust including:

- Watering traffic surfaces and active end dumping areas;
- Controlling vehicle speeds; and
- Applying approved dust suppressants to high traffic areas.

2.9 Geotechnical Stability

The stability of the waste rock piles is an important consideration for traffic safety and for containment of the waste rock.

The waste rock piles are designed such that the foundation pad extends 2.5 to 3 m beyond the toe of the waste rock pile. The outer edge of the pads also have a safety berm that will prevent any large boulders from rolling off of the pad during construction. The waste rock piles have been designed with slopes of 2H:1V, and will be constructed in lifts, which will result in a configuration that provides a high degree of geotechnical stability. Stability calculations confirm that there are no stability concerns associated with stockpile design.

2.9.1 Management Response

Based on a factor of safety (FOS) of 1.0, a minimum safe distance from the crest of the waste rock pile (1.2 m) should be maintained for haul trucks dumping waste rock close to the crest of the waste rock pile.

3 Monitoring and Evaluation

3.1 Mine Backfill Monitoring

As previously discussed, drainage from all surface stockpiles (ore and waste rock) and from the Doris, Madrid North and Madrid South underground mines are expected to be pH neutral with potential metal leaching, particularly arsenic. The water management plan is designed to address understood issues related to water quality and associated water treatment. As such, the monitoring program for mine backfill materials (waste rock, quarry rock and detoxified tailings) was designed to generate the required data set to support any unanticipated drainage quality and associated mitigative measure in consideration that characterization of mine backfill materials is more practical before placement underground. The objectives of the geochemical monitoring plan are described as follows:

- Monitor water quality from waste rock stockpiles and the underground as an indicator of the geochemical performance of backfill materials with respect to ML/ARD;
- Monitor the geochemical properties (ML/ARD) of the waste rock, quarry rock and/or detoxified tailings placed underground in each mine; and
- Inventory quantities of each material type placed as backfill according to the mine plan, including cemented rockfill;

Table 3-1 summarizes the operational monitoring programs, including program objectives and monitoring. An overview of the programs includes:

- Inventory of available backfill
- Maintaining records of backfill volumes according to material type (waste rock, detoxified tailings and quarry rock);
- Geological mapping inventory of waste rock from the underground workings;
- Annual inspections of the waste rock stockpile, including a freshet seepage survey and waste rock sampling program;
- Geochemical monitoring of detoxified tailings and quarry rock backfill; and
- Routine water quality monitoring of contact water quality from surface stockpiles and underground mine sumps.

Table 3-1. Overview of Mine Backfill Monitoring Programs and Objectives for Doris, Madrid North, Madrid South and Boston

Component	Report Section	Monitoring Program	Objective	Frequency
Waste Rock	3.1.1	Material handling records	• Inventory of waste rock backfill, including source mine.	• Reported monthly
	3.1.2	Routine geological mapping of blast round face and back[2]	• The geochemical characterization of waste rock for each mine was determined according to rock type therefore, the operational inventory of waste rock geology also provides an inventory of baseline ML/ARD potential of waste rock backfill, e.g. SRK 2017a.	• As determined by geology
	3.1.3	Annual inspection of waste rock stockpile and geochemical characterization of waste rock	• Visual inspection of waste rock stockpile and sampling and geochemical characterization of waste rock for comparison with baseline geochemical characterization, e.g. SRK 2017a.	• Annually
	3.1.4	Annual seepage monitoring	• Monitor stockpile contact geochemistry and confirm appropriate capture of contact water	• Annually at spring freshet
Detoxified Tailings	3.1.1	Material handling records	• Inventory of tailings placed as backfill	• Daily
	3.1.5	Geochemical characterization of detoxified tailings	• Geochemical characterization of detoxified tailings for ML/ARD potential.	• Monthly
Quarry Rock	3.1.1	Material handling records	• Inventory of quarry rock placed underground, including source quarry.	• Reported monthly
	3.1.6	Geochemical characterization of quarry rock (as backfill)	• Geochemical characterization of quarry rock used as backfill.	• Two samples per year when quarry active.
Waste rock stockpile	3.1.7	Water quality monitoring of contact water in downstream collection ponds.	• Monitor water chemistry from waste rock stockpiles	• Monthly
Ore stockpile	3.1.7	Water quality monitoring of contact water in downstream collection ponds.	• Monitor water chemistry of waste rock and ore stockpiles.	• Monthly
	3.1.4	Annual seepage monitoring	• Confirm appropriate capture of contact water	• Annually at spring freshet
Underground mine	3.1.2	Mine void space	• Inventory of available mine void space for backfill	• Reported monthly
	3.1.7	Water quality monitoring of mine sumps	• Monitor water chemistry of underground mine (mine backfill, blast residues and drilling brines)	• Monthly

[2] Conducted as part of the mine geological mapping program

3.1.1 Backfill Volume Tracking and Mine Void Space

Backfill volumes will be tracked together with each mine plan, which contains available mine void space at any given time in the mine life. This record indicates progress towards ensuring that all mine waste is placed underground prior to the completion of mining. Backfill volume tracking will include tracking of waste rock used for rockfill and cemented rockfill , detoxified tailings and quarry rock placement underground. As discussed in Section 3.1, waste rock geochemistry varies by mine and quarry rock geochemistry can vary by quarry. Accordingly, the volumes of waste rock and quarry rock backfill will also be traced according to source location to allow for geochemical tracking of backfill. This is in relation to Madrid North, which has waste rock backfill also sourced from the Doris and Madrid South mines. Quarry rock from multiple sources may also be placed as backfill at Madrid North and Boston.

3.1.2 Geological Mapping of Mine Workings

Geology routinely conducts geological mapping of each blast round within the underground workings. This program includes logging of the waste rock lithology, thereby allowing the tracking of waste rock according the ML/ARD potential, as established by the geochemical characterization program of waste rock and ore, e.g. SRK 2017x. The operational geochemical monitoring of waste rock is discussed in Section 3.1.3.

3.1.3 Annual Inspections and Geochemical Characterization of Waste Rock

Material in the waste rock stockpiles is inspected by a qualified geochemist on an annual basis. The purpose is to examine the waste rock for signs of sulphide oxidation and weathering, and conduct the operational waste rock geochemical monitoring program.

A representative sample set of the waste rock in the stockpile will be collected (approximately 5 to 20 samples based on volume and geology. Both location of origin and the location where the material is placed in the waste rock pile will be established and recorded. The samples will be submitted to a commercial testing laboratory for full ABA (including total sulphur, sulphur speciation, inorganic carbon, and modified Sobek NP), TIC and trace metals by ICP digestion. The -2 mm fraction of a subset of samples will be submitted for shake flask extractions to assess the soluble content, including residues from blasting and drilling brines.

Samples will be approximately 1 to 2 kg in size. The following information will be recorded at the time of sampling:

- GPS coordinates of the sample location;
- Approximate location of where the associated waste rock was deposited (location in the pile);
- The name of the person who collected the sample;
- Date and time of sampling; and
- Geological description, including rock type, estimated sulphide and carbonate content.

Data from confirmatory testing and geological inspections would be compared to the baseline ML/ARD characterization of waste rock. Results of the inspections and waste rock geochemical characterization are provided in the annual report to the NWB.

In addition, annual visual inspections of all pads, berms and containment ponds by TMAC geotechnical engineer are to be completed to determine if the facilities are operating as designed and to assess maintenance requirements.

3.1.4 Seep Survey

Spring seep surveys are conducted to characterise metal leaching and confirm appropriate capture of mine backfill runoff. Areas include the down-gradient toe of the waste rock pile, and below the contact water ponds and associated pads.

Seep surveys are completed annually during freshet each year where mine backfill and material is stored on a surface pad. Seep surveys are completed along all safely accessible areas along the down-gradient toe of the mine backfill piles and pads below the PCPs and CWPs and access roads to the pads that contain mine backfill. The surveys are completed during the latter part of the spring freshet, concurrent with other seep surveys completed elsewhere on-site.

Seeps are identified by walking along the down-gradient toe of the roads, piles and pads looking and listening for signs of flowing water. Samples of seepage water are collected for analysis where seepage flow exits the pads to the surface. A survey stake is installed to mark the location of each seep sampled and the following information is recorded:

- Description of the seep location;
- Global positioning system (GPS) location of the seep;
- A photographic record of the seep;
- A description of the flow pattern and magnitude of flow; and
- Field pH, Chloride, Electrical Conductivity (EC), Oxidation reduction potential (ORP) and temperature readings.

Field pH, chloride, EC, ORP and temperature measurements are also to be established at reference sites located in a similar geological, and physiographic setting, but away from the influence of mine related activities. These reference stations may also be shared with the quarry monitoring programs.

In the immediate area of the waste rock pile, water samples are collected from all distinct seepage locations. Where there are clusters of seeps within 50 m of each other, the one with the dominant flow will be sampled, appropriately preserved, labelled, and submitted to an accredited laboratory for analysis. The following information is recorded per sample:

- The name of the person who collected the sample;
- Date and time of sampling; and
- Date of analysis.

Following receipt of analytical results, the following are maintained on-site to support annual Water Licence reporting and record keeping:

- Name of person who completed the analysis;
- Analytical methods or techniques used; and
- Results of the analyses, including pH, total dissolved solids (TDS), acidity and/or alkalinity, sulphate, total ammonia, nitrate, total cyanide, and a full suite of metals by ICP-MS.

3.1.5 Geochemical Monitoring of Detoxified Tailings

Confirmatory monitoring of detoxified tailings includes a monthly discrete sample to be analysed for total metals by aqua regia digestion, total sulphur by Leco furnace and direct measurement of total inorganic carbon.

Results of the monitoring are provided in the annual report to the NWB.

3.1.6 Geochemical Monitoring of Quarry Rock Backfill

The geochemical monitoring of quarry rock backfill is outlined in Section 3.1 of the Quarry Management plan. In brief, the geochemical characterization program includes collection and analysis of two samples per year when the quarry is operating.

Results of the monitoring program are provided in the annual report to the NWB.

3.1.7 Water Quality Monitoring

The water quality monitoring program includes the following:

- Monthly sampling of contact water ponds downstream of all waste rock and ore stockpiles for parameters indicative of ML/ARD, blast residues and drilling brine;
- Monthly sampling of underground mine sump water at Doris, Madrid North and Madrid South for parameters indicative of ML/ARD, blast residues and drilling brine;
- Monthly sampling of underground mine sump water at Boston for parameters indicative of blast residues and drilling brine;

Results of the monitoring program are provided in the annual report to the NWB.

3.1.8 Ore Stockpile

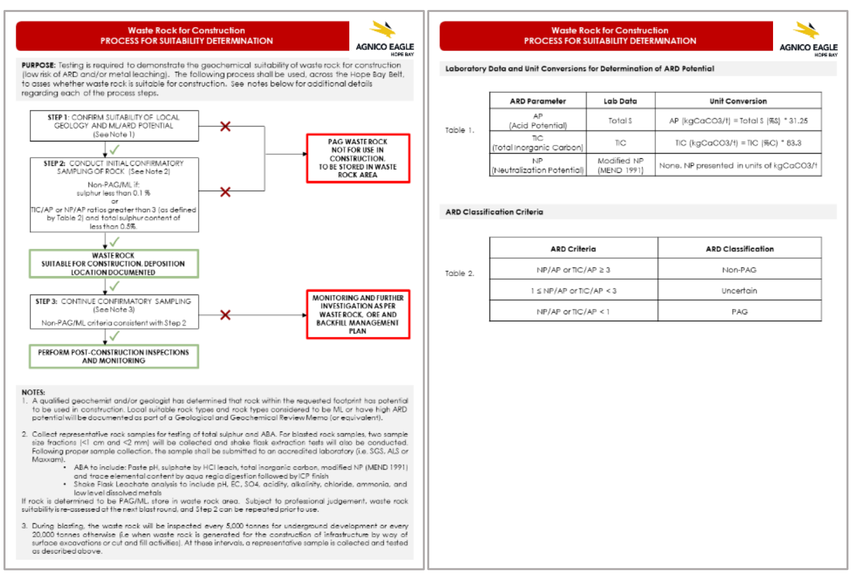
There are no specific monitoring requirements for the ore stockpile. The seepage and water quality monitoring programs also address the monitoring of contact water from this area.

3.2 Use of Waste Rock for Construction

Testing is required to demonstrate the geochemical suitability of waste rock for construction, including having a low risk of ARD and/or metal leaching. The control of drill brines and blast residues is managed at the source through operating procedures (Section 2.5 and 2.6) and monitored via the annual seep survey which evaluates the successful performance of these control measures.

Given the potential variability of waste rock within a given mine and between different mines (Section 2.1), each potential source needs to be assessed on a case-by-case basis. A process flow diagram titled ‘Waste Rock for Construction, Process for Suitability Determination’ (Appendix A), has been developed for use across the Hope Bay Belt to determine if a specific waste rock source is suitable for construction.

The process flow diagram provides the steps to determine if waste rock is suitable for construction. After the initial confirmation of suitability of the local geology and rock type, rock samples are submitted for testing prior to the onset of blasting, and then at a frequency of one sample for every 5,000 tonnes for underground development or every 20,000 tonnes otherwise (i.e. when waste rock is generated for the construction of infrastructure by way of surface excavations or cut and fill activities). At these intervals, a representative sample is collected as described in Appendix A. In the event that the results return a sulphur value of greater than (>) 0.1 % sulphur, the samples will be subjected to ABA and other confirmatory test work. The monitored parameters are consistent with the quarry rock sampling program which TMAC has performed successfully for many years. See Appendix A for complete diagram and details.



Waste Rock for Construction
PROCESS FOR SUITABILITY DETERMINATION

AGNICO EAGLE
HOPE BAY

PURPOSE: Testing is required to demonstrate the geochemical suitability of waste rock for construction (low risk of ARD and/or metal leaching). The following process shall be used, across the Hope Bay Belt, to asses whether waste rock is suitable for construction. See notes below for additional details regarding each of the process steps.

STEP 1: CONFIRM SUITABILITY OF LOCAL GEOLOGY AND ML/ARD POTENTIAL (See Note 1)

STEP 2: CONDUCT INITIAL CONFIRMATORY SAMPLING OF ROCK (See Note 2)
Non-PAG/ML if:
sulphur less than 0.1 %
or
TIC/AP or NP/AP ratios greater than 3 (as defined by Table 2) and total sulphur content of less than 0.5%.

PAG WASTE ROCK NOT FOR USE IN CONSTRUCTION. TO BE STORED IN WASTE ROCK AREA

WASTE ROCK SUITABLE FOR CONSTRUCTION. DEPOSITION LOCATION DOCUMENTED

STEP 3: CONTINUE CONFIRMATORY SAMPLING (See Note 3)
Non-PAG/ML criteria consistent with Step 2

MONITORING AND FURTHER INVESTIGATION AS PER WASTE ROCK, ORE AND BACKFILL MANAGEMENT PLAN

PERFORM POST-CONSTRUCTION INSPECTIONS AND MONITORING

NOTES:
1. A qualified geochemist and/or geologist has determined that rock within the requested footprint has potential to be used in construction. Local suitable rock types and rock types considered to be ML or have high ARD potential will be documented as part of a Geological and Geochemical Review Memo (or equivalent).
2. Collect representative rock samples for testing of total sulphur and ABA. For blasted rock samples, two sample size fractions (<1 cm and <2 mm) will be collected and shake flask extraction tests will also be conducted. Following proper sample collection, the sample shall be submitted to an accredited laboratory (i.e. SGS, ALS or Maxxam).
   - ABA to include: Paste pH, sulphate by HCl leach, total inorganic carbon, modified NP (MEND 1991) and trace elemental content by aqua regia digestion followed by ICP finish
   - Shake Flask Leachate analysis to include pH, EC, SO4, acidity, alkalinity, chloride, ammonia, and low level dissolved metals

   If rock is determined to be PAG/ML, store in waste rock area. Subject to professional judgement, waste rock suitability is re-assessed at the next blast round, and Step 2 can be repeated prior to use.
3. During blasting, the waste rock will be inspected every 5,000 tonnes for underground development or every 20,000 tonnes otherwise (i.e when waste rock is generated for the construction of infrastructure by way of surface excavations or cut and fill activities). At these intervals, a representative sample is collected and tested as described above.

Waste Rock for Construction
PROCESS FOR SUITABILITY DETERMINATION

AGNICO EAGLE
HOPE BAY

Laboratory Data and Unit Conversions for Determination of ARD Potential

Table 1.

ARD Parameter	Lab Data	Unit Conversion
AP (Acid Potential)	Total S	AP (kgCaCO3/t) = Total S (%S) * 31.25
TIC (Total Inorganic Carbon)	TIC	TIC (kgCaCO3/t) = TIC (%C) * 83.3
NP (Neutralization Potential)	Modified NP (MEND 1991)	None. NP presented in units of kgCaCO3/t

ARD Classification Criteria

Table 2.

ARD Criteria	ARD Classification
NP/AP or TIC/AP ≥ 3	Non-PAG
1 ≤ NP/AP or TIC/AP < 3	Uncertain
NP/AP or TIC/AP < 1	PAG

Figure 1. Image of Waste Rock for Construction Process Flow Diagram. See Appendix A for actual document.

3.2.1 Post-Construction

If qualified waste rock is used for construction outside of the water control area, the following post-construction inspections of infrastructure are to be conducted:

- An annual seep survey during spring freshet, as outlined in the Quarry Management Plan, will be carried out in the first 3 years following construction;
- Visual inspection of infrastructure with an emphasis on geology (lithology and sulphides);
- Seep sampling of pH, conductivity, sulphate, acidity, alkalinity, chloride, fluoride, nitrate, nitrite, phosphorus, ammonia, total dissolved solids (TDS), total suspended solids (TSS), total cyanide, and low-level dissolved metals; and
- ABA and trace element content (aqua regia digestion) test work on the -1 cm fraction collected from the infraction. Samples are to be collected at a frequency of 1 samples per 50,000 tonnes of rock or for a linear corridor, one sample every 500 m at pre-determined locations. The -2 mm fraction of a subset of samples will be tested by SFE to assess the soluble load of the construction material.

All results will be reported to the Board in the annual report. Should the material show evidence of acid rock drainage, the Board and TMAC will determine the best course of action.

Table 3-2. Hope Bay Waste Rock, Ore and Backfill Management Plan and Monitoring Summary

Aspect	Monitoring Activity	Monitoring Type	Data Management and Reporting
Mining Operations, including Waste Rock Deposition and Backfill	Pre-blast inspection by blaster	Identify "wet holes" and clean spilled ANFO	Maintain field notes
	Post-blast inspection by blaster	Confirm there were no misfires	Maintain field notes
	Visual inspection of blast face by mine geologist	Geological mapping of map faces and backs of accessible mine workings	Maintain field notes and internal record.
	Inventory of available mine void space and waste rock mined; amount waste rock and quarry rock stockpiled on surface and location; Amount of material used for backfill (source and final location) is recorded by the mine engineer.	Material quantities (cubic m and tonnes) summarized on a monthly basis	Maintain record for Annual Reporting
	Amount of detoxified tailings used for backfill is recorded by the mine engineer.	Material quantities (cubic m and tonnes) summarized on a daily basis	Maintain record for Annual Reporting
	Waste rock stockpile inspection and monitoring	Visual inspection and geochemical monitoring.	Maintain field notes. Discuss findings with site geologists. Report findings in Annual Report
	Annual seep survey of materials on surface by Environmental personnel	Water samples submitted for pH, total sulphate, total ammonia, nitrate, alkalinity, and metals by ICP-MS	Maintain field notes. Report findings in Annual Report
	Monthly Water Licence monitoring by Environmental personnel	Water samples and samples of detoxified tailings submitted for analysis of parameters specified in the Water Licence	Maintain field notes. Report findings in Monthly or Annual Reports to NWB as required
	Twice annually survey by Environmental personnel	Visual inspections for seepage and if present water samples submitted for analysis of parameters specified in the Water Licence	Maintain field notes. Report findings in Monthly or Annual Reports to NWB as required
Infrastructure Construction and Post-Construction	Amount of waste rock used for construction, and location of placement tracked by Construction Supervisor	Material quantities (tonnes) and geochemical monitoring	Maintain records for Annual Reporting
	Geochemical inspections and sampling of infrastructure areas constructed using waste rock by Environmental personnel	As per Quarry Management and Monitoring Plan (AEM 2022a)	As per Quarry Management and Monitoring Plan (AEM 2022a)
	Annual seep survey by Environmental personnel	As per Quarry Management and Monitoring Plan (AEM 2022a)	As per Quarry Management and Monitoring Plan (AEM 2022a)

3.3 Documentation and Reporting

All documentation related to waste rock and ore classification, sampling, material hauled from underground, material hauled underground for backfill and waste rock, ore and mine backfill storage facility inspection records are maintained on-site.

Annual reporting required under the water licence will include reporting of waste rock, quarry and detoxified tailings tonnages placed on the designated waste rock storage areas as part of the annual report to the Board. Tonnages of waste rock both above and returned to underground are tracked and reported, together with the available void space in the mine. Annual geochemical monitoring of backfill and waste rock storage assessment is included in the annual report.

Agnico will combine all other results from the inspections and monitoring programs related to waste rock and quarry rock in an annual “Waste Rock and Mine Backfill Monitoring Report”. The monitoring report would be prepared and submitted no later than March 31 of the year following the monitoring activities, and would include all data collected prior to December 31 of the preceding year.

This brief factual report will address the requirements specified in the Water Licenses and Quarry Permit Agreements. The report will include, but not necessarily be limited to:

- A summary of the geochemical inspections;
- Results of the seep surveys;
- Results of geochemical sampling and analysis, if any;
- A summary of all mitigation activities undertaken as a result of monitoring; and
- A summary of the backfill volumes and available mine void space.

4 Contingencies

4.1 Drainage with ML/ARD Issues in Underground Sumps or Rock Stockpile Collection Ponds

In the unlikely event that the results of the underground seepage monitoring program indicate an elevated potential for ML/ARD, further investigations will be undertaken to define the contributing backfill sources from the geological and material handling records maintained during operations. If warranted, and after discussion with the appropriate regulatory agencies, water treatment measures may be implemented prior to discharge of underground water. The underground water monitoring program is described in the Agnico Groundwater Management Plan (2022c).

4.2 Inappropriate Construction Material Identified

In the unlikely event that the results of the seep monitoring program or the confirmatory sampling program (Section 3.2) indicate the presence of material with an elevated potential for ML/ARD has been used in construction, further investigations will be undertaken to define the extent and assess the potential impacts of the material. If warranted, and after discussion with the appropriate regulatory agencies, the material may be mitigated in place or excavated and hauled to the waste rock stockpile for eventual disposal underground.

4.3 Permanent Storage of Waste Rock Stockpiles on Surface Required

While it is expected that all waste rock will be placed underground by the time of closure, if for some reason waste rock was to remain on surface it would be managed on existing pads consistent with principles of this Plan and the site relevant Closure and Reclamation Plans (SRK 2017h, SRK 2017i). Several alternatives were considered as contingency for any ore and/or mineralized waste rock left on surface. One option is moving the piles to Doris TIA and/or Boston TMA for placement in the tailings area or in the case of the Doris TIA, sub-aqueous disposal in the Reclaim Pond. Another option is consolidating, contouring and covering the piles with an impermeable liner and a 0.3 m thick protective layer of crushed rock. Additional options may also be considered. All above ground storage options are subject to approval by NWB.

5 References

[AEM] Agnico Eagle Mines Limited, 2022a. Hope Bay Project, Quarry Management and Monitoring Plan. March 2022.

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Figures

HOPE BAY PROJECT DORIS AND MADRID WATER MANAGEMENT PLAN

AGNICO EAGLE
HOPE BAY

HOPE BAY, NUNAVUT

MARCH 2022

Hope Bay Project Doris and Madrid Water Management Plan

Plain Language Overview:

The Doris and Madrid Water Management Plan (WMP; the Plan) describes the water management practices for the Hope Bay project at the Doris and Madrid mining sites.

The WMP outlines legislation and guidance relevant to the Plan, and describes the water management facilities. It also identifies various water management issues, and the mitigation measures which Agnico will implement during operations, closure and care and maintenance.

The Plan is intended primarily for use by Agnico and its contractors to ensure that best practices are employed throughout all water management activities associated with activities at Hope Bay, thus ensuring water licence conditions are met and minimal potential downstream environmental impacts occur.

Hope Bay, Nunavut

Publication Date: March 2022

Hope Bay Project
Agnico Eagle Mines Limited
145 King Street East, Suite 400
Toronto, Ontario, Canada
Canada M5C 2Y7
Tel: +1 (416) 947-1212

Revisions

Revision #	Date	Section	Changes Summary	Author	Approver
0	October 2006	New Document	Initial version of the Water Management Plan submitted with the 2006 water licence application	MHBL	MHBL
1	April 2007	Throughout	Consolidation of information on water management facilities	MMC	MHBL
2	December 2010	Throughout	Updated in accordance with Type A Water Licence 2AM-DOH0713	SRK	HMBL
3	July 2011		Address monitoring of Doris Lake water levels, address party review comments, RO water treatment	SRK	HBML
4	December 2011		Include Table of Concordance, incorporate underflow sumps	SRK	HBML
5	February 2012		Approved Doris North Interim Water Management Plan under 2AM-DOH1323	SRK	HBML, NWB
6	December 2012		Update to address Part F Item 1.a.,b.,c. of Water Licence	SRK	HBML
7	June 2015	Throughout	Update to TMAC as current licensee for the Hope Bay region. Changes to document structure for operational suitability and efficiency	TMAC (SRK)	TMAC
		Sections • 1.3; • 2.2; • 2.5; • 2.7; • 2.8; • 4.	Addition of: Doris North Infrastructure Monitoring Program Pollution Control Pond 2 Talik water management Revised: Effluent discharge criteria TIA Decommissioning Water management contingencies		
		Module A	Underground talik water management, addition of proposed second Pollution Control Pond, TIA discharge to Roberts Bay		
8	August 2016	Sections	Updated to focus on Operations once tailings deposition has started. Inclusion of changes arising from party comments through Amendment Application process: Consideration of freshet Consistency with other TMAC documents Inclusion of relevant Standard Operating Procedures Addition of Interim Water Management Strategy	TMAC	TMAC

Revision #	Date	Section	Changes Summary	Author	Approver
			Characterization of TIA inputs Management of TIA discharge during Care & Maintenance		
9	February 2016	Sections	Update to align with Amended Type A Water Licence 2AM-DOH1323	TMAC	TMAC
10	December 2017		Added Madrid North and South water mgmt. components	TMAC	TMAC
11	March 2019	3.2.4	Added Sump 3 and updated to align with Amended Type A Water Licence 2AM-DOH1335	TMAC	TMAC
12	March 2020	Sections	Updated to add details regarding RBDS. Clarified Madrid site to align with 2AM-DOH1335	TMAC	TMAC
13	March 2021	4.2.2	Updated to add Madrid WRP sumps	TMAC	TMAC
14	March 2022	Sections	Updated Madrid CWP Sump, section on erosion management and Discharge Criteria	AEM	AEM

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Glossary

Term	Definition
AEM	Agnico Eagle Mines
AEMP	Aquatic Effects Monitoring Program
CCME	Canadian Ministers of the Environment
CWP	Contact Water Pond
DOE	Department of Environment
ECCC	Environment and Climate Change Canada
GN	Government of Nunavut
CIRNAC	Crown Indigenous Relations and Northern Affairs Canada
KIA	Kitikmeot Inuit Association
MHBL	Miramar Hope Bay Ltd.
MMC	Miramar Mining Corporation
MDMER	Metal Mining Effluent Regulations
NIRB	Nunavut Impact Review Board
MMB	RBDS Pumphouse
NWB	Nunavut Water Board
PCP	Pollution Control Pond
RBDS	Roberts Bay Discharge System
TIA	Tailings Impoundment Area
The Plan	Water Management Plan
TMAC	TMAC Resources Inc.
WTP	Water Treatment Plant

1 Introduction

This *Hope Bay Doris and Madrid Water Management Plan* (the Plan) has been prepared by Agnico Eagle Mines Limited (Agnico) in accordance with various water licences held by Agnico associated with developments throughout the Hope Bay region.

The Plan is intended primarily for use by Agnico and its contractors to ensure that best practices are employed throughout all water management activities associated with the operation, closure and care and maintenance of the Doris and Madrid sites, thus ensuring water licence conditions are met and minimal potential downstream environmental impacts occur.

This document outlines Agnico's approach to water management as it pertains to the Doris and Madrid sites.

1.1 Relevant Legislation and Guidance

Table 1-1 provides a summary of federal and territorial regulations governing the Hope Bay Water Management Plan and associated guidelines.

Table 1-1. List of federal and territorial regulations and guidelines governing the Hope Bay Project Doris and Madrid Water Management Plan

Regulation	Year	Governing Body	Relevance
Nunavut Waters Regulations	2013	Nunavut Water Board	Licence for mining and milling undertaking to use water and deposit of waste in relation to the construction, operation, closure and reclamation.
Environmental Protection Act	1988	Government of Nunavut (GN), Department of Environment (DOE), Environmental Protection division	Legislation to authorize discharge of water
Environmental Rights Act	1988	GN, DOE, Environmental Protection division	Grants all residents the ability to launch an investigation
Metal Mining Effluent Regulation (MDMER)	2002	Federal Department of Fisheries and Oceans & Environment Canada	Allows for the designation of a water body for the deposition of mine waste and outlines requirements for mine-related discharges.
Territorial Lands Act	1985	Indigenous and Northern Affairs Canada (INAC)	Crown lease and land use permit
Guideline	**Year**	**Issued by**	**Relevance**
Canadian Environmental Quality Guidelines	1999	Canadian Council of Ministers of the Environment (CCME)	Provides guidance on water quality for the protection of aquatic life; both freshwater and marine

1.2 Related Agnico Documents and Programs

Table 1-2 provides a summary of documents related to the Hope Bay Water Management Plan.

Table 1-2. List of documents related to the Hope Bay Project Doris and Madrid Water Management Plan

Document Title	Year	Relevance
Hope Bay Project Waste Rock,Ore and Mine Backfilling Management Plan	2022	Management of surface contact water
Hope Bay Project Domestic Wastewater Treatment Management Plan	2017	Management of treated effluent
Hope Bay Project Spill Contingency Plan	2022	Spill response procedures
Tailings Impoundment Area Operations, Maintenance and Surveillance Manual	2020	Management of excess water from the TIA
Quality Assurance and Quality Control Plan	2022	Sampling practices document that is reviewed and approved by the NWB
Hope Bay Project Groundwater Management Plan	2022	Management of groundwater
Doris Water and Load Balance Model	2017	Identification of source terms, modelling results
Doris North Infrastructure Monitoring Program	2017	Water Management facility inspections
Standard Operating Procedure: Compliance Sampling – Water Samples (REF # ENV-SOP-EM-002)	2017	Procedures to be followed for sampling water quality within containment berms and sumps, planning and execution of compliant water discharge

1.3 Plan Management and Execution

This Plan is reviewed annually and updated as needed.

Personnel responsible for implementing and updating the Plan are identified in Table 1-3.

Table 1-3. Roles and responsibilities

Role	Responsibility
Mine General Manager	• Overall responsibility for and implementation of this management plan; • Provide the on-site resources to operate, manage, and maintain water management infrastructure, such as pipelines, diversion berms, lined ponds and holding tanks; • Provide input on modifications to design and operational procedures to improve operational performance.
Maintenance Manager (or designate)	• Conduct regular inspections of the water management facilities and audits of the maintenance records; • Responsible for tracking water movements between the various water management facilities, including from the pollution control ponds and sumps to the tailings impoundment area (TIA); • Maintain records of the source, disposition and volume of water transported/discharged; • Report irregularities identified during visual inspections to the Mine General Manager.
Environmental Superintendent	• Review and update this management plan as required; • Monitor water quality in the ponds, TIA and discharge points; • Assess whether water quality samples have met applicable regulatory standards and guidelines; • Coordinate with the surface manager responsible for water movements between the various water management facilities to ensure compliance with all licence requirements; • Audit of water management tracking records and all associated required reporting.

2 Water Management Strategy

2.1 Objectives

The objectives of water management at Hope Bay Mining areas are as follows:

- Minimize total volume of water which comes into contact with mining infrastructure by diverting non-contact runoff away from mining works;
- Capture and contain water which is deemed unsuitable for immediate discharge;
- Treat and dispose of water which cannot be discharged to meet water license requirements.

2.2 Water Classification

Water encountered at the Doris and Madrid mines is classified into five categories based on the contact surface. Each type of water is managed separately to achieve the water management goals, outlined in Section 2.1. Table 2-1 presents the water classifications.

Table 2-1: Water Classification

Type	Contact Surface
Non-Contact Water	Undisturbed runoff, runoff from access roads, overburden piles, quarries, fuel facilities, and landfills
Mine Water	Water which enters the underground workings
Contact Water	Runoff in contact with waste rock, ore stockpiles, tailings and process water
Freshwater	Freshwater from lake
Treated Sewage water	Domestic sewage

3 Doris Water Management

3.1 Management Approach

Figure 1 presents a flow diagram of the water management approach for the Doris Mining area. The following sections outline management and discharge strategy for each water classification.

3.1.1 Non-Contact Water

Best Management Practices (BMPs) will be put in place during construction of access roads and pads to ensure that sediment loading after initial material placement is controlled. This may include silt fences or coco matting around construction activities during the initial rainfall and snowmelt periods.

To divert water upstream of the mine area and reduce the amount of contact water, the Doris North diversion berm was constructed in 2011 and diverts water from the south slope of Doris Mountain away from the site.

Pad U does not require any diversion as it is on the downstream side of the existing access road to Doris Lake and the TIA. The surface of Pad U will be graded to ensure runoff and seepage flow to Contact Water Pond 2.

Runoff accumulating in individual quarries will be collected at the natural low point in each quarry area. If required, a sump may be constructed to improve containment of runoff at the based of the quarry. Excess waters will be tested against the discharge limits and suitable water will be discharged to the tundra at an approved location.

A sump exists at the natural low point in the landfarm. Vacuum trucks will dewater the sump and either discharge to surface or truck the water to Contact Water Pond #2, pending water quality results.

3.1.2 Contact Water

Contact water consists of tailings water, process water, waste rock and ore stockpile runoff. Process water is internally recycled in the Doris process plant, and excess water is sent to the TIA.

The TIA discharges to the RBDS Pumphouse, which pumps water to Roberts Bay.

Waste rock and ore stockpile runoff will be collected in contact water ponds, identified as pollution control ponds, which will be dewatered to the TIA.

Sumps capture shallow groundwater discharge from the active layer, downstream of the pollution control ponds. An automated float operated pump moves water from the sump back to the sedimentation ponds.

3.1.3 Mine Water

The Doris Mine will intercept talik and will therefore have mine inflows, according to the hydrogeological model (SRK, 2017b). For a period of time early in the mine life, Agnico will encounter saline groundwater similar in concentration to seawater, after which the salinity concentration is expected to decline due to an increased fresh water component of the mine inflow originating from Doris Lake.

The management of any groundwater interception is presented in the Hope Bay Groundwater Management Plan (Agnico, 2022).

3.1.4 Freshwater

Freshwater for potable and domestic use is sourced from either the North or South Windy Lake water intakes, and freshwater for fire protection, dust suppression and other industrial uses is sourced from Doris Lake.

Process freshwater is sourced from Doris Lake.

3.1.5 Treated Sewage Water

Domestic sewage will be treated on-site in the sewage treatment plant and discharged either to the TIA or the tundra at an approved location.

3.2 Facilities

Table 3-1 provides a summary of mine infrastructure relevant to the Doris Madrid Water Management Plan.

Table 3-1: Facilities within the Doris Mine Area and Associated Water Management Infrastructure

Facility	Reporting to
Pad X (Main Camp)	Sedimentation Pond
Pad B (Laydown Area)	Sedimentation Pond
Pad C (Administrative Buildings)	Sedimentation Pond
Pad R (Fuel Storage Area)	Sedimentation Pond
Pad Y (Warehouse/Laydown Area)	Sedimentation Pond
Pad E/P (Laydown Area)	Sedimentation Pond
Pad D (Mill Terrace)	Pollution Control Pond 1
Pad T (Waste Rock Storage Area)	Pollution Control Pond 1
Pad Q (Ore Storage Area)	Pollution Control Pond 1
Pad H/J (Ore Storage Area)	Pollution Control Pond 1
Pad I (Ore and Waste Rock Storage Area)	Pollution Control Pond 1
Pad F (Laydown Area)	Pollution Control Pond 1
Pad G (Laydown Area)	Pollution Control Pond 1
Pad U (Ore Storage Area)	Pollution Control Pond 2
Sumps	Contact water ponds
Doris North Diversion Berm	Non-contact area away from site
Water Treatment Plant	Roberts Bay
Tailings Impoundment Area	Roberts Bay

3.2.1 Sedimentation Pond

Surface runoff from pads located on the west side of the mine area reports to the existing sedimentation/holding pond. This pond also serves as a lined temporary holding pond for water from Pollution Control Pond (PCP) 1, the sumps, and other site water which is to be pumped to the TIA.

Operation

Water from this pond is pumped directly to the TIA on an as-needed basis. The existing sedimentation pond has capacity of 3,325 m^3.

Monitoring

Water level in the pond should be measured weekly during the open water season, and more frequently during intensive rainfall or snowmelt periods.

The pumps should have in-line flow meters to quantify total discharge.

A water quality sample should be collected at ST-1 annually during operations. Further details on monitoring are presented in Section 5. If water quality meets the designed criteria for discharge, excess water may be discharged to tundra at an approved location.

Inspection

The containment berm should be inspected by the Maintenance Manager on a regular basis to check for signs of seepage, erosion, slumping, or other signs of possible failure mechanisms.

Regular inspection along the dewatering pipeline will be performed by the Site Services department to check for signs of leaks.

An annual inspection of the containment berm will also be conducted as part of the Annual Geotechnical Inspection by the Engineer of Record (EOR). Results of the inspection are submitted with the 2AM-DOH1335 License Annual Report by March 31 of each year.

3.2.2 Pollution Control Pond 1

Pads located on the east side of the mine area are graded to ensure all runoff and seepage will be diverted and collected in PCP 1. PCP 1 is designed to be a retention pond for the 24 hr 1 in 25 year storm, and is adequately sized to accommodate typical freshet flows. The total volume of runoff captured in this pond will be transferred to the TIA.

Operation

It is expected that the pond will always be operated in a manner allowing pumping and/or trucking to commence as soon as the containment volume is large enough for one continuous hour of pumping.

Monitoring

Water level in the pond should be measured weekly during the open water season, and more frequently during intensive rainfall or snowmelt periods.

The pumps should have in-line flow meters to quantify total discharge.

A water quality sample should be collected at ST-2 annually during operations. Further details on monitoring are presented in Section 5. If water quality meets the designed criteria for discharge, excess water may be discharged to tundra at an approved location.

Inspection

The containment berm should be inspected by the Maintenance Manager on a regular basis to check for signs of seepage, erosion, slumping, or other signs of possible failure mechanisms.

Regular inspection along the dewatering pipeline will be performed by the Environment Superintendent to check for signs of leaks.

An annual inspection of the containment berm will also be conducted as part of the Annual Geotechnical Inspection by the EOR. Results of the inspection are submitted with the 2AM-DOH1335 License Annual Report by March 31 of each year.

3.2.3 Pollution Control Pond 2

Pad U will be located on the east side of the access road leading towards Doris Lake. The primary intent of use for Pad U is general laydown and temporary ore storage, if needed. The pad will be graded in a manner to ensure runoff and seepage is collected by a downstream pollution control pond. The pollution control pond will be designed to manage water and contain flow from the overall drainage area for a 100-year, 24 hour storm event.

Operation

The PCP 2 will always be operated in a manner allowing pumping to commence as soon as the containment volume is large enough for one continuous hour of pumping. All water will be transferred to the TIA.

Monitoring

Water level in the pond should be measured weekly during the open water season, and more frequently during intensive rainfall or snowmelt periods.

The pumps should have in-line flow meters to quantify total discharge.

A water quality sample should be collected at ST-13 annually during operations. Further details on monitoring are presented in Section 5. If water quality meets the designed criteria for discharge, excess water may be discharged to tundra at an approved location.

Inspection

The containment berm should be inspected by the Maintenance Manager on a regular basis to check for signs of seepage, erosion, slumping, or other signs of possible failure mechanisms.

Regular inspection along the dewatering pipeline will be performed by the Environment Superintendent to check for signs of leaks.

An annual inspection of the containment berm will also be conducted as part of the Annual Geotechnical Inspection by the EOR. Results of the inspection are submitted with the 2AM-DOH1335 License Annual Report by March 31 of each year.

3.2.4 Sumps

Sump 1 is constructed downstream of the Sedimentation PCP 1, downstream of the south-east corner of the facility. Sump 2 is constructed downstream of Pad F/G along the east edge of the TIA Access Road. Sump 3 is constructed approximately 40 m south-west of Sump 1, within the tundra. The sumps ensure any seepage that may be bypassing the pond or emanating from Pad F/G is captured and returned to the water management system via an automated float operated pump.

Monitoring

Water level in the pond should be measured weekly during the open water season, and more frequently during intensive rainfall or snowmelt periods.

Water quality monitoring is not expected in the sumps.

The pumps should have in-line flow meters to quantify total discharge.

Inspection

Regular inspection of the sumps should be performed by the Environment Superintendent to ensure they are functioning as intended.

An annual inspection of the sumps will also be conducted as part of the Annual Geotechnical Inspection by the EOR Results of the inspection are submitted with the 2AM-DOH1335 License Annual Report by March 31 of each year.

3.2.5 Tailings Impoundment Area

The TIA is an existing facility bounded by the North Dam, which is water retaining, and the South and West Dams, which are solids retaining. Sub-aerial tailings deposition occurs at the southern end of the facility with reclaim water being pumped from the Reclaim Pond in the north end of the facility.

During the operations, closure and care and maintenance phases additional characterization of TIA inputs as summarized in Table 5-1 will occur.

Operation

The TIA is operated to maintain sufficient water to supply the mill, while not exceeding the full supply level of 33.5 m and allowing for contingency water holding capacity. The current water management strategy is to convey all mine surface contact water to the TIA. Compliant TIA water, in excess of operational needs, is discharged to Roberts Bay, via the RBDS Pumphouse located at the mill building. Based on inflow volumes, the TIA effluent may comingle with groundwater discharge from the mine and both mine and excess TIA water will be co-disposed in Roberts Bay in compliance with the effluent quality limits outlined in License 2AM-DOH1335, Part I, Item 14, and the MDMER limits.

In the event of effluent non-compliance, discharge pipeline malfunction or excessive mine water inflows, the TIA has the capacity to contain water without discharging.

Monitoring

The following water quality samples will be collected from the TIA:

- At the reclaim pipeline at TL-1 on a monthly basis;
- Quarterly samples at the process plant in the tailings slurry line, TL-5;
- Monthly samples from the solids component of mill effluent at TL-6;
- Tailings sent underground will be sampled at TL-7 on a monthly basis;

Visual inspections will consist of the following:

- Water level in the pond should be measured weekly during the open water season, and more frequently during intensive rainfall or snowmelt periods.

Inspection

Regular inspections of the TIA should be performed by the Mill Operations Team to ensure the TIA is functioning as intended. An annual inspection of the TIA will also be conducted as part of the Annual Geotechnical Inspection by the EOR. Results of the inspection are submitted with the 2AM-DOH1335 License Annual Report by March 31 of each year.

3.2.6 Mine Water

The Doris Mine will intercept talik which will result in groundwater inflows. The mine inflows will be made up of fresh water from lake infiltrations and hypersaline water from the surrounding rock, with a water quality dominated by high salinity, specifically chloride. Agnico will actively manage and mitigate inflows to protect workers, the environment, and ensure the mine can keep operating.

Operation

Groundwater will be collected in underground sumps and pumped to surface, from where it will be treated and discharged to Roberts Bay, either directly, or via the Tailings Impoundment Area (TIA).

The management of any groundwater interception is presented in the Hope Bay Groundwater Management Plan (Agnico, 2022) (TMAC, 2017f).

Monitoring

During periods of mine water discharge, either directly to Roberts Bay, or to the TIA, mine water is sampled as follows:

- Weekly water quality samples will be collected at TL-12 at the mine discharge point; and
- Twice annually from backfilled stopes as TL-11.

The Environmental Superintendent is responsible for conducting and documenting inflow water quality sampling. A record of this sampling and results of this analysis will be maintained on site.

Daily flow measurements will also be collected at the main portal flow metering point.

Additional monitoring details are presented in Section 5 and in the Hope Bay Groundwater Management Plan (Agnico, 2020).

Inspection

The underground operational crews are responsible for regular inspections of safely accessible non-working areas and providing daily reports of active work areas. Non-working areas are inspected on a monthly basis, or as necessary, if combined flows from those areas are observed to increase at main collection sumps.

Where new inflow or a change in inflow higher than 250 m^3/day is encountered, a description of the feature and related inflow characteristics are documented as part of the shift boss's daily mining report. This report includes:

- Description of features encountered;
- Inflow rates; and
- Estimated pressures.

An annual inspection of the underground workings will also be conducted as part of the Annual Geotechnical Inspection by the EOR. Results of the inspection are submitted with the 2AM-DOH1335 License Annual Report by March 31 of each year.

3.2.7 Water Treatment Plant

Operation

Underground mine water is pumped from a settling sump system to a WTP on surface designed to provide Total Suspended Solids (TSS) removal from the effluent stream prior to final discharge to Roberts Bay. The multi-stage process consists of coarse suspended solids removal via a lamella clarifier and the addition of a polymer flocculent followed by fine suspended solids removal utilizing multimedia filters. This treatment process is capable of meeting the authorized limits for TSS outlined in Schedule 4 of the MDMER.

Monitoring

During periods of mine water treatment and discharge, either directly to Roberts Bay, or to the TIA, untreated and treated effluent is sampled as follows:

- Weekly water quality samples will be collected at TL-12 at the mine discharge point.
- Weekly water quality samples will also be collected after treatment to determine the performance for the WTP.

The Environmental Superintendent is responsible for conducting and documenting effluent water quality sampling. A record of this sampling and results of this analysis will be maintained on site.

Daily flow measurements are also collected at the WTP flow metering point.

Inspection

The Mill Operations Team is responsible for the operation, maintenance and most aspects of surveillance for the WTP. This includes daily inspections of the WTP and all ancillary equipment to ensure they are functioning as intended.

3.2.8 Quarry Water Management

The quarries will be developed such that runoff drains to the low point and is confined within the quarry boundaries. Sumps will be constructed on an as-needed basis, depending on the geometry of the quarry. For further detail, reference the Quarry Management and Monitoring Plan (TMAC, 2017g).

Monitoring

After storm events or snowmelt, a sample of the ponded water will be collected. Care will be taken to ensure that discharged water does not enter fish bearing waters and that the pump discharge is positioned in a manner that minimizes erosion and siltation of the area downstream of the discharge.

In the event that the quarry water does not meet the discharge criteria, an inquiry of the cause of the noted exceedance will be conducted, and appropriate mitigation developed. Any non-compliant water that needs to be discharged would be transported to the TIA.

3.2.9 Sewage Treatment

Domestic sewage will be treated on-site. During construction and closure, the treated effluent will be discharged to the tundra. The discharge pipeline will consist of a series of diffusers, situated such that each stream will flow in a different direction at the top of the catchment. During operations, the treated effluent will be discharged to tundra and/or pumped to TIA.

Monitoring

A monthly water quality sample will be collected during discharge periods. The sample will be collected at the effluent discharge tank at ST-8. While discharging to the tundra, a sample will be collected downstream of the discharge point, prior to entering Glen Lake, at ST-9.

During discharge to the tundra, additional monitoring will take place at the diffusers. Signs of erosion will be noted and mitigation measures will be implemented by realigning the diffuser pipeline or protecting erodible material.

3.2.10 Freshwater Intake

Domestic and potable water for the camp will be sourced from Windy Lake via the existing Windy Camp intake structure as well as the new Windy Lake North Freshwater intake (SRK, 2017c).

The new Windy Lake North intake pipeline will follow the access road and will transition from shoreline to lakebed beneath a protective rock berm. The insulated heat-traced pipeline will be anchored to the lakebed beneath the rock berm until the lake depth is a minimum of 3 m year-round. The pipeline will continue to a lake depth of 5 m year-round. The pipeline intake will be installed with a fish screen to protect fish in the lake, as per the requirements of Department of Fisheries and Oceans (Department of Fisheries and Oceans, 1995). Additional freshwater is pumped from Doris Lake to the process plant.

Monitoring

A water quality sample will be collected on a monthly basis during active pumping periods from ST-7 in Doris Lake and at ST-7a in Windy Lake. Further details on monitoring are presented in Section 5.

Total water volume extracted from both lakes will be recorded and reported in monthly and annual reports.

Inspection

Regular inspection along the intake pipeline will be performed by the Site Services department to check for signs of leakage.

3.2.11 Various Use Containment Sumps

Various containment sumps will capture runoff from associated land uses. Monitoring is summarized as follows:

- Non-hazardous landfill sump, sampled at ST-3 prior to discharge;
- Landfarm sump, sampled at ST-4 prior to discharge;
- Plant site fuel storage and containment area sump, sampled at ST-6 and ST-6b prior to discharge;
- Reagent and cyanide storage facility sump, sampled at ST-11 annually;

At each facility, if water is deemed acceptable for discharge, it will be safely discharged at an approved location. If water does not meet the effluent quality limits outlined in License 2AM-DOH1335, Part F, and the MDMER, it will be pumped or trucked to TIA.

Details on water quality monitoring at the landfarm and fuel storage and containment area sumps are presented in the Hydrocarbon Contaminated Material Management Plan (TMAC, 2017h).

4 Madrid Water Management

4.1 Management Approach

Figure 2 presents a flow diagram of the water management approach for Madrid Mining area. The following sections outline management and discharge strategy for each water classification. The Madrid site is currently operating under the existing Water Licence No. 2AM-DOH1335 (referred to as “Type A”). The Madrid Advanced Exploration Program operates under Water Licence No. 2BB-MAE1727 (referred to as “Type B”).

4.1.1 Non-Contact Water

Best Management practices will be put in place during construction of access roads and pads to ensure that sediment loading after initial material placement is controlled. This may include silt fences and coco matting around construction activities and during the initial rainfall and snowmelt periods.

Runoff collected in individual quarries will be collected at the natural low point in each quarry area. If required, a sump may be constructed to improve containment of runoff at the base of the quarry. Excess waters will be pumped to surface and tested against the discharge limits. Suitable water will be discharged to the tundra at an approved location.

A sump will be constructed at the natural low point in the fuel facilities at Madrid North and South. Vacuum trucks will dewater the sump and either discharge to surface or truck the water to the Primary contact water pond at Madrid North, pending water quality results.

4.1.2 Contact Water

Contact water consists of tailings water, process water, waste rock and ore stockpile runoff.

A concentrator will be constructed at the Madrid North site to process a portion of the Madrid North ore through a flotation circuit. The resulting tailings will be pumped via pipeline and deposited in the TIA. The concentrate will be trucked to the Doris process plant for gold extraction. Process water and tailings water are internally recycled in the concentrator as much as practical. Excess water is pumped to the TIA in the tailings stream (i.e. tailings at a higher moisture content).

Waste rock and ore stockpile runoff will be collected in contact water ponds which will be dewatered to the TIA.

4.1.3 Mine Water

The Madrid North mine will intercept talik below Patch, Windy and Imniagut Lakes, and mining at Madrid South mine is expected to intercept the talik below Wolverine and Patch Lakes (SRK, 2017b). This intercepted mine water is expected to be saline similar in concentration to seawater.

Mine water will be pumped or hauled to the Doris WTP and discharged to Roberts Bay, as described in the Groundwater Management Plan (TMAC, 2020).

4.1.4 Freshwater

Freshwater including potable and raw water for industrial use (brine mixing, and dust suppressant), will be sourced from Windy Lake via the existing water intake near the old Windy Camp, or if required from the Windy Lake North Fresh Water Intake (SRK, 2017c). Make-up water for the concentrator at Madrid North will be pumped from Doris Lake, and freshwater may be pumped from Patch Lake or Wolverine Lake, as needed.

4.1.5 Treated Sewage Water

There will not be a camp at the Madrid North or South sites. Sewage water will be trucked to Doris Site sewage treatment facility.

4.2 Facilities

Table 4-1 provides a summary of mine infrastructure relevant to the Madrid Water Management Plan.

Table 4-1: Facilities within the Madrid Mining Area and Associated Water Management Infrastructure

Facility	Reporting to
Madrid North Waste Rock Pile	Madrid North Contact Water Pond
Madrid North Ore Stockpile	Madrid North Contact Water Pond
Madrid North Equipment Pad	Madrid North Contact Water Pond
Madrid North Process Plant	Madrid North Contact Water Pond
Portal Laydown Area	Madrid South Secondary Contact Water Pond
Madrid South Waste Rock Pile	Madrid South Primary Contact Water Pond
Madrid South Ore Stockpile	Madrid South Primary Contact Water Pond
Madrid South Fuel Storage Facility	Madrid South Primary Contact Water Pond
Quarries	Windy Lake, tundra, or Primary Contact Water Pond
Sumps	Madrid North Contact Water Pond

4.2.1 Madrid North Contact Water Pond

The Madrid North CWP will capture contact water from the Madrid North concentrator area, ore stockpile, and waste rock pile. The pond will be situated against the contact water berm and access road, and is discussed in more detail in the Contact Water Pond Berm Thermal Modelling report (SRK, 2017d). At the maximum level, the freeboard against the contact water access road berm is 1.3 m.

Operation

The pond should be operated at a near-empty level such that capacity is always available for the design rainfall and snowmelt events.

After an inflow event, resulting from snowmelt or a precipitation event, pumps should be activated to dewater the Madrid North CWP to one of the following locations:

- Concentrator for use as make-up water to reduce the freshwater draw from Windy Lake;
- Tailings discharge line from Madrid North Concentrator to TIA; or
- Mine water line to the Doris WTP.

The maximum dewatering period is 14 days, based on the design capacity of the pond and pump. Should the pond water level approach the freeboard limit, dewatering should be immediately initiated via the pump and pipeline or hauled by tank truck.

Monitoring

Water level in the pond should be measured weekly during the open water season, and more frequently during intensive rainfall or snowmelt periods.

The pumps or tank trucks should have in-line flow meters to quantify total discharge.

A water quality sample will be collected prior to discharge at MAE-04(Type B)/ MMS-1 (Type A). If water quality meets the designed criteria for discharge, excess water may be discharged to tundra at an approved location. Further details on monitoring are presented in Section 5.

Inspection

The contact water pond access road berm should be inspected by the Maintenance Manager on a regular basis to check for signs of seepage, erosion, slumping, or other signs of possible failure mechanisms.

Regular inspection along the dewatering pipeline will be performed by the Site Services department to check for signs of leaks.

An annual inspection of the containment berm will also be conducted as part of the Annual Geotechnical Inspection by the EOR. Results of the inspection are submitted with the 2AM-DOH1335 License Annual Report by March 31 of each year.

4.2.2 Sumps

Water management at the Madrid North Waste Rock Pile includes three water collection sumps located on the northern, eastern and western extents of the waste rock pile.

Agnico plans to install an underflow interception sump to enhance the existing water management at the Madrid North Contact Water Pond. The sump will be installed downstream of the contact water pond and any water captured in the sump will be returned to the contact water pond via an automated float operated pump.

Monitoring

Water level in the sumps should be measured weekly during the open water season, and more frequently during intensive rainfall or snowmelt periods.

Water quality monitoring is not expected in the sumps.

The pumps should have in-line flow meters to quantify total discharge.

Inspection

Regular inspection of the sumps should be performed by the Environment Superintendent to ensure they are functioning as intended.

An annual inspection of the sumps will also be conducted as part of the Annual Geotechnical Inspection by the EOR Results of the inspection are submitted with the 2AM-DOH1335 License Annual Report by March 31 of each year.

4.2.3 Madrid South Primary Contact Water Pond

The Madrid South Primary CWP captures contact water within the Madrid South site. The Primary CWP is contained against the contact water berm access road (SRK, 2017d), and is located west of the waste rock pile. At the maximum level, the freeboard against the contact water access road berm is 1.3 m.

Operation

The pond should be operated at a near-empty level such that capacity is always available for the design rainfall and snowmelt events.

After an inflow event, resulting from snowmelt or a precipitation event, pumps should be activated to dewater the Madrid South Primary CWP to the Madrid North CWP.

The maximum dewatering period is 14 days, based on the design capacity of the pond and pump. Should the pond water level approach the freeboard limit, dewatering should be immediately initiated via the pump and pipeline.

Monitoring

Water level in the pond should be measured weekly during the open water season, and more frequently during intensive rainfall or snowmelt periods.

The pumps should have in-line flow meters to quantify total discharge.

A water quality sample will be collected prior to discharge at MAE-05 (Type B) / MMS-2 (Type A). If water quality meets the designed criteria for discharge, excess water may be discharged to tundra at an approved location. Further details on monitoring are presented in Section 5.

Inspection

The contact water pond access road berm should be inspected by the Maintenance Manager on a regular basis to check for signs of seepage, erosion, slumping, or other signs of possible failure mechanisms.

Regular inspection along the dewatering pipeline will be performed by the Site Services department to check for signs of leaks.

An annual inspection of the containment berm will also be conducted as part of the Annual Geotechnical Inspection by the EOR. Results of the inspection are submitted with the 2AM-DOH1335 License Annual Report by March 31 of each year.

4.2.4 Madrid South Secondary Contact Water Pond

The Secondary CWP at Madrid South captures runoff from the portal laydown area and is confined by berms to the north and east, including the Portal Haul road. At the maximum level, the freeboard against the contact water access road berm is 1.3 m.

Operation

The pond should be operated at a near-empty level such that capacity is always available for the design rainfall and snowmelt events.

After an inflow event, resulting from snowmelt or a precipitation event, pumps should be activated to dewater the Madrid South Secondary CWP to the Madrid South Primary CWP.

The maximum dewatering period is 14 days, based on the design capacity of the pond and pump. Should the pond water level approach the freeboard limit, dewatering should be immediately initiated via the pump and pipeline.

Monitoring

Water level in the pond should be measured weekly during the open water season, and more frequently during intensive rainfall or snowmelt periods.

The pumps should have in-line flow meters to quantify total discharge.

A water quality sample will be collected prior to discharge at MAE-06 (Type B) / MMS-3 (Type A). If water quality meets the designed criteria for discharge, excess water may be discharged to tundra at an approved location. Further details on monitoring are presented in Section 5.

Inspection

The contact water pond access road berms should be inspected by the Maintenance Manager on a regular basis to check for signs of seepage, erosion, slumping, or other signs of possible failure mechanisms.

Regular inspection along the dewatering pipeline will be performed by the Site Services department to check for signs of leaks.

An annual inspection of the containment berm will also be conducted as part of the Annual Geotechnical Inspection by the EOR. Results of the inspection are submitted with the 2AM-DOH1335 License Annual Report by March 31 of each year.

4.2.5 Quarry Water Management

The quarries will be developed such that runoff drains to the low point and is confined within the quarry boundaries. Sumps will be constructed on an as-needed basis, depending on the geometry of the quarry. For further detail, reference the Quarry Management and Monitoring Plan (TMAC, 2017g).

Monitoring

After storm events or snowmelt, a sample of the ponded water will be collected. Quarries G, H, and I will have samples collected at MAE-11, MAE-12 and MAE-13, respectively (as required, under Type B). If the water quality is acceptable for discharge, care will be taken to ensure that discharged water does not enter fish bearing waters and that the pump discharge is positioned in a manner that minimizes erosion and siltation of the area downstream of the discharge.

In the event that the quarry water does not meet the discharge criteria, an inquiry of the cause of the noted exceedance will be conducted, and appropriate mitigation developed. Any non-compliant water that needs to be discharged would be transported to one of the CWPs.

4.2.6 Sewage Treatment

Madrid North and South will be equipped with a portable wash car containing toilets, washbasins and showers with heated black and grey water day tanks. These tanks will be emptied via a vacuum sewage truck and transported to a holding tank at the Doris Site for blending into the Doris Site sewage treatment facility.

Monitoring for Doris sewage treatment facility is described in Section 3.2.9.

4.2.7 Freshwater Intake

Domestic, potable and industrial water, including water for brine mixing and dust suppressant, will be sourced from Windy Lake via the existing Windy Camp intake structure as well as the new Windy Lake North Freshwater intake (SRK, 2017c).

The new Windy Lake North intake pipeline will follow the access road and will transition from shoreline to lakebed beneath a protective rock berm. The insulated heat-traced pipeline will be anchored to the lakebed beneath the rock berm until the lake depth is a minimum of 3 m year-round. The pipeline will continue to a lake depth of 5 m year-round. The pipeline intake will be installed with a fish screen to protect fish in the lake, as per the requirements of Department of Fisheries and Oceans (Department of Fisheries and Oceans, 1995).

Make-up water for the concentrator at Madrid North will be pumped from Doris Lake. Water may also be pumped from Patch Lake and Wolverine Lake, as needed.

Monitoring

A water quality sample will be collected on a monthly basis during active pumping periods from the freshwater intake in Windy Lake (MAE-01 (Type B) / MMS-4a (Type A)), and from Patch Lake (at MAE-02 (Type B)), and from Wolverine Lake (MAE-03 (Type B)), as needed. Further details on monitoring are presented in Section 5.

An in-line flow meter will measure total water volume extracted from Windy Lake.

Inspection

Regular inspection along the intake pipeline will be performed by the Site Services department to check for signs of leakage.

4.2.8 Fuel Facility Water Management

Fuel facilities at Madrid North and South will include self-contained sumps.

Monitoring

After a storm event or snowmelt and prior to discharge, water samples will be collected from the following locations:

Under Water Licence 2BB-MAE1727:

- MAE-07 at Madrid North fuel storage area sump;
- MAE-08 at Madrid North fuel transfer station sump;
- MAE-09 at Madrid South fuel storage area sump; and
- MAE-10 at Madrid South fuel transfer station sump.

Under Water Licence 2AM-DOH1335:

- MMS-5 at the Madrid South Fuel Storage facility
- MMS-8 at the Madrid North Fuel Storage facility

Samples will be sent for analysis to an accredited laboratory. If water quality is within the required limits for discharge, the water will be discharged to the tundra at a location approved by the inspector, or else water will be discharged into one of the contact water ponds.

5 Detailed Monitoring Plan

5.1 Monitoring Objectives

The objective of the monitoring undertaken under this Plan is to:

- Comply with monitoring requirements outlined in applicable water licences, project certificates, and the *MDMER*;
- Ensure water in the TIA, and that directed to the TIA is characterized to provide information for appropriate operation of the TIA, and so that it is available in case of an unintentional release;
- Ensure water being discharged to the environment meets the appropriate discharge limits;
- Ensure points of discharge to tundra are not negatively affected by pooling water or erosion; and
- Ensure tracking of water movement and volumes.

Monitoring is carried out in accordance with the Standard Operating Procedures.

5.2 Erosion Management and Mitigation Measures

Effective erosion and sediment control measures will be installed prior to construction work commencing to minimize the potential for the introduction of sediment into watercourse or waterbodies. Slopes from containment berms that contain loose or erodible, will be fortified under the direction of a QEP. An adequate supply of erosion and sediment control contingency supplies will be maintained at the site. The speed of any flowing water on site, specifically during periods of tundra discharge, will be minimized since the erosive power of flowing water increases exponentially with velocity (speed). Supplies include: Silt fence Tarps Polly sheeting Sandbags Hand tools Geotextile Erosion control matting (with anchors) Trash pumps (with suitable lengths of hose).

5.3 Monitoring Plan

Monitoring locations, frequency, and parameters for the Doris site are summarized in Table 5-1 as per the existing Type A Water Licence 2AM-DOH1335. Monitoring locations, frequency, and parameter for the Madrid site are summarized in Table 5-2 as per the existing Type A Water Licence 2AM-DOH1335 or the Type B Water Licence 2BB-MAE1727. Monitoring locations are presented in Figure 3 for Doris and Figure 4 for Madrid.

Table 5-1 Water monitoring at Doris Site.

SNP Station	Description	Phase	Frequency during Operations and Any Time After Initial Deposit of Tailings to the TIA
ST-1	Sedimentation Pond	Construction, Operation, Care and Maintenance, Closure	Annually
ST-2	Doris Contact Water Pond	Construction, Operation, Care and Maintenance, Closure	Annually
ST-3	Discharge from Non-hazardous Landfill pollution control sump	Construction, Care and Maintenance, Operation, Closure	Annually. Once prior to every discharge onto the tundra
			Daily during periods of discharge
ST-4	Discharge from Landfarm sump	Construction, Operation, Care and Maintenance, Closure	Annually. Once prior to every discharge onto the tundra
			Daily during periods of discharge
ST-5	Discharge from the Plant Site Fuel Storage and Containment Area Sump	Construction, Operation, Care and Maintenance, Closure	Annually. Once prior to every discharge onto the tundra
			Daily during periods of discharge
ST-6a and ST-6b	Discharge from the Roberts Bay Fuel Storage and Containment Area Sumps	Construction, Operation, Care and Maintenance, Closure	Annually. Once prior to every discharge onto the tundra
			Daily during periods of discharge
ST-7	Freshwater pumped from Doris Lake	Construction, Operation, Care and Maintenance, and Closure	Monthly during periods pumping
			Monthly during periods of pumping
			Annually
ST-7a	Freshwater pumped from the Windy Lake freshwater intake	Construction, Operation, Care and Maintenance, Closure	Monthly during periods of pumping
ST-8	Discharge from Doris Sewage Treatment Plant	Construction, Operation, Care and Maintenance, Closure	Monthly when discharge to the Tundra, Annually when discharge to the TIA
			Monthly during periods of discharge
			Daily during periods of discharge
ST-9	Runoff from Doris Sewage Treatment Plant	Construction, Operation, Care and Maintenance, Closure	Monthly when discharged to the tundra
ST-10	Site Runoff from Sediment Controls	Construction, Operations, Closure	Daily during periods of discharge
ST-11	Reagent and Cyanide Storage Facility Sumps	Construction, Operation, Care and Maintenance, Closure	Annually
ST-12	Doris Lake	Operation, Closure	Monthly
			Annually in April
ST-13	Doris Contact Water Pond Pad U	Construction, Operation, Care and Maintenance, Closure	Annually
TL-1	TIA at the Reclaim Pipeline	Operation, Care and Maintenance, Closure, Post Closure (for up to nine (9) years after cessation of mining)	Monthly during Operations, Closure and Post Closure. Annually during Care and Maintenance.
			Annually
			Annually during Post-Closure
			Annually
TL-2	Doris Outflow Creek - upstream (at the flow monitoring station adjacent to the bridge)	Closure, Post Closure (for up to nine (9) years after cessation of mining)	Annually during Care and Maintenance Annually for 2 years prior to Post-Closure, and during Post-Closure, Increase to three times per year (under ice, freshet, and pre-freeze up), two years prior to breach of the North Dam.
		Operation	Daily upon commencement of mining in or beneath the Doris Lake Talik.
TL-3	Doris Outflow Creek (~80m downstream of the base of the waterfall)	Care and Maintenance, prior to any deposit of tailings to the TIA	Inactive
TL-4	TIA Discharge End-of-Pipe	Care and Maintenance, prior to any deposit of tailings to the TIA	Inactive
TL-5	Effluent from Process Plant (tailings slurry/ water)	Operations	Quarterly
TL-6	Tailings Discharged into TIA (Solid Component) taken from a valve in the mill at the discharge end of the mill tailings pumps	Operations	Monthly during periods of discharge
			Sampled on a weekly basis with analyses carried out monthly on a composite sample of the TL-6 weekly samples
TL-7A	Detoxified tailings solids sent underground as backfill	Operations	Monthly
TL-7B	Filtrate from TL-7A	Operations	Monthly
TL-8	Reclaim water pumped from TIA to Mill Process water tank taken from a valve at the discharge end of the reclaim water pump	Inactive	Inactive
TL-9	Detox tailings reactor tank (650-TK-565)	Operations	
TL-10	Water Column in deepest portion of Tail Lake and at a location away from the TIA Reclaim water floating pump house, sampled at surface, mid- depth and near bottom.	Inactive	Inactive
TL-11	Seepage from underground backfilled stopes	Operations	Survey Twice annually
TL-12	Mine Water Discharge Point	Operations during continuous pumping	Weekly
			Monthly
			Daily during periods of discharge

Notes:
(1) 1 As per Schedule J Table 2
(2) 2 Monitored under Groundwater Management Plan (Agnico 2022)

Table 5-2a: Water monitoring at Madrid sites based on Type A Water Licence No. 2AM-DOH1335

SNP Station	Description	Phase	Frequency during Operations and Any Time After Initial Deposit of Tailings to the TIA
MMS-1	Madrid North Contact Water Pond	construction, operations, care and maintenance	Sampled twice annually, Weekly water levels
MMS-2	Madrid South Primary Contact Water Pond	construction, operations, care and maintenance, closure	Sampled twice annually, Weekly water levels
MMS-3	Madrid South Secondary Contact Water Pond	construction, operations, care and maintenance, closure	Sampled twice annually, Weekly water levels
MMS-4A	Fresh Water Intake at Windy Lake North	construction, operations, care and maintenance, closure	Sampled monthly during active pumping periods
MMS-4B	fresh Water Intake at Windy Lake South (Windy Camp)	construction, operations, care and maintenance, closure	Sampled monthly during active pumping periods
MMS-5	Discharge from Madrid South Fuel Storage facility	construction, operations, care and maintenance, closure	Annually. Once prior to every discharge onto the tundra
MMS-6	Bring Mixing Facility	Operations during continuous pumping	Sampled monthly during active pumping periods
MMS-7	Effluent from Madrid North Concentrator to TIA	Operations	Sampled quarterly during active pumping periods
MMS-8	Discharge from Madrid North Fuel Storage facility	construction, operations, care and maintenance, closure	Annually. Once prior to every discharge onto the tundra
MMS-9	Site runoff from sediment controls during construction	construction	Sampled daily during periods of discharge
MMS-10	Mine Water Discharge Point	Operations during continuous pumping	Weekly (Chloride, TDS, Nitrate) and Monthly (remaining parameters)

Table 5-3b: Water monitoring at Madrid sites based on Type B Water License No. 2BB-MAE1727

SNP Station	Description	Phase	Frequency during Operations and Any Time After Initial Deposit of Tailings to the TIA
MAE-01	Madrid North freshwater intake at Windy Lake	Construction, Operations, Closure	Daily during periods of pumping
MAE-02	Madrid South freshwater intake at Patch Lake	Construction, Operations, Closure	Daily during periods of pumping
MAE-03	Freshwater intake at other lakes	Construction, Operations, Closure	Daily during periods of pumping
MAE-04	Madrid North contact water pond	Construction, Operations, Closure	Once prior to every discharge to tundra
MAE-05	Madrid South primary contact water pond	Construction, Operations, Closure	Once prior to every discharge to tundra
MAE-06	Madrid South secondary contact water pond	Construction, Operations, Closure	Once prior to every discharge to tundra

SNP Station	Description	Phase	Frequency during Operations and Any Time After Initial Deposit of Tailings to the TIA
MAE-07	Madrid North fuel storage area sump	Operations	Once prior to every discharge to tundra
MAE-08	Madrid North fuel transfer area sump	Operations	Once prior to every discharge to tundra
MAE-09	Madrid South fuel storage area sump	Operations	Once prior to every discharge to tundra
MAE-10	Madrid South fuel transfer area sump	Operations	Once prior to every discharge to tundra
MAE-11	Quarry G contact water sump	Operations	Once prior to every discharge to tundra
MAE-12	Quarry H contact water sump	Operations	Once prior to every discharge to tundra
MAE-13	Quarry I contact water sump	Operations	Once prior to every discharge to tundra
MAE-14	Windy Lake, immediately downgradient of the Pollution Control Pond Discharge	Operations	Once prior to every discharge and a maximum of two weeks post discharge
MAE-15	Patch Lake, immediately downgradient of the Pollution Control Pond Discharge	Operations	Once prior to every discharge and a maximum of two weeks post discharge
MAE-16	Wolverine Lake, immediately downgradient of the Pollution Control Pond Discharge	Operations	Once prior to every discharge and a maximum of two weeks post discharge

5.4 Discharge Criteria

Effluent discharged will be monitored as applicable and required under the MDMER. MDMER effluent discharge limits are presented Table 5-4. To discharge to Roberts Bay, the MDMER requires that effluent be non-acutely lethal when tested in accordance with the applicable Reference Method. The appropriate test is based on the salinity of the effluent and is presented in Table 5-5.

Table 5-4 Effluent limits during periods of discharge to Roberts Bay

Parameter	**Units**	***Maximum Authorized Monthly Mean Concentration***	***Maximum Authorized Concentration in a Grab Sample***
pH		6 to 9.5	6 to 9.5
Total Arsenic	mg/L	0.30	0.60
Total Copper	mg/L	0.30	0.60
Total Cyanide	mg/L	0.50	1.00
Total Lead	mg/L	0.10	0.20
Total Nickel	mg/L	0.50	1.00
Total Zinc	mg/L	0.50	1.00
Total Suspended Solids	mg/L	15.00	30.00
Total Radium 226	Bq/L	0.37	1.11
Unionized Ammonia	mg of N /L	0.50	1.00

Table 5-5 Acute Lethality Testing

	Salinity Level of Effluent			
	Salinity > 10 ppt	**Salinity < or = 10 ppt**	**Salinity > 4 ppt**	**Salinity < or = 4 ppt**
Marine Environment	Threespine stickleback	Rainbow trout	*Acartia tonsa*	*Daphnia magna*

Quarry water samples will be compared against quarry effluent quality limits as stated in Part D Item 18 Water License 2BE-HOP122 and presented in the Quarry Management Plan (Agnico, 2022).

5.5 Inspections

Routine visual inspections of all water management structures will be completed by site staff to determine whether the facilities are operating as designed and to assess maintenance requirements. Facility inspections are carried out following significant rain events and throughout the annual snowmelt period. Annual geotechnical inspections of all engineered facilities are carried out by the engineer of record. During construction activities, daily visual inspections and inspections after significant rain events, including those associated with freshet, are completed to:

- Monitor for signs of erosion and implement mitigation measures to prevent entry of sediment to any water body;
- Integrity of all piping and other water conveyance structures;
- Signs of erosion or water pooling occurring during high flow periods;
- Volumes of water in the contact water ponds;
- Geotechnical integrity of contact water berms; and
- Integrity of erosion protection at point of discharge to the tundra.

Any irregularities identified during the visual inspection will be recorded and relayed to the Mine General Manager and/or the Engineer of Record for the facility in order to ensure corrective action can be implemented.

5.6 Documentation and Reporting

All monitoring data compiled will be documented and reported as prescribed under the water licence, MDMER, or otherwise. Any data not explicitly requiring monthly reporting under the Water Licence will be reported in the existing Annual Reports to the NWB. These reports will include but are not limited to:

- An assessment of data to identify areas of non-compliance with regulated discharge parameters;
- A summary of all water inputs to the water treatment plant, water treatment plant discharges and discharges to tundra; and
- Annual review of the water balance and water quality predication model.
- Water management facility inspection and operations records will be retained on site and available for review upon request.
- An Annual Geotechnical Inspection Report will be submitted to the NWB annually.
- A Construction Monitoring Report will be prepared in applicable years and submitted to regulators where required. The report will include but is not limited to the following:
- A summary of all inspections conducted during construction; and
- Updated “As-built” drawings of the constructed infrastructure.

5.6.1 Record Keeping

Records of operation and maintenance are required to evaluate the effectiveness of the operation of all water management structures. Daily records include the following information:

- Volume, quality and discharge location of any effluent moved between facilities or discharged to environment; and
- Details of any construction or maintenance undertaken at site.

Record sheets and daily operations or inspection logs are maintained with the Site Services and Environmental Departments.

Results of sampling as presented in Table 5-1 and Table 5-2 are reported to the NWB in conjunction with Annual Reporting.

5.6.2 Monitoring

Monitoring of Doris Lake and Windy Lake water levels will occur under the Aquatic Effects Monitoring Program (AEMP). TIA water levels are monitored and reported in the Annual Geotechnical Inspection Report.

Sediment, pollution control ponds, and contact water ponds will have permanent staff gauges to allow for visual monitoring of water accumulations in each pond. Weekly staff gauge readings converted to volumes will be recorded in for each pond.

All volumes of water movements will be monitored with flow meters, tracked by truck load, or otherwise quantified as appropriate during the transfers. These include, but are not limited to, movements from:

- Discharges to tundra;
- Transfers between pollution control ponds, sedimentation ponds, or contact water ponds;
- Transfers to the TIA;
- Groundwater to the RBDS Pumphouse;
- TIA excess water to RBDS Pumphouse, and
- MMB to Roberts Bay.

Water quality in the ponds, TIA and discharge points will be monitored in accordance the Water Licence and MDMER where applicable. Confirmation of compliance will be required prior to discharging any water from facilities, as applicable. The Environmental Department is responsible for water quality monitoring and compliance reporting.

6 Closure and Care and Maintenance

6.1 Water Management at Closure and Post-Closure

At closure, the remaining inventory of TIA water will be discharged to Roberts Bay. This can be done in one open water season. The small pond behind the North Dam will be filled in and the tailings surface covered, after which it is expected that surface water runoff from the TIA will be suitable to discharge to the Doris system. Water quality criteria in the TIA for discharge to the Doris System will be determined in advance of final closure and in consultation with interested parties. Once the discharge criteria is met, the North Dam can be breached and flow restored to the Tail Lake Outflow. Sampling of the TIA water would be conducted prior to Post-Closure to ensure the North Dam can be breached. This sampling will be outlined in the Final Closure Plan, and would be discussed with relevant parties prior to dam breaching. Following breaching of the dam, water quality will be monitored in accordance with the provisions of the water licence. Post-Closure sampling will be described in the Final Closure Plan and at the time of water licence renewal.

6.2 Care and Maintenance Options

Should the project be placed into Care and Maintenance following tailings deposition in the TIA, compliant water will continue to be discharged to Roberts Bay seasonally to maintain water levels at or below the full supply level. Monitoring will continue as described above and as required under the MDMER.

7 References

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