24 June 2019

Assol Kubeisinova
Technical Advisor, NWB
P.O. Box 119
Gjoa Haven, NU X0B 1J0

RE: Issued for Construction Drawings Submission
Revised Run of Mine Stockpile and Sedimentation Pond
Mary River Project - Type 'A' Water Licence 2AM-MRY1325 - Amend. No. 1

On behalf of Baffinland Iron Mines Corporation (Baffinland), please find attached transmission of the following drawings and documents in accordance with Part D, Item 2 of the Type 'A' Water Licence 2AM-MRY1325 (the Licence):

- Design Brief
  - Design Summary for the KM106 Stockpile Access Road and Runoff Management Designs
- Drawings
  - 300 – General Arrangement
  - 301 – Specifications
  - 310 – Access Road - Plan and Section
  - 320 – Sedimentation Pond and Runoff Management Measures – Plan, Sections and Details
  - 321 – Sedimentation Pond and Runoff Management Measures – Sections and Details
- Geotechnical Invesitgation
  - KM106 and KM107 Stockpile – 2019 Geotechnical Site Investigation

This submission is an update to the prior submitted drawings and design brief regarding the KM107 Stockpile. Following a pre-construction geotechnical investigation (attached), it was determined that the KM107 area was not a suitable location due to the presence of massive ice. An alternative location was identified at the KM106 location in the area of the former the D1Q2 Quarry, and the geotechnical investigation confirmed the location would be appropriate.

The change in location to KM106 constitutes a minor change and adaptive measure to address geotechnical concerns, and is considered to be within the scope of the approved project. The Run of Mine (ROM) Stockpile infrastructure was included in the Final Environmental Impact Statement (FEIS), and is already considered in the scope of the Licence. Within the Licence the sedimentation pond has been identified as 'MS-07'. Construction of this facility does not require a Modification to the Licence. Minor updates to the *Surface Water and Aquatic Ecosystems Management Plan* and the *Fresh Water Supply, Sewage, and Wastewater Management Plan* were completed and submitted with the QIA/NWB Annual

Report for Operations on March 31, 2019, and are posted on the Baffinland Document Portal. Implementation of the monitoring program associated with MS-07 will conform to the requirements of Schedule I of the Licence. Reclamation security for this specific activity was included in the 2019 Work Plan.

Baffinland will prepare a Construction Summary Report within ninety (90) days following completion of this work, in accordance with Part D, Item 17 of the Licence.

We trust that this information meets the requirements under Part D of the Licence.

Regards,

Christopher Murray
Environmental & Regulatory Compliance Manager

Attachments:
Attachment 1: Design Brief & For-Construction Drawings
Attachment 2: Geotechnical Investigation

Cc:
Karén Kharatyan (Nunavut Water Board)
Chris Spencer, Jared Ottenhof (Qikiqtani Inuit Association)
Bridget Campbell, Godwin Okonkwo (Crown-Indigenous Relations and Northern Affairs Canada)
Solomon Amuno (Nunavut Impact Review Board)
Megan-Lord Hoyle, Lou Kamermans, Timothy Ray Sewell, Simon Fleury (Baffinland)

Attachment No. 1

Design Brief & For Construction Drawings

Knight Piésold CONSULTING

June 20, 2019

Knight Piésold Ltd.
1650 Main Street West
North Bay, Ontario
Canada, P1B 8G5
T +1 705 476 2165
E northbay@knightpiesold.com
www.knightpiesold.com

Mr. Allan Knowlton
Project Manager
Baffinland Iron Mines Corporation
#300-2275 Upper Middle Road East
Oakville, Ontario
Canada, L6H 0C3

Dear Allan,

Re: Design Summary for the KM106 Stockpile and Runoff Management Measures

1.0 INTRODUCTION

Baffinland Iron Mines Corporation (Baffinland) owns and operates the Mary River Project located on northern Baffin Island, Nunavut. As part of Baffinland's mining strategy, a long-term stockpile is required to stockpile run-of-mine ore material. Knight Piésold Ltd. (KP) has been retained to complete the design for the KM106 Stockpile Access Road and runoff management measures, including the Sedimentation Pond. This letter provides a summary of the detailed design for these structures.

2.0 SITE CONDITIONS, DESIGN CRITERIA AND MATERIALS

2.1 GENERAL

The design of the Stockpile Access Road, Sedimentation Pond and runoff management measures have been developed by KP based on the proposed KM106 Stockpile layout (Baffinland, 2019). The KM106 Stockpile area is shown in plan view on Drawing 300. Additional details are provided on other drawings and in the sections below.

2.2 SITE CONDITIONS

KP completed a site investigation at the KM106 Stockpile from May 15 to 16, 2019 (KP, 2019). Baffinland provided topographical contours for the KM106 Stockpile location (Baffinland, 2019). The KM106 site generally consists of exposed bedrock or bedrock covered by shallow overburden up to 4 m thick.

2.3 DESIGN CRITERIA

The project design criteria were previously developed for the KM107 design work (KP, 2018). The design criteria were developed based on the following documents:

- The RFP for the KM107 Design (Caserta, 2018)
- The Mary River Project Civil Design Philosophy and Criteria (Hatch, 2013 and 2018)
- The Crusher Pad Sedimentation Pond expansion design (Golder Associates (Golder), 2017)
- The Mary River Project Water License (NWB, 2014)
- The Nunavut *Mine Safety and Health Act* (MHSA, 2011)

- The *Nunavut Waters and Nunavut Surface Rights Tribunal Act* and Nunavut Waters Regulations (NWNSRTA, 2018)
- The Metal and Diamond Mining Effluent Regulations (MDMER, 2018)
- The *Fisheries Act* (2016)

The design criteria are summarized in Table 1.

2.4 MATERIALS

Baffinland has indicated that the materials currently used (or proposed to be used) to construct other structures at site, including the Haul Road (Golder, 2018a), Waste Rock Dump Sedimentation Pond (Golder, 2018b) and the Crusher Pad Sedimentation Pond (Golder, 2017) will also be available for construction of the KM106 Stockpile Access Road and associated runoff management measures, including the Sedimentation Pond. In general, all fill materials shall meet the following requirements:

- Fill materials used for construction shall not be potentially acid generating (PAG) or metal leaching (ML).
- All materials shall consist of hard, durable fill material, free of clay, loam, tree stumps, roots and other deleterious materials or organic matter, and shall contain no ice.

The material specifications are described as follows:

- KM106 Stockpile Ore (blasted rock)
  - 500 mm minus blasted rock ore
  - Ore to be placed by truck and bulldozer in maximum 1000 mm lifts starting at the end of the Access Road.
  - Nominal compaction to be achieved by routing haulage traffic over the entire surface of the stockpile.
- 500 mm Minus Rockfill
  - To be used for the Access Road, safety berms, and downstream portion of the Sedimentation Pond perimeter berm.
  - Material shall consist of well graded, clean, durable and angular rockfill with a maximum particle size gradation of 500 mm.
  - To be placed in maximum 1000 mm lifts by truck and bulldozer; placement in the Access Road will start at the existing Haul Road.
  - Compaction to be achieved by routing haulage traffic and other construction equipment over the entire surface of the road.
  - Safety berm fill to be placed and nominally compacted to the dimensions shown on the Drawings.
- Berm Fill
  - To be used for the Collection/Diversion Berms and upstream slope of the Sedimentation Pond perimeter berm.
  - Material shall consist of well graded, clean, durable and angular rockfill with a maximum particle size of 150 mm.
  - Sedimentation Pond berm fill to be placed and spread in maximum 300 mm thick layers after compaction with a vibratory roller D9 dozer.
  - Collection/Diversion Berm fill to be placed and spread in maximum 200 mm layers after compaction. Compaction to be nominal.

- Intermediate Bedding
  - To be used for anchor trench backfill, anchor berms, and bedding material for geomembrane.
  - Material shall consist of well graded, clean, durable and angular sand and gravel with a maximum particle size gradation of 32 mm.
  - Material to be placed, spread and moisture conditioned in maximum 200 mm layer after compaction with a vibratory roller or plate packers.
- Fine and Coarse Riprap
  - To be used for Sedimentation Pond spillway inlet and channel, Collection/Diversion Berms, and riprap aprons.
  - Material shall consist of well graded, clean, durable and angular rockfill with a maximum particle size gradation not to exceed one and a half times the specified D50 value and minimal fines content.
  - Fine Riprap to have a D50 of 150 mm.
  - Coarse Riprap to have a D50 of 300 mm.
  - Material to be placed and spread in maximum 300 mm layer (Fine Riprap) or 600 mm layer (Coarse Riprap) and placed to form a tightly interlocking layer.

All materials shall be produced and sourced from an approved construction material source as required under Water License No. 2AM-MRY1325-Ammendment No. 1.

3.0 ACCESS ROAD DESIGN

3.1 GENERAL

The Access Road will provide vehicular access from the main Haul Road to the new KM106 Stockpile. The general layout for the Access Road developed by Baffinland is shown on Drawing 310. The road embankment is planned to be constructed using Road Embankment Fill. The initial fill will be placed by dumping and pushing the material from the existing Haul Road. Subsequent fill will be dumped and pushed from the final design grade of the Access Road. Due to the required fill placement method, the side slopes will be developed at the angle of repose for the rockfill (approximately 1.3H:1V or 37 degrees).

3.2 GEOMETRY

The Access Road is required to provide two-way access for Caterpillar 793 haul trucks (design vehicle) (CAT, 2017). The road cross section is shown on Drawing 310. The following design constraints have been incorporated in the road design:

- Road Width: The minimum width of the road surface between the safety berms is 25.5 m, equal to three times the width of the CAT 793 design vehicle (8.5 m) (Nunavut *Mine Health and Safety Act* (MHSA), 2011).
- Grade: The maximum grade is 10%.
- Radius: The minimum radius for horizontal curves is 50 m.

The connection to the existing Haul Road will be field fit at the time of construction. The portion of the Haul Road that is adjacent to and immediately upslope of the Access Road shall be graded with a minimum uphill cross slope of 3% (Hatch, 2013) to ensure that runoff water from the Haul Road is routed away from the KM106 Stockpile and Access Road.

Vehicle safety berms are included on each side of the road (where required by the MHSA (2011)). The geometry of the safety berms has been designed to meet the minimum requirements set by the MHSA (2011) and the project design criteria, and are described as follows:

- Height: 2.7 m
- Side Slopes: 1H:1V
- Crest Width: 1 m

The design criteria used for the Access Road are included in Table 1.

4.0 KM106 STOCKPILE DESIGN

The general layout for the KM106 Stockpile developed by Baffinland is shown on Drawing 300. The stockpile will be constructed by dumping and pushing the ore material from the Access Road. Due to the required fill placement method, the side slopes will be developed at the angle of repose for the material being placed in the stockpile (approximately 1.3H:1V or 37 degrees).

5.0 SEDIMENTATION POND DESIGN

5.1 GENERAL

The general layout for the Sedimentation Pond is shown on Drawings 300 and 320. The Sedimentation Pond will provide sediment control for runoff originating from the following catchment areas, shown on Figure 1:

- The KM106 Stockpile area.
- The pond itself.
- The localised area between the stockpile and the pond (where it can not be easily diverted around the pond).

This runoff will flow directly to the pond by gravity or be conveyed to the pond by perimeter Collection/Diversion Berms. Unimpacted runoff from upstream catchment areas will be diverted around the KM106 Stockpile and Sedimentation Pond.

5.2 PERIMETER BERM GEOMETRY AND LAYOUT

The Sedimentation Pond will be established by constructing a perimeter berm along the west, south and east sides of the basin, while the north side of the pond will be delineated by the existing ground slope (see Drawing 320).

The perimeter berm will be constructed using compacted 500 mm Minus Rockfill with a layer of compacted Berm Fill and a layer of compacted Intermediate Bedding placed over the upstream slope of the berm. The geometry of the perimeter berm is shown on Drawings 320 and 321 and is generally summarized as follows:

- Upstream Slope: 2.5H:1V
- Downstream Slope: 2H:1V
- Crest Width: 6 m

The Sedimentation Pond basin and upstream slopes of the perimeter berm will be lined with a geomembrane liner underlain by a non-woven geotextile as a cushion layer. The geomembrane liner and non-woven geotextile will extend up the interior (upstream) slope of the perimeter berm (where present) and will be anchored at the crest, as indicated on the Drawings. Where there is no perimeter berm, a mound

of Intermediate Bedding will be placed along the edge of the pond at approximate elevation 268.5 m and the geomembrane and non-woven geotextile placed over the fill. Additional Intermediate Bedding will be placed over the edge of the geomembrane and non-woven geotextile to anchor it in place. Fine riprap will be placed over the Intermediate Bedding to minimize erosion where runoff from the stockpile area reports to the pond.

Where a Diversion Berm is present along the upstream edge of the pond, the Diversion Berm will be constructed on top of the Intermediate Bedding as shown on the Drawings.

5.3 DAM CLASSIFICATION

The Sedimentation Pond is classified as a LOW consequence structure (CDA, 2007) based on the following criteria:

- There is no downstream population at risk.
- There is no potential for loss of life.
- The potential environmental losses are considered to be short term and include erosion and sedimentation of downstream waterways (i.e. the Mary River).
- The potential economic losses are considered to be limited. There is no mine site infrastructure downstream of the Sedimentation Pond. Economic loses are likely to be limited to repairs of the affected structure.

The CDA recommends that LOW consequence dams be designed based an annual exceedance frequency of 1 in 100 years for flood and earthquake hazards.

The 1 in 200-year design storm event (72 mm of rainfall in 24 hours) has been adopted for the design of the runoff management measures, including the Sedimentation Pond spillway and the Collection/Diversion Berms based on the project design criteria.

The peak ground acceleration for the 1 in 100-year earthquake event is 0.019g (NRC, 2015). The PGA is specified for Site Class C (NRCC, 2010) corresponding to firm ground with an average shear wave velocity of 450 m/s in the upper 30 m.

5.4 STORAGE CAPACITY

The Sedimentation Pond capacity has been developed for the following (from bottom to top):

- Temporary sediment storage up to a depth of approximately 0.5 m.
- An operating water pond capacity of approximately 3,500 m^3 to temporarily store runoff collected from the contributing catchment areas resulting from the 1 in 10 year, 24-hour rainfall event (Hatch, 2013). This runoff volume was estimated by multiplying the total contributing catchment area by the rainfall depth by the relevant runoff coefficient of 0.9 for all contributing areas except the pond itself which has a runoff coefficient of 1.0.
- A flow depth of 0.3 m through the Emergency Overflow Spillway which has been sized to safely convey the runoff resulting from the 1 in 200 year, 24-hour rainfall event.
- A freeboard depth of 0.3 m.

Based on the information provided, the 1 in 10 year, 24-hour rainfall event of 41 mm is larger than the 1 in 10 year, one day freshet runoff depth of 32 mm which includes rainfall and snowmelt (Golder, 2018c). The Sedimentation Pond configuration has been developed assuming that the pond is empty when the 1 in 10 year, 24-hour rainfall event occurs.

The Sedimentation Pond has been designed to allow for some settling of total suspended solids (TSS) prior to the runoff being removed from the pond. The pond is sized to temporarily contain runoff resulting from the 1 in 10 year, 24-hour rainfall event, and has a L:W ratio of approximately 5:1 which aids in settling of suspended solids by reducing the potential for short-circuiting (British Columbia Ministry of Environment (BCMOE), 2015). The sedimentation pond should be maintained empty during normal operating conditions. Baffinland will be responsible for implementing appropriate de-watering measures and procedures to remove runoff collected in the Sedimentation Pond. Continuous pumping may be necessary in order to manage potentially higher inflows during freshet.

5.5 LINER

It is understood that Baffinland has purchased geomembrane liner and non-woven geotextile for the pond from Western Tank and Lining Ltd. (Western). The previous design for the KM107 Stockpile Sedimentation Pond (KP, 2018) included 40 mil Atarfil Linear Low Density (LLD) liner above a 10 oz/yd^2 non-woven geotextile liner based on recommendations by Western. The technical specifications for the LLD liner and the non-woven geotextile are provided in Appendix A. KP understands that Western has recent experience installing the Atarfil LLD liner in cold conditions, as cold as -36 °C, and that the liner has cold crack resistance to -40 °C (C. Powell, Western Tank and Lining Ltd, personal communication, August 13, 2018). Based on Baffinland's previous experience with this lining system, the recommendations provided by Western are judged to be suitable for the Sedimentation Pond.

A 0.2 m thick layer of Intermediate Bedding will be placed along the upstream slopes of the perimeter berm and over the basin to act as a cushion layer for the geomembrane liner. It will be necessary to closely monitor the geomembrane liner for holes, tears and other leaks, and to complete any necessary repairs promptly.

It is recommended that all geomembrane liners and non-woven geotextile be stored indoors at temperatures above 0 °C prior to installation in order to maintain maximum workability. The geosynthetics specifications are provided on Drawing 301.

The design provided herein assumes that the upper surface of the geomembrane liner is exposed, consistent with our understanding of other sedimentation ponds on site. When a liner is left exposed, there is potential for physical damage from ice in the pond. As such, the pond should only be drained when there is no ice present. In addition, regular monitoring and maintenance of the liner will be performed consistent with the requirements of the Type A Water License 2AM-MRY1325 for physical damage or degradation.

5.6 SPILLWAY DESIGN

The Sedimentation Pond's Emergency Overflow Spillway has been sized to safely convey the peak flow resulting from the 1 in 200 year, 24-hour rainfall event following the project design criteria (Hatch, 2013). The peak flow resulting from this event was estimated by applying an SCS Type I distribution to the design rainfall depth of 72 mm in HydroCAD® (2015). The peak runoff flow was estimated as 1.22 m^3/s. In order to pass this flow, the spillway is required to have a minimum base width of 5 m and an inlet depth of 0.3 m.

The spillway will consist of a trapezoidal shaped inlet and channel to be constructed through the crest of the perimeter berm, at the location shown on Drawing 320. The spillway inlet and channel on the downstream slope of the perimeter berm will be lined with Riprap. Details are provided on Drawings 320 and 321. A riprap apron will be installed at the base of the spillway outlet channel to dissipate energy as the runoff leaves the spillway. The peak flow estimated from HydroCAD® (2015) was used, with the

Sedimentation Pond spillway section geometry developed in the flood routing model, to estimate the median particle size (D_{50}) of the riprap lining required to resist berm erosion and scour (Smith and Kells, 1995).

5.7 COLLECTION/DIVERSION BERMS

In order to direct runoff originating within the KM106 Stockpile area to the Sedimentation Pond, a series of berms will be constructed around the perimeter of the stockpile, except where the stockpile is directly adjacent to the existing haul road. Additional berms will be constructed between the Sedimentation Pond and undisturbed upstream areas in order to divert runoff from those areas around the pond and to the environment. Construction of each berm will result in the formation of a channel between the berm and the stockpile, or the berm and the natural ground slope. Where existing ground conditions permit, natural overburden material may be excavated to form part of the channel and any suitable excavated material used to form the berm.

The Collection/Diversion Berms were sized for a 1 in 200 year, 24-hour rainfall event by treating the space between the berm's upstream slope and the stockpile slope (or the natural ground) as the two sides of a trapezoidal channel, with a base width of approximately 2.5 m. A freeboard depth of 0.3 m was included in the berm sizing to account for minor variations in the berm cross section and grade following construction.

The peak flows estimated from HydroCAD® (2015) were used in the flood routing model, with the typical Collection/Diversion Berm section details, to estimate the median particle size (D_{50}) of the riprap lining required to resist berm erosion and scour (Smith and Kells, 1995).

A v-shaped channel will be formed between the existing Haul Road and the west side of the KM106 stockpile. Coarser material is expected to collect in this channel due to gravity separation during end dumping activities. This coarser material will partially armour this channel during storm events. There is potential for some erosion of this channel to occur during the design storm event. The erosion, if any, can be repaired by placing additional material in this area during normal dumping activities.

6.0 STABILITY

6.1 GENERAL

Infinite slope and limit equilibrium stability modelling was completed to evaluate the stability of the KM106 Stockpile (including the Access Road) and the Sedimentation Pond berm under the expected loading and foundation conditions. Limit Equilibrium stability analyses were completed using SLOPE/W©, a two-dimensional Limit-Equilibrium slope stability program (Geo-Slope, 2018). The stability models incorporated the proposed embankment/berm configurations and the estimated strength of the foundation and fill materials. Three representative cross sections including two cross sections through the KM106 Stockpile and one cross section through the Sedimentation Pond, shown on Figure 2, were evaluated based on the embankment/berm height and foundation conditions.

The following sections describe the loading conditions, materials and results of the stability analyses.

6.2 LOADING CONDITIONS AND TARGET FACTORS OF SAFETY

The stability models evaluated the following loading conditions:

- **Long-Term, Static Loading**
  - *KM106 Stockpile and Access Road* - The stability models for the KM106 Stockpile and Access Road incorporated the full weight of the Stockpile and Access Road fill and a fully loaded

and stationary CAT 793 truck. The rear axle of the CAT 793 truck was modelled as a surcharge load 9 m wide and 1 m deep with an effective pressure of 265 kN/m^3. The location of the truck load was evaluated at 3 m from the edge of the stockpile based on the Combined Dump Procedures (Baffinland, 2013).

- o *Sedimentation Pond* - The upstream slopes were evaluated with the pond empty. The downstream slopes were evaluated with the water level at El. 267.9 m corresponding to the maximum filling elevation.

- **Pseudo-Static Loading -** A horizontal seismic coefficient equal to the full PGA of 0.019g corresponding to the 1 in 100-year event was applied for the pseudo-static loading condition. Using this method, a FoS greater than 1.0 indicates that the slope is not sensitive to seismic loading. The water levels and surcharge loads applied to the long-term, static loading analyses were adopted for the pseudo-static loading analyses.
- **Post-Earthquake Loading -** Any strength reduction in the fill and foundation materials following an earthquake event is expected to be negligible. As such, post-earthquake loading conditions were not evaluated and are considered to be identical to the long-term, static loading conditions.

The KM106 Stockpile and Access Road will be constructed on a natural slope using material that is end dumped in thick lifts with minimal compaction. This method of fill placement will produce slopes that are at the angle of repose for the material and have a corresponding Factor of Safety (FoS) of 1.0 for surficial slope movement. As such, the slopes are expected to deform over time, and may exhibit surface sloughing and cracking. Winter construction will encourage aggregation of the permafrost into the fill and enhance the overall stability, provided snow and ice are not encapsulated in the fill.

The minimum FoS targets developed for the analysis are summarized in Table 2.

Table 2 Target Minimum FoS for the KM106 Stockpile and Access Road

Loading Condition	FoS
Long-Term, Static Loading	1.2
Pseudo-Static	1.0

The Sedimentation Pond is classified as a dam following the Canadian Dam Association Dam Safety Guidelines (CDA, 2007 and 2013). The recommended minimum FoS for embankment dams following the CDA Guidelines are summarized in Table 3:

Table 3 Recommended Minimum FoS for the Sedimentation Pond (CDA, 2007)

Loading Condition	FoS
Long-Term, Static Loading	1.5
Pseudo-Static	1.0
Post-Earthquake	1.2

6.3 MATERIALS AND PARAMETERS

Site investigations consisting of geotechnical drilling were completed in the area of the proposed KM106 Stockpile and Sedimentation Pond (KP, 2019). The stratigraphy generally consists of

the following geotechnical units:

- Glacial Till - consisting of gravelly SAND, some silt, trace clay with cobbles and boulders. The surficial soils are generally well-graded, non-plastic, medium greyish brown, massive, and moist.
- Bedrock - consisting of very strong and fresh to slightly weathered gneiss.

The Glacial Till was observed to be discontinuous across the site, varying in thickness from less than 0.5 m below the KM106 Stockpile to 4 m in areas south of the proposed stockpile. Bedrock outcrops were observed at surface across the site. Massive ice was not encountered during the drilling. The stability analyses incorporate a foundation consisting of 0.5 m of Glacial Till overlying competent bedrock.

The material parameters for the fill and foundation units were estimated based on typical correlations (Carter and Bentley, 2016) and are summarized in Table 4. The Rockfill for the KM106 Stockpile was modelled using a relationship between the shear strength of rockfill and the applied shear stress following Leps (1970) and modification recommended by Yamaguchi et al (2009). The material parameters are estimated based on thawed conditions and do not include the potential strength contribution of the aggrading permafrost, if any.

6.4 RESULTS

The results of the stability analyses are summarized in Table 5 and illustrated on Figures 3 to 6. The results indicate the following:

- KM106 Stockpile and Access Road (Figures 3 and 4):
  - The target FoS is achieved.
  - The material will be end dumped at the angle of repose with a FoS equal to unity at the edge of the slope. As such, sloughing and cracking may develop in this area and regular monitoring is required. Trimming of the outer slope of the Stockpile and Access Road may be necessary to maintain the design geometry and grading of the Access Road to maintain access.
- Sedimentation Pond (Figures 5 and 6) - The computed FoS exceed the recommended values for all cases.

7.0 CONSTRUCTION DETAILS

7.1 GENERAL

All construction materials must be maintained free of visible ice, snow and other deleterious materials prior to placement. Geotextiles and geomembranes must be protected from UV exposure, and stored and handled in accordance with the manufacturer's recommendations. Snow and ice must be removed from the footprint of the proposed structures prior to construction.

The locations and configurations of the KM106 Stockpile, Access Road, Sedimentation Pond and associated runoff management measures may change based on actual encountered site conditions.

The following sections provide general construction requirements and recommendations related to the Access Road, Sedimentation Pond and associated runoff management measures. Details, including material specifications and compaction requirements, are provided on the Drawings.

7.2 EROSION AND SEDIMENT CONTROL

Baffinland will employ a combination of sediment and erosion control measures as outlined in Baffinland's

Environmental Protection Plan (Baffinland, 2016a), and Surface Water and Aquatic Ecosystems Management Plan (Baffinland, 2016b), to address and manage sedimentation concerns during construction of the KM106 Stockpile, Access Road, Collection/Diversion Berms and Sedimentation Pond.

7.3 SURVEYING

Setting out details are provided on the Drawings for each of the structures. The structures will be located using suitably accurate surveying methods.

As-built surveys will be required following construction of each of the structures. The surveys will be sufficiently detailed to properly document the completed construction.

7.4 FOUNDATION PREPARATION

The site investigation results suggest that overburden soils located in the foundation areas are not ice rich, and that significant layers of organics or other unsuitable materials are not present. As such, disturbance to the original ground (excavation, scarifying, etc.) should be minimized so as to not impact current permafrost conditions. The foundations must be maintained clear of snow, ponded water and ice.

7.5 KM106 STOCKPILE AND ACCESS ROAD

The stockpile and access road will be constructed starting from the edge of the existing Haul Road. The fill material will be dumped and pushed with a bulldozer. The stockpile dumping face will be monitored by Baffinland site personnel and operators working in the area according to standard dumping procedures (Baffinland, 2013). Any potential settlement and cracking of the access road and/or stockpile dump face will be monitored and addressed as necessary with additional fill placement and/or grading.

7.6 SEDIMENTATION POND

Following foundation preparation, 500 mm Minus Rockfill and Berm Fill will be placed and compacted to construct the Sedimentation Pond perimeter berm (Drawings 320 and 321). Intermediate Bedding will be placed over the compacted Berm Fill, along the upstream slope, and over the floor of the pond. The integrated geomembrane and non-woven geotextile will be installed over the Intermediate Bedding layer. Specifications for the geosynthetics installation are shown on Drawing 301.

The Emergency Overflow Spillway will be constructed as part of the pond perimeter berm construction. For the spillway, 12 oz/yd^2 non-woven geotextile (or approved equivalent) will be placed over the prepared foundation of the spillway inlet and channel invert and side slopes. Fine Riprap will be tightly placed over the geotextile along the spillway inlet invert and side slopes. Coarse Riprap will be tightly placed over the geotextile along the spillway channel invert and side slopes, and a Coarse Riprap apron will be tightly placed over the geotextile at the outlet of the spillway channel. Typical sections and details are provided on Drawings 320 and 321.

Prior to placement of the Intermediate Bedding layer, care must be taken to ensure that the final surface of the underlying prepared foundation is smooth and uniform. No angular particles or voids may be present.

7.7 COLLECTION/DIVERSION BERMS

Berm Fill will be placed and compacted to construct the Collection/Diversion Berms. Non-woven geotextile will be placed over the upstream slope of the berm and the crest to provide a barrier against the migration of finer materials. Fine Riprap will be placed over the non-woven geotextile to form a tightly interlocking layer. A typical Collection/Diversion Berm section is provided on Drawing 320.

7.8 MATERIALS AND QUANTITIES

A summary of materials and quantity estimates for the Access Road, Sedimentation Pond and runoff management measures is presented in Table 6. The materials and quantities are based on the drawings included herein. In general, quantities have been estimated using neat line measurements from the Drawings and are based on the typical sections and details provided on the Drawings. No contingencies have been included.

7.9 CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Construction Quality Assurance/Quality Control (QA/QC) shall be completed in general accordance with the specifications for the Waste Rock Facility Pond Expansion (Golder, 2018c). Technical specifications specific to the KM106 Stockpile and runoff management measures have been provided as notes and details on the attached drawings. The following general comments are provided relative to the QA/QC requirements

- It is assumed that a qualified Engineer will oversee and document construction of the Access Road, Sedimentation Pond and associated runoff management measures.
- Daily inspections should be carried out during construction to verify the suitability of the fill materials.
- The foundation must be approved and documented by the supervising Engineer prior to fill placement.
- Geosynthetic materials shall be installed as per the manufacturer's specifications and recommendations. The geosynthetics contractor will be responsible for performing and documenting the geosynthetics QC program.
- Qualified personnel will be responsible for conducting the QC testing and inspections required on all placed and compacted fill materials.
- A qualified Engineer that is licensed in Nunavut will be responsible for preparing and sealing as-built documentation for the completed work.

8.0 INSPECTIONS AND MAINTENANCE

Material placement and runoff management for the KM106 Stockpile will need to be closely monitored during operation of the stockpile area, including use of the Access Road, and operation of the Sedimentation Pond and runoff management measures. The Sedimentation Pond will need to be emptied in a timely manner following a runoff event or during freshet such that the pond is empty during normal operating conditions. Ongoing inspections and maintenance will be required to ensure that each of these structures are being operated as designed and that the Collection/Diversion Berms and Sedimentation Pond water removal system and Emergency Overflow Spillway are performing as designed. The recommended inspections are described below:

- As required, based on Baffinland's standard operating procedures (In progress)
  - Inspect the Access Road for any cracks, settlement or rutting of the road surface.
  - Inspect the Safety Berms along the Access Road to ensure they are in good condition and have the design configuration.
  - Inspect the water removal system from the Sedimentation Pond to ensure each component is performing as designed.
  - Inspect the Sedimentation Pond to ensure the liner is in good condition, there are no visible holes or leaks, there is no erosion of the berms, and the berms and spillway are performing as designed

- Inspect the Collection/Diversion Berms to ensure there is no erosion of the berms and that no material is blocking flow along the Collection/Diversion Berms.

- Prior to Freshet, Following Freshet and After Any Large Storm Event
  - Inspect Access Road to ensure there is no erosion of fill materials.
  - Inspect the Collection/Diversion Berms to ensure there is no erosion of the berms and that no material is blocking flow along the Collection/Diversion Berms.
  - Inspect the Sedimentation Pond to ensure the liner is in good condition, there are no visible holes or leaks, there is no erosion of the berms, and the berms and spillway are performing as designed.

- Biannually
  - In accordance with Part D., Clause 18 of the Mary River Project Water License (NWB, 2014), "inspections of earthworks and geological and hydrological regimes of the Project" will be conducted "biannually during the summer or as otherwise approved by the Board in writing. These inspections shall be conducted by a Geotechnical Engineer…".

9.0 CLOSING

We trust that this letter provides you with the information you require at this time. Please feel free to contact us if you require any additional information.

Yours truly,
Knight Piésold Ltd.

Prepared:

Amy L. Adams, Ph.D., P.Eng., P.E.
Project Engineer

Prepared:

Deena Duff, P.Eng.
Senior Engineer

REGISTERED PROFESSIONAL ENGINEER
K.E. HAWTON
LICENSEE
June 20/19
NWT/NU

PERMIT TO PRACTICE
KNIGHT PIESOLD LTD.
Signature
Date June 20/2019
PERMIT NUMBER: P 547
The Association of Professional Engineers, Geologists and Geophysicists of NWT/NU

Reviewed:

Kevin Hawton, P.Eng.
Specialist Engineer | Associate

Approval that this document adheres to Knight Piésold Quality Systems:

Attachments:

Table 1 Rev 0	Design Criteria
Table 4 Rev 0	Summary of Material Parameters for Slope Stability Analyses
Table 5 Rev 0	Summary of Slope Stability Results
Table 6 Rev 0	Schedule of Materials and Estimated Quantities
Figure 1 Rev 0	Estimated Catchment Areas
Figure 2 Rev 0	Slope Stability Section Locations
Figure 3 Rev 0	Slope Stability Results - KM106 Stockpile - Section 1
Figure 4 Rev 0	Slope Stability Results - KM106 Stockpile - Section 2
Figure 5 Rev 0	Slope Stability Results - Sedimentation Pond - Static, Long-Term Loading
Figure 6 Rev 0	Slope Stability Results - Sedimentation Pond - Pseudo-Static Loading
Drawing 300 Rev 0	General Arrangement
Drawing 301 Rev 0	Specifications
Drawing 310 Rev 0	Access Road - Plan and Sections
Drawing 320 Rev 0	Sedimentation Pond and Runoff Management Measures - Plan, Section and Details
Drawing 321 Rev 0	Sedimentation Pond and Runoff Management Measures - Sections and Detail
Appendix A	Geomembrane and Non-Woven Geotextile Information

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Copy To: Roger Doyle, Baffinland Iron Mines Corporation
Matt Brown, Baffinland Iron Mines Corporation
Trevor Brisco, Baffinland Iron Mines Corporation
Simon Fleury, Baffinland Iron Mines Corporation
Saroosh Syed, Baffinland Iron Mines Corporation

/ala

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TABLE 1

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

DESIGN SUMMARY FOR THE KM106 STOCKPILE AND RUNOFF MANAGEMENT MEASURES
DESIGN CRITERIA

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Item No.	Item	Design Criteria	Reference
1.0	**GENERAL**		
1.1	Regulatory	• Water Licence No. 2AM-MRY1325 Amendment No. 1	NWB, 2014
		• Nunavut Mine Health and Safety Act and Regulations	MHSA, 2011
		• Nunavut Waters and Surface Rights Tribunal Act and Nunavut Waters Regulations	NWNSRTA, 2018
		• Metal and Diamond Mining Effluent Regulations (MDMER)	MDMER, 2018
		• Fisheries Act	Fisheries Act, 2016
1.2	Guidelines and Reference	• Civil Design Criteria	Hatch, 2013 and 2018
		• Canadian Dam Association Dam Safety Guidelines (2007, 2013)	CDA, 2007 and 2013
2.0	**WATER MANAGEMENT**		
2.1	General	• Runoff from the upstream catchment areas will be diverted around the KM106 Stockpile and Access Road, and around the Sedimentation Pond	-
		• Meteoric water reporting to the KM106 Stockpile will be collected and temporarily stored in the Sedimentation Pond	-
		• A spillway in the Sedimentation Pond will convey excess runoff from the KM106 Stockpile	-
2.2	Design Storm Events	• Sedimentation Pond designed to provide temporary storage for runoff resulting from the 1 in 10 year, 24-hour rainfall event	Hatch, 2013 and 2018
		• Ditches and berms sized to convey flows resulting from the 1 in 200 year, 24-hour rainfall event	KP (based on Hatch, 2013)
		• Emergency overflow spillway (Sedimentation Pond) sized to convey flows resulting from the 1 in 200 year, 24-hour rainfall event	Hatch, 2013
		• Storm events are rain only events; no snowfall or snowmelt is included	KP Estimate
2.3	Hydrological Parameters	• Catchment Areas:	
		o KM106 Stockpile: approximately 7.4 ha	Estimated from mapping provided by Baffinland
		o Sedimentation Pond: approximately 0.7 ha	Estimated from mapping provided by Baffinland
		o Upstream of Sedimentation Pond: approximately 0.6 ha	Estimated from mapping provided by Baffinland
		• Runoff Coefficients:	
		o KM106 Stockpile: 0.9	Hatch, 2013
		• Time of Concentration Method:	KP Estimate
		o KM106 Stockpile: Kirpich (1940)	-
		o Upstream Areas: Kirpich (1940)	-
		• Rainfall Distribution: SCS Type I	KP Estimate
		• SCS Curve Number:	
		o KM106 Stockpile: 89	KP Estimate
		o Undisturbed/Upstream: 86	KP Estimate
2.4	Meteorological Parameters	• Return Period Rainfall Events:	
		o 1 in 10 year, 24-hour rainfall event: 41 mm	Hatch, 2013
		o 1 in 200 year, 24-hour rainfall event: 72 mm	Hatch, 2013
2.5	Ditch Parameters	• Shape: Trapezoidal cross section	Hatch, 2013
		• Base Width: 0.5 m minimum	Hatch, 2013
		• Side Slopes: 2H:1V (soil)	Hatch, 2013 and 2018
		• Grade: 0.2% minimum	Hatch, 2018
		• Depth: 0.3 m minimum	Hatch, 2013
		• Freeboard: 0.3 m	Hatch, 2013
		• Manning's "n" Value: 0.040 (riprap)	Hatch, 2013
2.6	Diversion Berms	• Shape: Trapezoidal cross section	Hatch, 2013
		• Side slopes: 2H:1V	Hatch, 2018
		• Freeboard: 0.3 m	Hatch, 2018
		• Height: 1 m minimum (including 0.3 m freeboard)	Hatch, 2013
		• Top Width: 0.5 m	Hatch, 2013 and 2018
3.0	**Construction Materials**		
3.1	Source	• Approved sources following Water Licence No. 2AM-MRY1325 Amendment No. 1	NWB, 2014
3.2	Quality	• Clean, free of debris and organics (see Drawing 301)	KP Estimate
3.3	Description	• 500 mm Minus Rockfill: Well graded; consisting of hard, durable, fresh rockfill	KP Estimate
		• Berm Fill: Well graded, 150 mm minus processed rockfill	KP Estimate
		• Intermediate Bedding: 32 mm minus sand and gravel, gradation as per Golder, 2018a	Golder, 2018a
		• Riprap: Maximum particle diameter not exceeding one and a half times the specified D_{50} value, well graded, with a fines content not exceeding 5%	KP Estimate (based on Golder, 2018a)
		o Fine Riprap: D_{50} of 150 mm	
		o Coarse Riprap: D_{50} of 300 mm	
4.0	**KM106 STOCKPILE**		
4.1	Geometry	• Footprint Area: 7.1 ha	Estimated from mapping provided by Baffinland
4.2	Condition	• Not lined; constructed on existing ground after clearing	Baffinland
5.0	**ACCESS ROAD**		
5.1	Design Vehicle	• Caterpillar (CAT) 793F Mining Truck	Baffinland
		• Truck Width: 8.6 m	Caterpillar, 2017
		• Tire Size: 50/80 R57	Colorado OTR, 2019
		• Tire Diameter: 3.6 m	Michelin, 2018
		• Turning Circle Clearance Diameter: 33 m (radius: 16.5 m)	Caterpillar, 2017
5.2	Road Geometry	• Road Width: 3 times width of CAT 793 haul truck (one-way traffic)	Baffinland
		• Design Speed: 30 km/h	Hatch, 2013
		• Posted Speed: 20 km/h	Hatch, 2013
		• Minimum Horizontal Curve C/L Radius: 50 m	Hatch, 2013
		• Minimum Intersection Inner Radius: 30 m	Hatch, 2013
		• Minimum Cross Slope: 3%	Hatch, 2013
		• Maximum Road Grade: 10%	Hatch, 2013
5.3	Vehicle Safety Berms	• Berm Height: 3/4 of the diameter of the largest wheeled vehicle (CAT 793)	Nunavut Mine Health and Safety Regulations, Surface Haulage Roads, Section 1.143
		• Berm Locations: All areas where drop off is greater than 3 m	Nunavut Mine Health and Safety Regulations, Surface Haulage Roads, Section 1.143
		• Side Slopes: 1H:1V	Hatch, 2013
5.4	Stability	• Factors of Safety:	
		o Static: 1.2	KP
		o Pseudo-Static: 1.0	KP
6.0	**SEDIMENTATION POND**		
6.1	Function	• Function: Runoff management and sedimentation control	Baffinland
6.2	Geometry	• Shape: Rectangular; L:W = approximately 5:1	KP Estimate; BCMOE (2015)
		• Pond Depth: 5 m maximum	Hatch, 2013
		• Berm Side Slopes: 2.5H:1V (upstream); 2H:1V (downstream)	KP Estimate
		• Berm Crest: 6 m	Golder, 2017
		• Freeboard: 0.3 m	Golder, 2017
		• Sediment Storage: approximately 0.5 m deep	KP Estimate
6.3	Liner	• Liner: required	Baffinland
		• Liner installation: Liner to be pre-welded in large panels by Western Tank and Lining Ltd.	Baffinland
		• Geomembrane Liner: Atarfil LLD, 40 mil	Baffinland
		• Non-Geotextile: Texel 100P, 10 oz/yd^2	Western Tank and Lining Ltd.
6.4	Dam Hazard Classification	• Potential Loss of Life: None - no downstream population	KP Estimate
		• Potential Loss to Environmental and Cultural Values:	KP Estimate
		o Short Term - Slope erosion and sedimentation of the Mary River	
		o Long Term - None	
		• Potential Economic Loss: Minimal, associated with repairs to the Sedimentation Pond itself	KP Estimate
		• Dam Hazard Classification: LOW	KP Estimate; CDA, 2013
6.5	Stability	• Factors of Safety:	
		o Static: 1.5	CDA, 2007 & 2013
		o Pseudo-Static: 1.0	CDA, 2007 & 2013
		o Post-Earthquake: 1.2	CDA, 2007 & 2013
6.6	Seismic Design Criteria	• 1 in 100 year event: 0.019g (based on Section 6.4)	CDA, 2013 & NRC, 2015

I:\1\02\00181\57\A\Data\Workfiles\WF03 - Design Criteria Table - KM106 Stockpile\[Design Criteria Table 20190618.xlsx]Table

REV	DATE	DESCRIPTION	PREP'D	RVW'D
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TABLE 4

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

DESIGN SUMMARY FOR THE KM106 STOCKPILE AND RUNOFF MANAGEMENT MEASURES
SUMMARY OF MATERIAL PARAMETERS FOR SLOPE STABILITY ANALYSES

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Material Description	Unit Weight (kN/m3)	Cohesion (kPa)	Effective Friction Angle (°)
Road Embankment Fill	21	0	37
Berm Fill	21	0	37
Rock Fill	21	0	Shear Normal Function [1]
Glacial Till	19	0	34
Bedrock	Impenetrable		

I:\1\02\00181\57\A\Data\Workfiles\WF06 - Updated Stability for KM106 Stockpile\[Summary Tables and Figures -20190618.xlsm]Table 4

NOTES:

1. A SHEAR NORMAL FUNCTION BASED ON AVERAGE VALUES (LEPS, 1970; MODIFIED BY YAMAGUCHI ET AL., 2009) WAS USED TO MODEL THE SHEAR STRENGTH OF THE ROCKFILL.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
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TABLE 5

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

DESIGN SUMMARY FOR THE KM106 STOCKPILE AND RUNOFF MANAGEMENT MEASURES
SUMMARY OF SLOPE STABILITY RESULTS

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Section	Factor of Safety (FoS)			
	Static (Required)	Static (Achieved)	Pseudo-Static (Required)	Pseudo-Static (Achieved)
Stockpile				
Section 1	1.2	1.5	1.0	1.4
Section 2	1.2	1.5	1.0	1.4
Sedimentation Pond				
Upstream	1.5	2.6	1.0	2.4
Downstream	1.5	1.7	1.0	1.6

I:\1\02\00181\57\A\Data\Workfiles\WF06 - Updated Stability for KM106 Stockpile\[Summary Tables and Figures -20190618.xlsm]Table 5

NOTES:

1. STABILITY ANALYSES COMPLETED USING SLOPE/W© (GEO-SLOPE, 2019).
2. STOCKPILE SLOPES ARE 1.3H:1.0V BASED ON THE DESIGN PROVIDED BY BAFFINLAND.
3. DESIGN HAUL TRUCK LOAD ON THE ACCESS ROAD IS THE REAR AXLE OF A FULLY LOADED CAT 793. MODELLED AS A SURCHARGE LOAD 9 m WIDE, 1 m HIGH AT 265 kN/m3.
4. SEDIMENTATION POND EMBANKMENT SIDE SLOPES ARE 2.5H:1.0V UPSTREAM AND 2.0H:1.0V DOWNSTREAM, CREST WIDTH IS 6 m.
5. MAXIMUM DEAD STORAGE ELEVATION OF SEDIMENTS IN SEDIMENTATION POND IS 265 m, MAXIMUM POND ELEVATION IS 268.5 m.
6. A HORIZONTAL SEISMIC COEFFICIENT OF 0.019 g IS APPLIED TO ALL PSEUDO-STATIC ANALYSES (NRCAN, 2015).

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TABLE 6

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

DESIGN SUMMARY FOR THE KM106 STOCKPILE AND RUNOFF MANAGEMENT MEASURES
SCHEDULE OF MATERIALS AND ESTIMATED QUANTITIES

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Item No.	Description	Unit	Estimated Quantity
SEDIMENTATION POND			
1.0	**Earthworks**		
1.1	**Sedimentation Pond Embankment and Basin**		
1.1.1	Prepare Foundation Area	m^2	10,700
1.1.2	Supply, Haul, Place and Compact - 500mm Minus Rockfill	m^3	15,500
1.1.3	Supply, Haul, Place and Compact - Berm Fill	m^3	1,900
1.1.4	Supply, Haul, Place and Compact - Intermediate Bedding	m^3	1,200
1.2	**Emergency Overflow Spillway**		
1.2.1	Supply, Haul, Place - Fine Riprap - Inlet	m^3	12
1.2.2	Supply, Haul and Place - Coarse Riprap - Channel and Apron	m^3	200
1.3	**Diversion Berms**		
1.3.1	Prepare Foundation Areas	m^2	4,300
1.3.2	Supply, Haul and Place - Berm Fill - Diversion Berms	m^3	2,400
1.3.3	Supply, Haul and Place - Fine Riprap - Diversion Berms	m^3	2,310
	Subtotal Item 1.0		
2.0	**Geosynthetics**		
2.1	**Pond Lining**		
2.1.1	Supply and Install - 40 mil Atarifil LLD Geomembrane	m^2	7,500
2.1.2	Supply and Install - Texel 100 P 10 oz/yd^2 Non-Woven Geotextile	m^2	7,500
2.1.3	Supply and Install - 12 oz/yd^2 Non-Woven Geotextile	m^2	3,300
	Subtotal Item 2.0		
ACCESS ROAD			
3.0	**Earthworks**		
3.1	**Road Fill**		
3.1.1	Supply, Haul and Place - Road Embankment Fill or Rockfill	m^3	0 [2]
3.2	**Safety Berms**		
3.2.1	Supply, Haul and Place - Road Embankment Fill or Rockfill [2]	m^3	2,000
3.3	**Haul Road Culverts**		
3.3.1	Supply, Haul, and Place - Coarse Riprap - Apron	m^3	300
	Subtotal Item 3.0		

I:\1\02\00181\57\A\Data\Workfiles\WF07 - Updated Materials and Quantities\[Materials and Quantities Table - SM - 19JUN'19.xlsm]Table 6

NOTES:

1. MATERIAL QUANTITIES ARE BASED ON NEAT LINE MEASUREMENTS OF THE DRAWINGS AND DO NOT INCLUDE ANY CONTINGENCIES.
2. IT IS ASSUMED THAT THE ACCESS ROAD AND SAFETY BERMS WILL BE CONSTRUCTED USING STOCKPILE MATERIALS (ROCKFILL).

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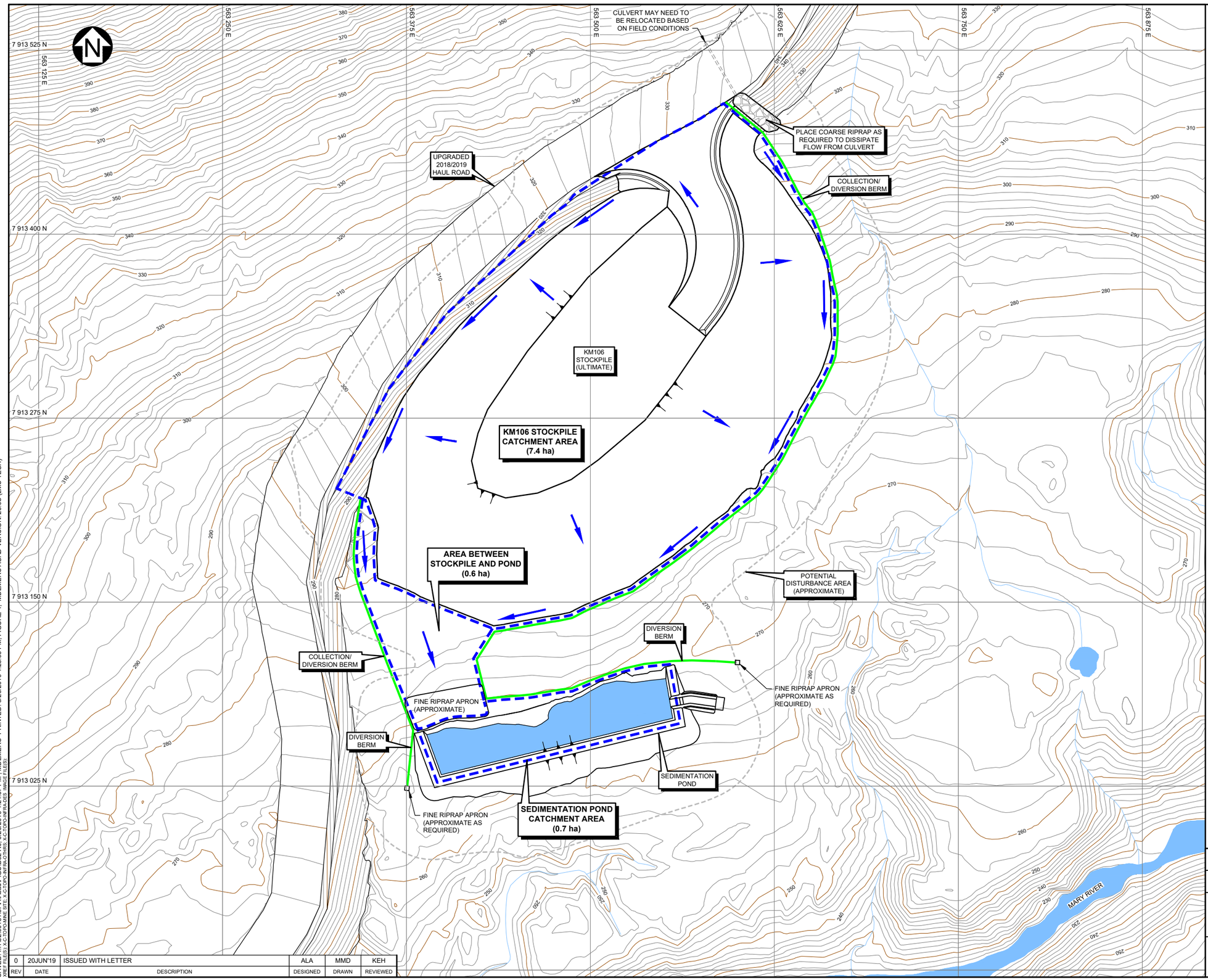

LEGEND:

- WATER
- COARSE RIPRAP
- CULVERT
- COLLECTION/DIVERSION BERM
- ESTIMATED CATCHMENT AREA BOUNDARY
- POTENTIAL DISTURBANCE AREA (APPROXIMATE)
- FLOW DIRECTION

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 17.
2. TOPOGRAPHY BASED ON INFORMATION PROVIDED BY EAGLE MAPPING (2008).
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 2 m.
4. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
5. LOCATIONS AND DETAILS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT ACTUAL SITE CONDITIONS.
6. UPGRADED 2018/2019 HAUL ROAD AND KM106 STOCKPILE PROVIDED BY BAFFINLAND.
7. ALL INFRASTRUCTURE SHOWN IS PROPOSED UNLESS NOTED OTHERWISE.

SCALE A 25 12.5 0 25 50 75 100 125 m

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BAFFINLAND IRON MINES CORPORATION

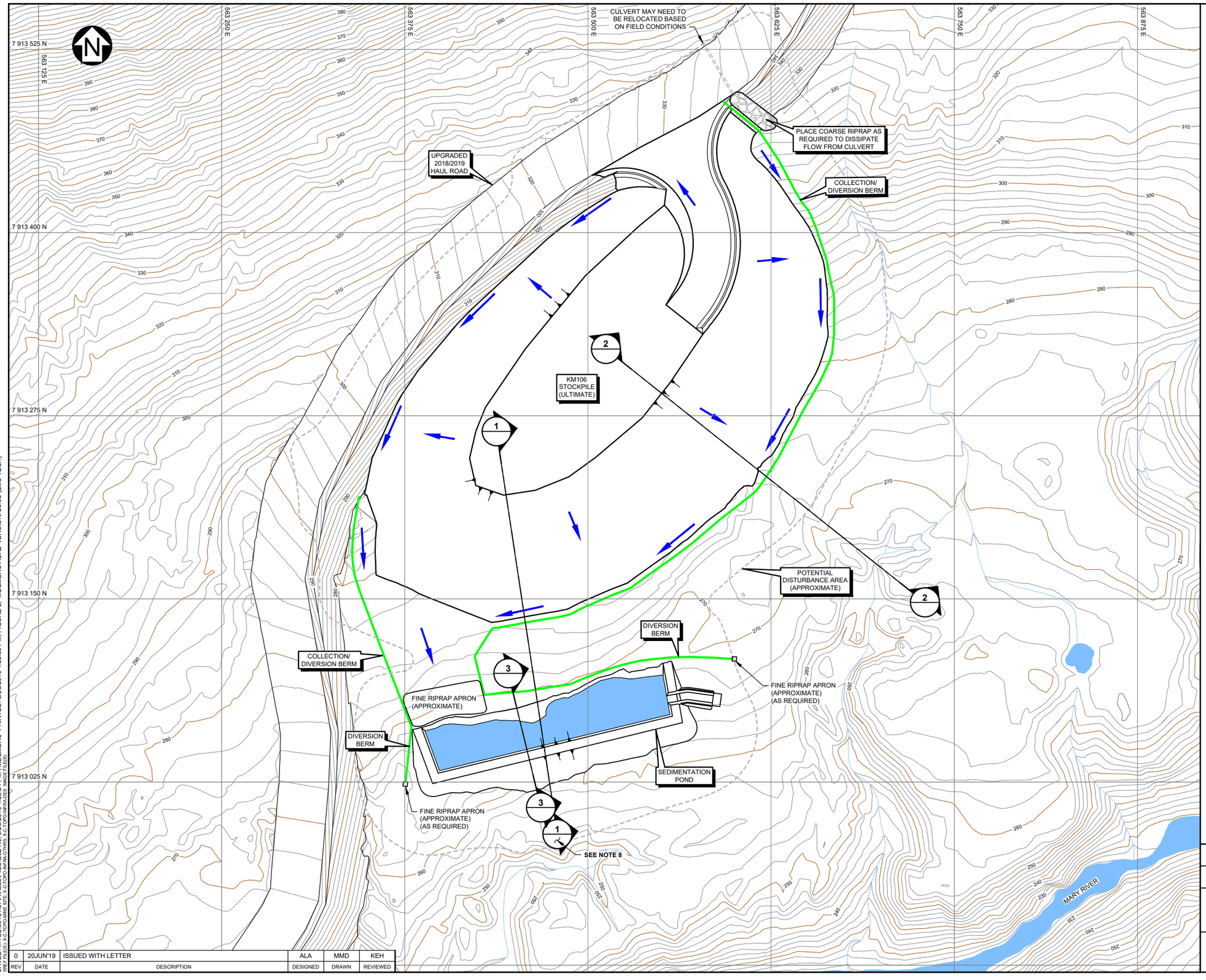
MARY RIVER PROJECT

KM106 STOCKPILE ESTIMATED CATCHMENT AREAS

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/57	NB19-00443

FIGURE 1 REV 0



LEGEND:

- WATER
- COARSE RIPRAP
- CULVERT
- COLLECTION/DIVERSION BERM
- POTENTIAL DISTURBANCE AREA (APPROXIMATE)
- FLOW DIRECTION

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 17.
2. TOPOGRAPHY BASED ON INFORMATION PROVIDED BY EAGLE MAPPING (2008).
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 2 m.
4. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
5. LOCATIONS AND DETAILS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT SITE CONDITIONS.
6. UPGRADED 2018/2019 HAUL ROAD AND KM106 STOCKPILE PROVIDED BY BAFFINLAND.
7. ALL INFRASTRUCTURE SHOWN IS PROPOSED UNLESS NOTED OTHERWISE.
8. STABILITY SECTION NO. 1 DOES NOT INCLUDE THE SEDIMENTATION POND.

SCALE A: 25 12.5 0 25 50 75 100 125 m

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM106 STOCKPILE SLOPE STABILITY SECTION LOCATIONS

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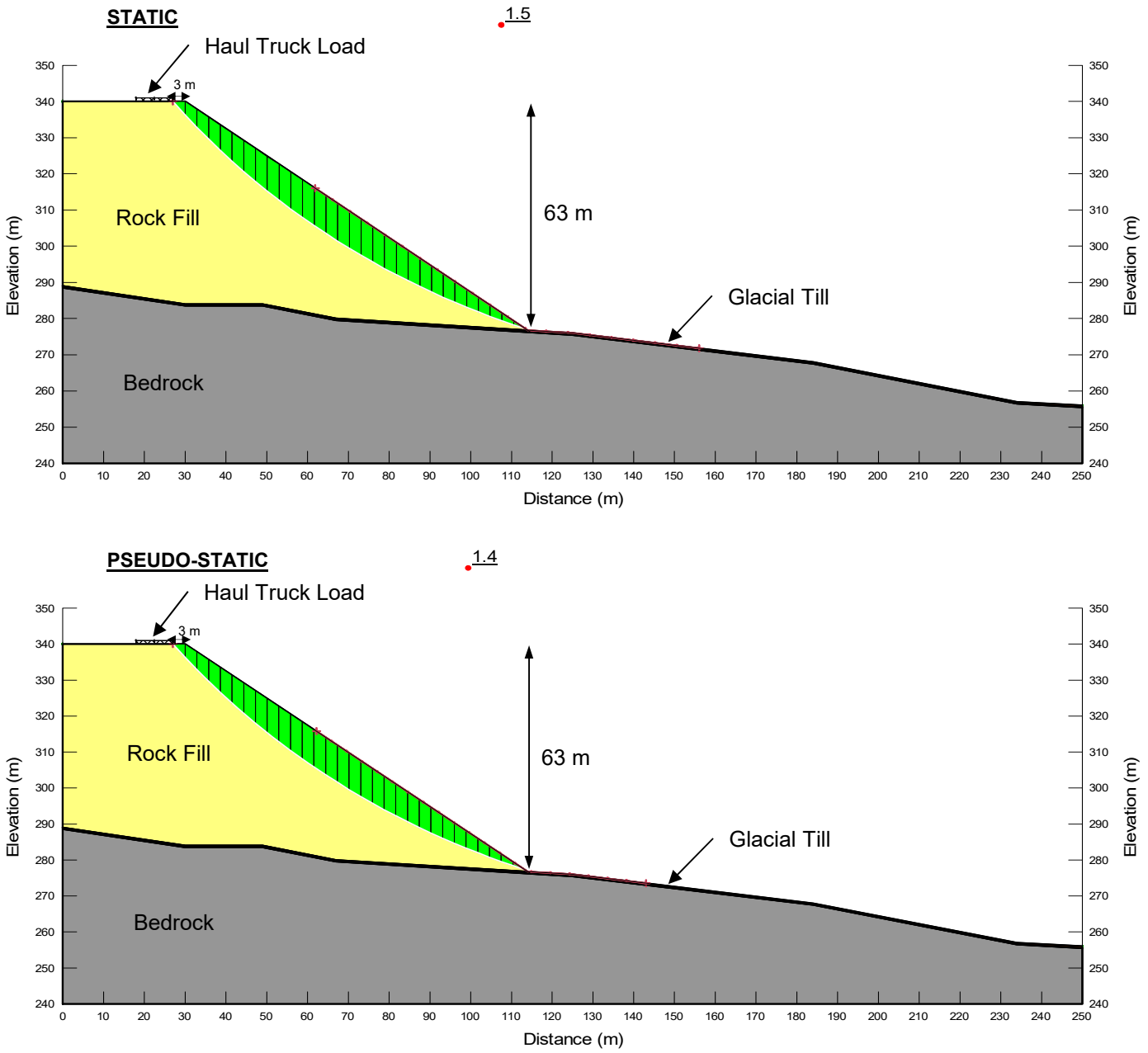
P/A NO. NB102-181/57 | REF NO. NB19-00443

FIGURE 2 | REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	20JUN'19	ISSUED WITH LETTER	ALA	MMD	KEH

SAVED: I:\1102\00181\57\A\Acad\FIGS\B02 R0, 6/20/2019 1:25:24 PM, MDEMERS PRINTED: 6/20/2019 1:25:39 PM, FIGURE 2, MDEMERS ACAD VERSION: 23.0S (LMS TECH)
XREF FILE(S): X-C-TOPO-MINE SITE, X-C-TOPO-INFRA-OTHRS, X-C-TOPO-INFRA-DSS IMAGE FILE(S):



NOTES:

1. STOCKPILE SLOPES ARE 1.3H:1.0V AND ARE BASED ON THE DESIGN PROVIDED BY BAFFINLAND.
2. MINIMUM DISTANCE BETWEEN THE EDGE OF THE HAUL TRUCK AND THE EDGE OF THE STOCKPILE IS 3 m.
3. A HORIZONTAL SEISMIC COEFFICIENT CORRESPONDING TO A PGA OF 0.019g WAS APPLIED TO ALL PSEUDO-STATIC ANALYSES (NRCAN, 2015).
4. DESIGN HAUL TRUCK LOAD IS THE REAR AXLE OF A FULLY LOADED CAT 793. MODELLED AS A SURCHARGE LOAD 9 m WIDE, 1 m HIGH AT 265 kN/m^3.
5. MODEL INCLUDES 0.5 m OF GLACIAL TILL OVERLYING BEDROCK.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	20JUN'19	ISSUED WITH LETTER	AB	ALA

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

SLOPE STABILITY RESULTS
KM106 STOCKPILE
SECTION 1

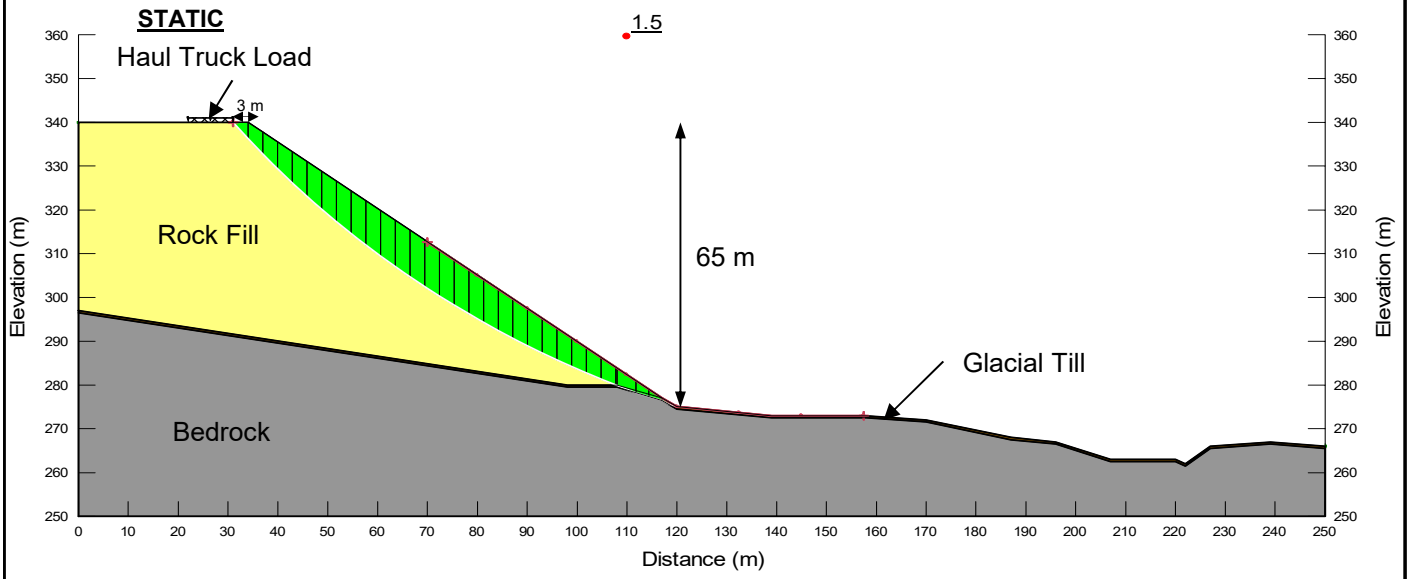
Knight Piésold CONSULTING

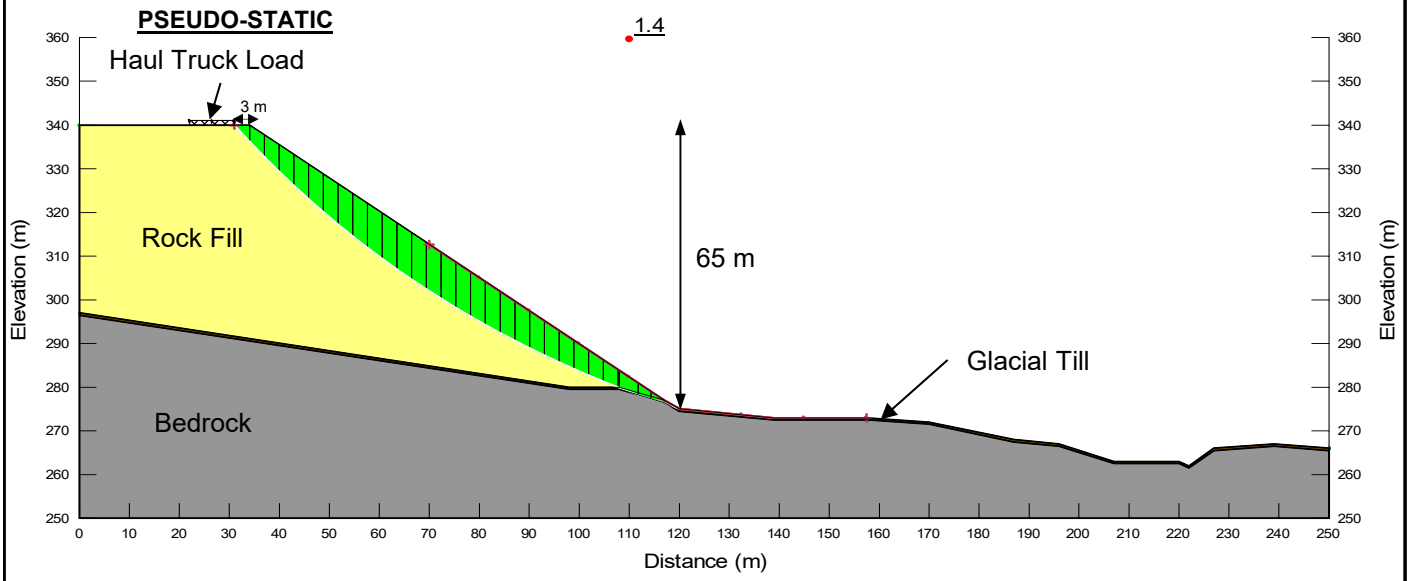
P/A NO. NB102-181/57

REF. NO. NB19-00443

FIGURE 3

REV 0





NOTES:

1. STOCKPILE SLOPES ARE 1.3H:1.0V.
2. HAUL TRUCK TO MAINTAIN A DISTANCE OF 3 m FROM EDGE OF STOCKPILE.
3. A HORIZONTAL SEISMIC ACCELERATION CORRESPONDING TO A PGA OF 0.019g WAS APPLIED TO ALL PSEUDO-STATIC ANALYSES (NRCAN, 2015).
4. DESIGN HAUL TRUCK LOAD IS THE REAR AXLE OF A FULLY LOADED CAT 793. MODELLED AS A SURCHARGE LOAD 9 m WIDE, 1 m HIGH AT 265 kN/m^3.
5. MODEL INCLUDES 0.5 m OF GLACIAL TILL OVERLYING BEDROCK.

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BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

SLOPE STABILITY RESULTS
KM106 STOCKPILE
SECTION 2

Knight Piésold CONSULTING

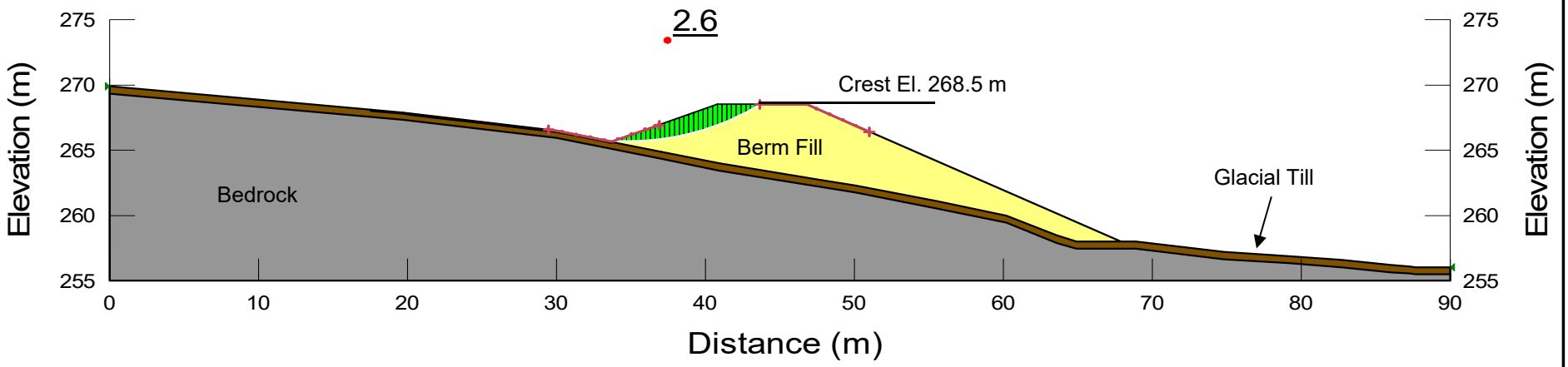
P/A NO. NB102-181/57

REF. NO. NB19-00443

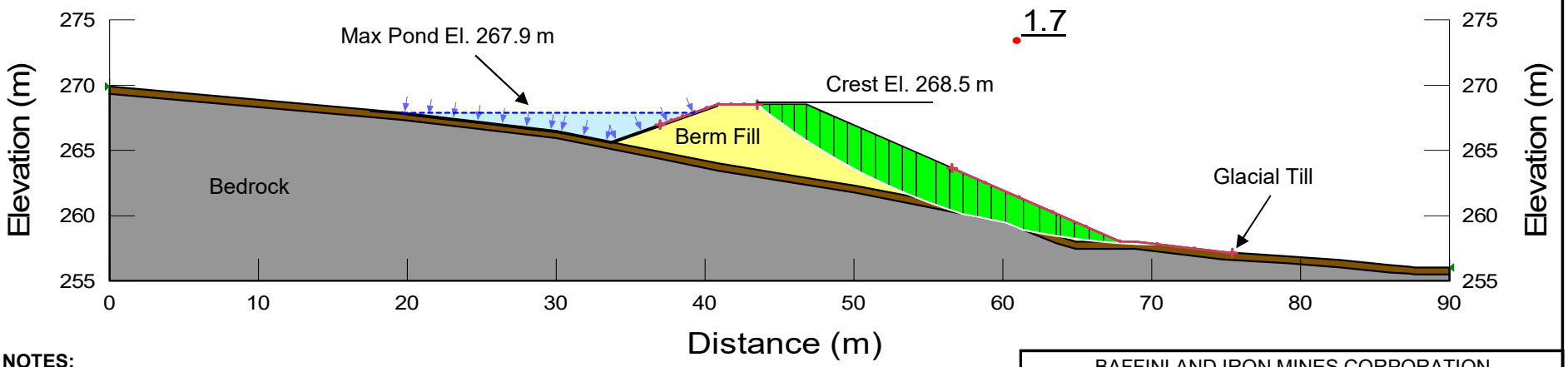
FIGURE 4

REV 0

UPSTREAM SLOPE



DOWNSTREAM SLOPE



NOTES:

1. EMBANKMENT SIDE SLOPES ARE 2.5H:1.0V DOWNSTREAM AND 2.0H:1V UPSTREAM.
2. CREST WIDTH IS 6 m.
3. SEDIMENT DEPOSITS NOT SHOWN IN POND.
4. DOWNSTREAM SLOPE MODELLED AT THE MAXIMUM FILLING LEVEL OF 267.9 m.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	20JUN'19	ISSUED WITH LETTER	AB	ALA

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

SLOPE STABILITY RESULTS
SEDIMENTATION POND
STATIC, LONG-TERM LOADING

Knight Piésold CONSULTING

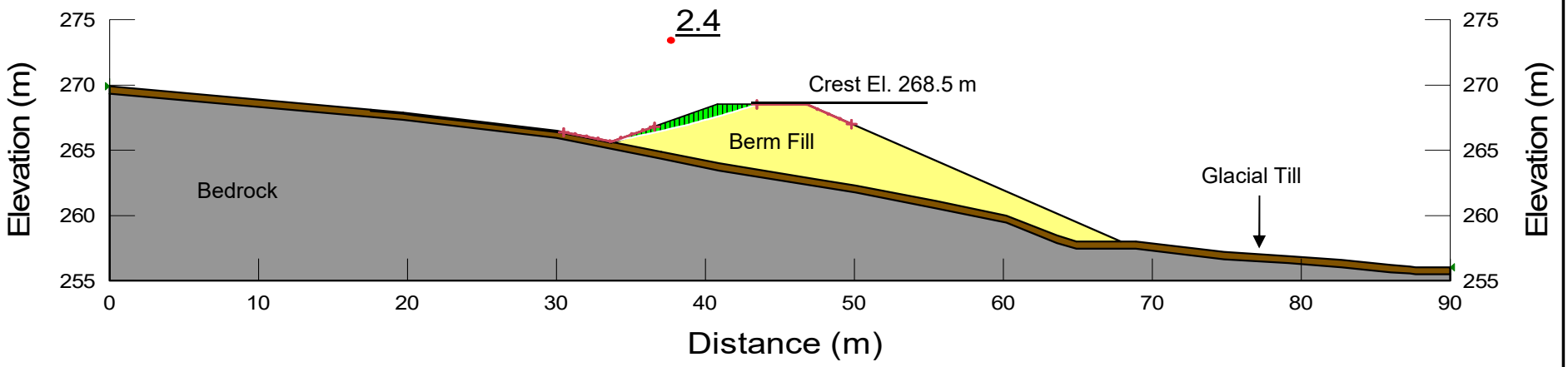
P/A NO. NB102-181/57

REF. NO. NB19-00443

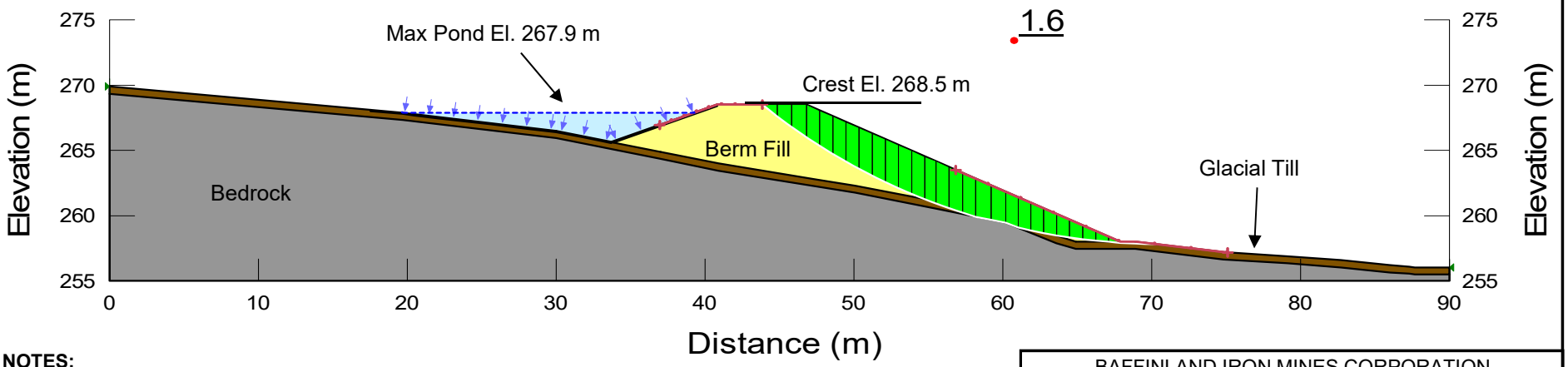
FIGURE 5

REV 0

UPSTREAM SLOPE



DOWNSTREAM SLOPE



NOTES:

1. EMBANKMENT SIDE SLOPES ARE 2.5H:1.0V DOWNSTREAM AND 2.0H:1V UPSTREAM.
2. CREST WIDTH IS 6 m.
3. SEDIMENT DEPOSITS NOT SHOWN IN POND.
4. DOWNSTREAM SLOPE MODELLED AT THE MAXIMUM FILLING LEVEL OF 267.9 m.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	20JUN'19	ISSUED WITH LETTER	AB	ALA

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

SLOPE STABILITY RESULTS
SEDIMENTATION POND
PSEUDO-STATIC LOADING

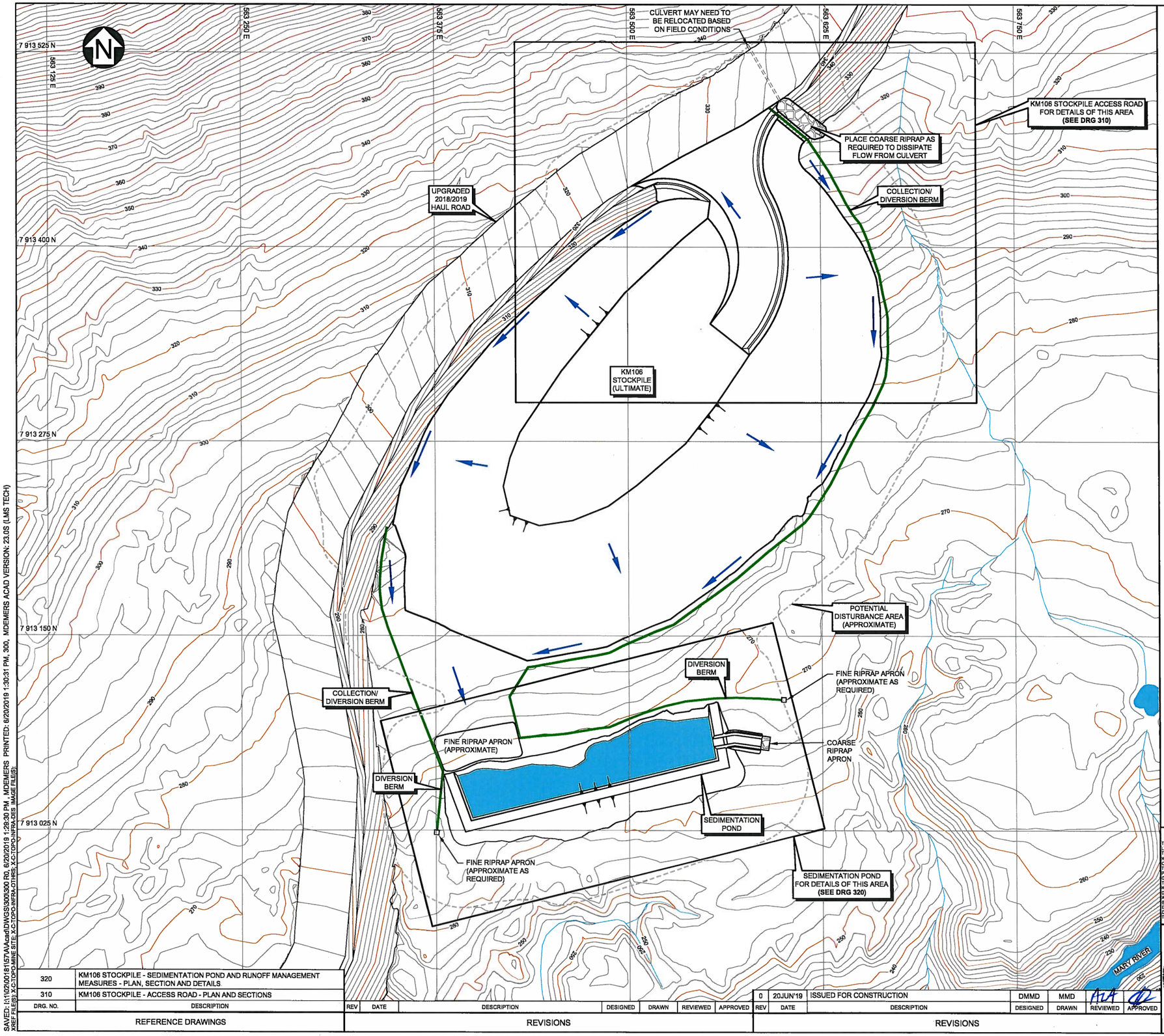
Knight Piésold CONSULTING

P/A NO. NB102-181/57

REF. NO. NB19-00443

FIGURE 6

REV 0



LEGEND:

- WATER
- COARSE RIPRAP
- CULVERT
- COLLECTION/DIVERSION BERM
- POTENTIAL DISTURBANCE AREA (APPROXIMATE)
- FLOW DIRECTION

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 17.
2. TOPOGRAPHY BASED ON INFORMATION PROVIDED BY EAGLE MAPPING (2008).
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 2 m.
4. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
5. LOCATIONS AND DETAILS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT ACTUAL SITE CONDITIONS.
6. UPGRADED 2018/2019 HAUL ROAD AND KM106 STOCKPILE PROVIDED BY BAFFINLAND.
7. FINAL SLOPES SHALL BE TRIMMED TO THE LINES AND TOLERANCES INDICATED ON THE DRAWINGS AND IN THE TECHNICAL SPECIFICATIONS.
8. ALL INFRASTRUCTURE SHOWN IS PROPOSED UNLESS NOTED OTHERWISE.
9. THE DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONTRACT DOCUMENTS AND APPLICABLE TECHNICAL SPECIFICATIONS.
10. FOUNDATION PREPARATION: PROVIDED THE AMOUNT OF ORGANICS AND UNSUITABLE MATERIAL ON THE GROUND IS NEGLIGIBLE, DISTURBANCE TO THE ORIGINAL GROUND (EXCAVATION, SCARIFYING, ETC.) SHOULD BE MINIMIZED SO AS NOT TO IMPACT CURRENT PERMAFROST CONDITIONS. ALTERNATIVE METHODS OF FOUNDATION PREPARATION MAY BE NECESSARY FOR SOME AREAS, AT THE DISCRETION OF THE OWNER'S REPRESENTATIVE. ALL FOUNDATIONS MUST BE MAINTAINED CLEAR OF SNOW, PONDED WATER AND ICE.

ISSUED FOR CONSTRUCTION

SCALE A 25 12.5 0 25 50 75 100 125 m

DRG. NO.	DESCRIPTION
320	KM106 STOCKPILE - SEDIMENTATION POND AND RUNOFF MANAGEMENT MEASURES - PLAN, SECTION AND DETAILS
310	KM106 STOCKPILE - ACCESS ROAD - PLAN AND SECTIONS

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	20JUN'19	ISSUED FOR CONSTRUCTION	DMMD	MMD	AHT	KEH

REVISIONS

REGISTERED PROFESSIONAL ENGINEER
K.E. HAWTON
LICENSEE
June 20/19
NWT/NU

Knight Piésold CONSULTING

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM106 STOCKPILE GENERAL ARRANGEMENT

PROJECT NO.	DRAWING NO.	REVISION
NB102-181/57	300	0

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XREF FILE(S): X-C-TOPO-MINE SITE, X-C-TOPO-INFRA-OTHRS, X-C-TOPO-INFRA-DES IMAGE FILE(S):

GEOSYNTHETICS:

CO-ORDINATION BETWEEN OWNER, ENGINEER AND CONTRACTOR

1. AFTER THE CONTRACTOR HAS COMPLETED PREPARING THE SUBGRADE SURFACE WHICH WILL LIE DIRECTLY BELOW THE GEOSYNTHETICS, THE CONTRACTOR, ENGINEER AND OWNER WILL VERIFY ACCEPTANCE BY SIGNING A FORM WHICH DESCRIBES THE EXTENT OF THE AREA. AT THAT TIME, THE CONTRACTOR ASSUMES RESPONSIBILITY OF PROTECTING THE APPROVED SURFACE, UNTIL IT IS COVERED WITH GEOSYNTHETICS.
2. ANY DAMAGE BY MECHANICAL MEANS CAUSED BY THE CONTRACTOR TO APPROVED SUBGRADE AREAS SHALL BE REPAIRED TO THE SATISFACTION OF THE ENGINEER AT THE EXPENSE OF THE CONTRACTOR. ANY DAMAGE CAUSED BY WEATHER TO APPROVED SUBGRADE AREAS SHALL BE REPAIRED TO THE SATISFACTION OF THE ENGINEER AT THE EXPENSE OF THE OWNER. ANY DAMAGE CAUSED BY WEATHER TO APPROVED SUBGRADE AREAS RESULTING FROM WIND EROSION OR POOR SURFACE RUNOFF CONTROL (E.G. ALLOWING SURFACE RUNOFF ONTO APPROVED AREAS) AS A RESULT OF OPERATIONS OF THE CONTRACTOR SHALL BE REPAIRED TO THE SATISFACTION OF THE ENGINEER AT THE EXPENSE OF THE CONTRACTOR.
3. AFTER INSTALLATION OF THE GEOSYNTHETICS AND FINAL QUALITY CONTROL MEASURES ARE COMPLETED BY THE CONTRACTOR, AREAS RECEIVING COVER MATERIAL SHALL BE CLEARLY IDENTIFIED AND THE ENGINEER SHALL BE NOTIFIED FOR GEOSYNTHETICS INSPECTION. UPON SIGNED ACCEPTANCE BY THE ENGINEER THAT THE GEOSYNTHETICS HAVE BEEN INSTALLED IN ACCORDANCE WITH THE SPECIFICATIONS, IT WILL BE AVAILABLE TO THE CONTRACTOR FOR PLACING THE COVER MATERIAL, WHERE APPLICABLE. AT THAT TIME THE CONTRACTOR WILL ASSUME RESPONSIBILITY FOR MAINTAINING THE CONDITION OF THE PORTION OF THE GEOSYNTHETICS UNTIL IT IS ADEQUATELY COVERED.
4. ANY DAMAGE TO PREVIOUSLY ACCEPTED GEOSYNTHETICS AS A RESULT OF THE CONTRACTOR'S OPERATION WILL BE REPAIRED TO THE SATISFACTION OF THE ENGINEER AT THE CONTRACTOR'S EXPENSE.
5. IN THE EVENT OF CONTRADICTION OR CONFLICT BETWEEN PARTIES MENTIONED ABOVE, QUESTIONS WILL BE TAKEN TO THE ENGINEER AND OWNER FOR FINAL DECISION.

SUBGRADE PREPARATION

1. SUBGRADE PREPARATION SHALL BE CARRIED OUT IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS AND INSTALLATION GUIDELINES.
2. SUBGRADE PREPARATION OVER ROCK SURFACES SHALL REQUIRE THE REMOVAL OF ANY PROTRUDING OBJECT SUCH THAT A SMOOTH GEOMEMBRANE SURFACE IS PROVIDED. NO OVERHANGS, PROTRUSIONS, OR LEDGES OF MORE THAN 0.1 m IN HEIGHT SHALL BE ACCEPTED.
3. PLACEMENT AND COMPACTION OF BEDDING OVER EXPOSED BEDROCK SURFACES SHALL BE CONDUCTED USING PLACEMENT AND COMPACTION METHODS TO SUIT THE SPECIFIC FIELD CONDITIONS. WHERE COMPACTION WITH A STANDARD VIBRATORY ROLLER IS NOT POSSIBLE, ALTERNATIVE COMPACTION EQUIPMENT MAY BE ACCEPTED. THE PLACEMENT AND COMPACTION METHODS MUST BE SUBMITTED TO THE ENGINEER FOR APPROVAL PRIOR TO THEIR IMPLEMENTATION.

DELIVERY, HANDLING AND STORAGE

1. DELIVERY, HANDLING AND STORAGE OF GEOSYNTHETICS MATERIAL SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S PRINTED INSTRUCTIONS.

GEOSYNTHETICS INSTALLATION

1. THE GEOMEMBRANE SHALL BE ATARFIL LLD, 40 mil, OR APPROVED EQUIVALENT. THE GEOTEXTILE SHALL BE TEXEL 100 P, 10 oz/yd², OR APPROVED EQUIVALENT AND SHALL BE INSTALLED IN INTIMATE CONTACT WITH THE GEOMEMBRANE.
2. THE GEOTEXTILE AND GEOMEMBRANE SHALL BE HANDLED IN SUCH A MANNER AS TO ENSURE THAT IT IS NOT DAMAGED IN ANY WAY. THE MATERIALS SHALL BE STORED INDOORS AT TEMPERATURES ABOVE 0 DEGREES CELSIUS PRIOR TO PLACEMENT. SHOULD THE CONTRACTOR DAMAGE THE GEOTEXTILE TO THE EXTENT THAT IT IS NO LONGER USABLE AS DETERMINED BY THESE SPECIFICATIONS OR BY THE ENGINEER, THE CONTRACTOR SHALL REPLACE THE GEOTEXTILE AT THEIR EXPENSE.
3. THE SUBGRADE UNDERLYING THE GEOTEXTILE SHALL BE APPROVED BY THE ENGINEER AND SHALL BE SMOOTH AND FREE OF RUTS OR PROTRUSIONS WHICH COULD DAMAGE THE GEOTEXTILE. THE GEOTEXTILE AND GEOMEMBRANE SHALL BE LAID FLAT AND SMOOTH SO THAT IT IS IN DIRECT CONTACT WITH THE SUBGRADE. THE GEOTEXTILE SHALL BE FREE OF TENSILE STRESSES, FOLDS AND WRINKLES SO THAT THE OVERLYING MATERIALS WILL NOT EXCESSIVELY STRETCH OR TEAR THE FABRIC. ON SLOPES STEEPER THAN 10H:1V, THE GEOTEXTILE SHALL BE LAID WITH THE MACHINE DIRECTION OF THE FABRIC PARALLEL TO THE SLOPE DIRECTION. ANCHORING OF THE TERMINAL ENDS OF THE GEOTEXTILE SHALL BE ACCOMPLISHED THROUGH THE USE OF ANCHOR TRENCHES, ANCHOR BERMS OR APRONS AT THE CREST AND TOE OF THE SLOPE. THE GEOTEXTILE SHALL BE PLACED DIRECTLY ON THE PREPARED SUBGRADE WITH SEAMS UPWARD AND SHALL EXTEND FOR A MINIMUM OF 0.9 m PAST THE DESIGNED SLOPE TOE.
4. UNLESS OTHERWISE NOTED INSTALLATION OF GEOSYNTHETICS SHALL BE IN ACCORDANCE WITH THE FOLLOWING:
   - INTERNATIONAL ASSOCIATION OF GEOSYNTHETICS INSTALLERS - "GUIDELINES FOR INSTALLATION OF FACTORY FABRICATED HEAVY WEIGHT >0.64 mm (25 mil) THICKNESS FABRIC - SUPPORTED GEOMEMBRANES" (MARCH 2014)
   - APPLICABLE GEOSYNTHETICS RESEARCH INSTITUTE STANDARDS, AND THE MANUFACTURER'S "QUALITY CONTROL MANUAL" (JANUARY 2017)
   - GUIDELINES FOR INSTALLATION OF "FACTORY FABRIC SUPPORTED GEOMEMBRANES" (MARCH 2014)
5. THE CONTRACTOR SHALL PROVIDE A WRITTEN GUARANTEE COVERING MATERIALS AND ALL WORKMANSHIP AS WELL AS DEGRADATION DUE TO ULTRAVIOLET LIGHT FOR EXPOSED AREAS. THE MATERIAL SHALL BE WARRANTED AGAINST MANUFACTURER'S DEFECTS FOR A PERIOD OF 5 YEARS FROM THE DATE OF INSTALLATION. THE INSTALLATION SHALL BE WARRANTED AGAINST DEFECTS IN WORKMANSHIP FOR A PERIOD OF 2 YEARS FROM THE DATE OF INSTALLATION.
6. THE GEOSYNTHETICS SHALL BE INSTALLED ON THE AREA SHOWN ON THE DRAWINGS OR AS DIRECTED BY THE ENGINEER.
7. PRIOR TO DEPLOYMENT OF THE GEOSYNTHETICS, THE CONTRACTOR, WITH THE OWNER AND ENGINEER SHALL INSPECT, CERTIFY, AND ACCEPT ALL SURFACES ON WHICH THE GEOTEXTILE AND GEOMEMBRANE IS TO BE PLACED TO ENSURE CONFORMANCE WITH THE DESIGN AND SPECIFICATIONS. SURFACES NOT IN COMPLIANCE WITH THE SPECIFICATIONS SHALL BE RECTIFIED BY THE CONTRACTOR. ACCEPTANCE OF THE ANCHOR TRENCHES FOR PLACEMENT OF THE GEOMEMBRANE SHALL BE INCLUDED IN THE SURFACE PREPARATION ACCEPTANCE.
8. THE CONTRACTOR SHALL PROVIDE THE ENGINEER WITH A FINAL PANEL LAYOUT DRAWING, AND HARDCOPY FORMATS, AT LEAST ONE WEEK PRIOR TO PLACING THE GEOMEMBRANE. NO HORIZONTAL SEAMS ON A SLOPE WILL BE ACCEPTED. NO GEOSYNTHETICS SHALL BE INSTALLED WITHOUT PRIOR APPROVAL BY THE ENGINEER OF THE PROPOSED LAYOUT.
9. THE GEOSYNTHETICS WILL BE PLACED USING METHODS AND PROCEDURES THAT ENSURE A MINIMUM OF HANDLING. THE INSTALLER SHALL PROVIDE ADEQUATE TEMPORARY ANCHORING DEVICES TO PREVENT DAMAGE DUE TO WINDS.
10. THE GEOSYNTHETICS SHALL BE INSTALLED IN A RELAXED CONDITION AND SHALL BE FREE OF TENSION OR STRESS UPON COMPLETION OF THE INSTALLATION. ALL NECESSARY PRECAUTIONS, INCLUDING PROVISIONS FOR INSTALLING EXTRA MATERIAL, SHALL BE TAKEN TO AVOID TRAMPOLINING OF ANY GEOMEMBRANE WHICH MAY REMAIN EXPOSED.
11. SEAMS SHALL BE MADE BY LAPPING THE UPSLOPE MATERIAL OVER THE DOWNSLOPE MATERIAL WITH SUFFICIENT OVERLAP. A MINIMUM OF 1 m IS REQUIRED FROM THE TOE OF THE SLOPE TO ANY HORIZONTAL SEAM ON FLAT AREAS.
12. EXTREME CARE SHALL BE TAKEN BY THE CONTRACTOR IN THE PREPARATION OF THE AREAS TO BE WELDED. THE AREAS TO BE WELDED SHALL BE CLEANED AND PREPARED ACCORDING TO THE APPROVED PROCEDURES, AND ALL SHEETING SHALL BE WELDED TOGETHER BY THERMAL METHODS.
13. THE WELDING EQUIPMENT USED SHALL BE CAPABLE OF CONTINUOUSLY MONITORING AND CONTROLLING THE TEMPERATURES IN THE ZONE OF CONTACT WHERE THE MACHINE IS ACTUALLY FUSING THE GEOMEMBRANE MATERIAL, TO ENSURE CHANGES IN WEATHER CONDITIONS WILL NOT AFFECT THE INTEGRITY OF THE WELD.
14. NO "FISH MOUTHS" SHALL BE ALLOWED WITHIN THE SEAM AREA. WHERE "FISH MOUTHS" OCCUR, THE MATERIAL SHALL BE CUT, OVERLAPPED, AND EXTRUSION WELDED. ALL WELDS ON COMPLETION OF THE WORK SHALL BE TIGHTLY BONDED. ANY GEOMEMBRANE AREA SHOWING DISTRESS DUE TO EXCESSIVE SCUFFING OR PUNCTURE DURING INSTALLATION BE REPLACED OR REPAIRED AT THE CONTRACTOR'S EXPENSE.
15. THE CONTRACTOR SHALL TAKE INTO ACCOUNT THAT RAPID WEATHER CHANGES ARE VERY POSSIBLE, RESULTING IN DELAYS IN CONSTRUCTION OF FIELD SEAMS. JOINTING OF PANELS AND REPAIRS WILL ONLY BE PERMITTED UNDER WEATHER CONDITIONS ALLOWING SUCH WORK WITHIN THE WARRANTY LIMITS IMPOSED BY THE GEOMEMBRANE MANUFACTURER.

FIELD SEAM INSPECTION AND TESTING

1. A MAXIMUM EFFORT SHALL BE MADE TO INSTALL A PERFECT LINER SYSTEM. THIS MEANS THAT ALL SEAMS COMPLETED IN THE FIELD, PATCHES AND EXTRUSIONS SHALL BE INSPECTED, TESTED AND RECORDED.
2. A QUALITY CONTROL TECHNICIAN SHALL INSPECT EACH SEAM, MARKING HIS/HER INITIALS AND THE DATE INSPECTED AT THE END OF EACH PANEL. ANY AREA SHOWING A DEFECT SHALL BE MARKED AND REPAIRED IN ACCORDANCE WITH APPLICABLE GEOMEMBRANE REPAIR PROCEDURES.
3. ALL FIELD SAMPLING AND TESTING SHALL BE DONE BY THE CONTRACTOR AS APPROVED BY THE ENGINEER.
4. THE FIELD INSTALLATION TESTING PROGRAM SHALL CONSIST OF PERIODIC VISUAL OBSERVATIONS, CONTINUITY, AND STRENGTH TESTS. THESE INSPECTIONS AND TESTS ARE TO BE MADE ROUTINELY AND ARE REQUIRED REGARDLESS OF OTHER TYPES OF TESTING THAT MAY BE COMPLETED. THE INSTALLER SHALL PERFORM QUALITY CONTROL TESTING ACCORDING TO THE TYPES AND FREQUENCY INDICATED BELOW.
   - VISUAL OBSERVATIONS ARE TO BE MADE ROUTINELY AND SHALL INCLUDE THE FOLLOWING:
     - VISUALLY CHECK FIELD SEAMS FOR SQUEEZE OUT, FOOT PRINT, MELT AND OVERLAP
     - CHECK MACHINES FOR CLEANNESS, TEMPERATURE AND RELATED ITEMS.
     - ANY AREA OF THE SEAM OR PANEL SHOWING A DEFECT SHALL BE MARKED AND REPAIRED IN ACCORDANCE WITH THE APPLICABLE REPAIR PROCEDURES.
   - CONTINUITY TESTING IS REQUIRED FOR ALL FIELD SEAMS AND REPAIRED AREAS. INTER-SEAM PRESSURE OR "AIR TESTING" AND TESTING USING VACUUM BOX ARE CONSIDERED ACCEPTABLE METHODS FOR CONTINUITY TESTING. THE TEST PROCEDURE FOR INTER-SEAM PRESSURE OR AIR TESTING IS AS FOLLOWS:
     - SEAL BOTH ENDS OF THE SEAM TO BE TESTED BY APPLYING HEAT TO THE END OF THE SEAM UNTIL FLOW TEMPERATURE IS ACHIEVED. CLAMP OFF THE ENDS AND LET COOL.
     - INSERT A PRESSURE GAUGE/NEEDLE ASSEMBLY INTO THE END OF THE SEAM AND SEAL.
     - THE SEAM SHALL BE PRESSURIZED TO AN INITIAL START PRESSURE, MINIMUM 28 psi AND MAXIMUM 30 psi.
     - THE INITIAL START PRESSURE IS READ AFTER A 2-MINUTE RELAXING PERIOD, WHICH ALLOWS THE AIR TO REACH AMBIENT GEOMEMBRANE TEMPERATURE, THE ENDING PRESSURE IS READ AFTER 5 MINUTES.
     - THE ALLOWABLE PRESSURE DROP IS 3 psi LESS THAN THE INITIAL START PRESSURE.
     - THE RESULTS OF THE AIR TEST SHALL BE MARKED AT THE TEST LOCATION AND SHALL BE RECORDED BY THE CONTRACTOR. IF THE TEST FAILS, THE LOCATION OF THE LEAK SHALL BE FOUND AND REPAIRED AND RETESTED OR THE ENTIRE SEAM SHALL BE REPAIRED AND RETESTED.
   - THE TEST PROCEDURE FOR VACUUM BOX TESTING IS AS FOLLOWS:
     - MIX A SOLUTION OF LIQUID DETERGENT AND WATER AND APPLY AN AMPLE AMOUNT TO THE AREA TO BE TESTED. IF A SEAM CONTAINS EXCESS OVERLAP OR LOOSE EDGES IT IS TO BE TRIMMED BEFORE TESTING.
     - PLACE A TRANSLUCENT VACUUM BOX OVER THE AREA AND APPLY A SLIGHT AMOUNT OF DOWNWARD PRESSURE TO THE BOX TO THE SEAL TO THE GEOMEMBRANE.
     - APPLY A VACUUM (3 psi TO 5 psi) TO THE AREA. ANY LEAKS WILL BECOME VISIBLE BY LARGE BUBBLES AND SHALL BE REPAIRED.
5. STRENGTH TESTS ON SEAMS SHALL BE CARRIED OUT ON SAMPLE COUPONS CUT FROM THE INSTALLED GEOMEMBRANE IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS AND THE INTERNATIONAL ASSOCIATION OF GEOSYNTHETICS INSTALLERS "GUIDELINES FOR INSTALLATION OF FACTORY FABRICATED HEAVYWEIGHT > 0.64 mm (25 mil) THICKNESS FABRIC - SUPPORTED GEOMEMBRANES" (MARCH, 2014), APPLICABLE GEOSYNTHETICS RESEARCH INSTITUTE STANDARDS AND THE MANUFACTURER'S QUALITY CONTROL MANUAL.

AS-BUILT DOCUMENTATION

1. THE CONTRACTOR SHALL PROVIDE THE OWNER AND ENGINEER WITH COPIES OF ALL THE FABRICATION AND INSTALLATION TEST LOGS AND CONFORMANCE DATA INCLUDING:
   - GEOSYNTHETIC CERTIFICATION
   - DAILY PANEL PLACEMENT LOGS
   - AS-BUILT PANEL LAYOUT DRAWINGS
   - SEAM CONTROL LOGS
   - CONSTRUCTION REPAIR REPORT
2. IN ADDITION, THE CONTRACTOR SHALL SUBMIT AS-BUILT DRAWINGS SHOWING THE INSTALLED GEOMEMBRANE PANEL LAYOUT WITH EACH PANEL OR PORTION OF PANEL IDENTIFIED BY THE MANUFACTURER'S IDENTIFICATION NUMBER. THE EXTENT OF THE INSTALLED GEOSYNTHETICS AND LOCATIONS OF ALL TESTS SHALL BE IDENTIFIED ALONG WITH LOCATIONS OF ANY REPAIRS. THE AS-BUILT DRAWINGS SHALL BE MADE AVAILABLE ELECTRONICALLY TO THE OWNER AND ENGINEER IN A TIMELY FASHION AFTER THE WORK IS COMPLETE.

FILL MATERIALS:

MATERIAL PLACEMENT AND COMPACTION REQUIREMENTS	
ZONE AND MATERIAL TYPE	**PLACING AND COMPACTION REQUIREMENTS**
500 mm MINUS ROCKFILL	MATERIAL SHALL BE WELL GRADED AND CONSIST OF HARD, DURABLE FRESH ROCKFILL FREE OF DELETERIOUS MATERIALS. ACCESS ROAD: MATERIAL TO BE PLACED BY TRUCK AND BULLDOZER STARTING AT THE EXISTING HAUL ROAD. COMPACTION TO BE ACHIEVED BY ROUTING HAULAGE TRAFFIC OVER THE ENTIRE SURFACE OF THE ROAD. SAFETY BERMS: MATERIAL TO BE PLACED AND NOMINALLY COMPACTED TO THE DIMENSIONS SHOWN ON THE DRAWINGS. SEDIMENTATION POND: MATERIAL TO BE PLACED AND SPREAD IN MAXIMUM 1000 mm LAYERS AFTER COMPACTION. COMPACTION TO CONSIST OF MINIMUM 6 PASSES BY A D9 DOZER.
RIPRAP	RIPRAP SHALL BE WELL GRADED AND CLEAN, DURABLE AND ANGULAR IN SHAPE. FINE RIPRAP D_{50} = 150 mm; COARSE RIPRAP D_{50} = 300 mm. MATERIAL TO BE PLACED AND SPREAD IN MAXIMUM 300 mm LAYER (FINE RIPRAP) OR 600 mm LAYER (COARSE RIPRAP). PLACED TO FORM A TIGHTLY INTERLOCKING LAYER.
INTERMEDIATE BEDDING	MATERIAL SHALL CONSIST OF 32 mm MINUS CLEAN SAND AND GRAVEL FREE OF CLAY, LOAM, ORGANICS, AND OTHER DELETERIOUS MATERIAL. MATERIAL SHALL BE PLACED, SPREAD AND MOISTURE CONDITIONED IN MAXIMUM 200 mm LAYER AFTER COMPACTION FROM A VIBRATORY COMPACTOR OR PLATE COMPACTORS.
BERM FILL	MATERIAL SHALL CONSIST OF CLEAN, WELL GRADED, 150 mm MINUS PROCESSED ROCKFILL AND SHALL BE FREE OF CLAY, LOAM, ORGANICS, AND OTHER DELETERIOUS MATERIALS. SEDIMENTATION POND: PLACED AND SPREAD IN MAXIMUM 300 mm LAYERS AFTER COMPACTION FROM A VIBRATORY COMPACTOR. COLLECTION/DIVERSION BERMS: PLACED AND SPREAD IN MAXIMUM 200 mm LAYERS AFTER COMPACTION. NOMINAL COMPACTION.

NOTES:

1. THE DRAWING SHALL BE READ IN CONJUNCTION WITH THE ACCOMPANYING CONTRACT DOCUMENTS AND APPLICABLE TECHNICAL SPECIFICATIONS.
2. 500 mm MINUS ROCKFILL TO BE USED FOR THE ACCESS ROAD, SAFETY BERMS AND THE SEDIMENTATION POND BERMS.
3. FINE RIPRAP TO BE USED FOR THE SEDIMENTATION POND SPILLWAY INLET, COLLECTION/DIVERSION BERMS AND APRONS AS NOTED ON THE DRAWINGS. COARSE RIPRAP TO BE USED FOR EXISTING CULVERT OUTLET AND SEDIMENTATION POND SPILLWAY CHANNEL AND APRON.
4. INTERMEDIATE BEDDING TO BE USED FOR ANCHOR TRENCH BACKFILL AND ANCHOR BERMS; BEDDING MATERIAL FOR GEOMEMBRANE, AND BEDDING AND BACKFILL FOR CULVERTS AND PIPES.
5. BERM FILL TO BE USED FOR THE SEDIMENTATION POND BERMS AND COLLECTION/DIVERSION BERMS.
6. FILL MATERIALS USED FOR CONSTRUCTION SHALL NOT BE POTENTIALLY ACID GENERATING (PAG) OR METAL LEACHING (ML). THROUGHOUT CONSTRUCTION, ADEQUATE INSPECTION AND PERIODIC TESTING SHOULD BE CARRIED OUT TO DEMONSTRATE THE SUITABILITY OF THE FILL MATERIALS.
7. UNLESS OTHERWISE NOTED ALL MATERIALS SHALL CONSIST OF HARD, DURABLE FILL MATERIAL, FREE OF CLAY, LOAM, TREE STUMPS, ROOTS AND OTHER DELETERIOUS MATERIALS OR ORGANIC MATTER, AND CONTAIN NO MASSIVE ICE.

ISSUED FOR CONSTRUCTION

DRG. NO.	DESCRIPTION
REFERENCE DRAWINGS	

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	20JUN'19	ISSUED FOR CONSTRUCTION	DMMD	MMD		

REVISIONS

REGISTERED PROFESSIONAL ENGINEER — K.E. HAWTON — LICENSEE — June 20/19 — NWT/NU

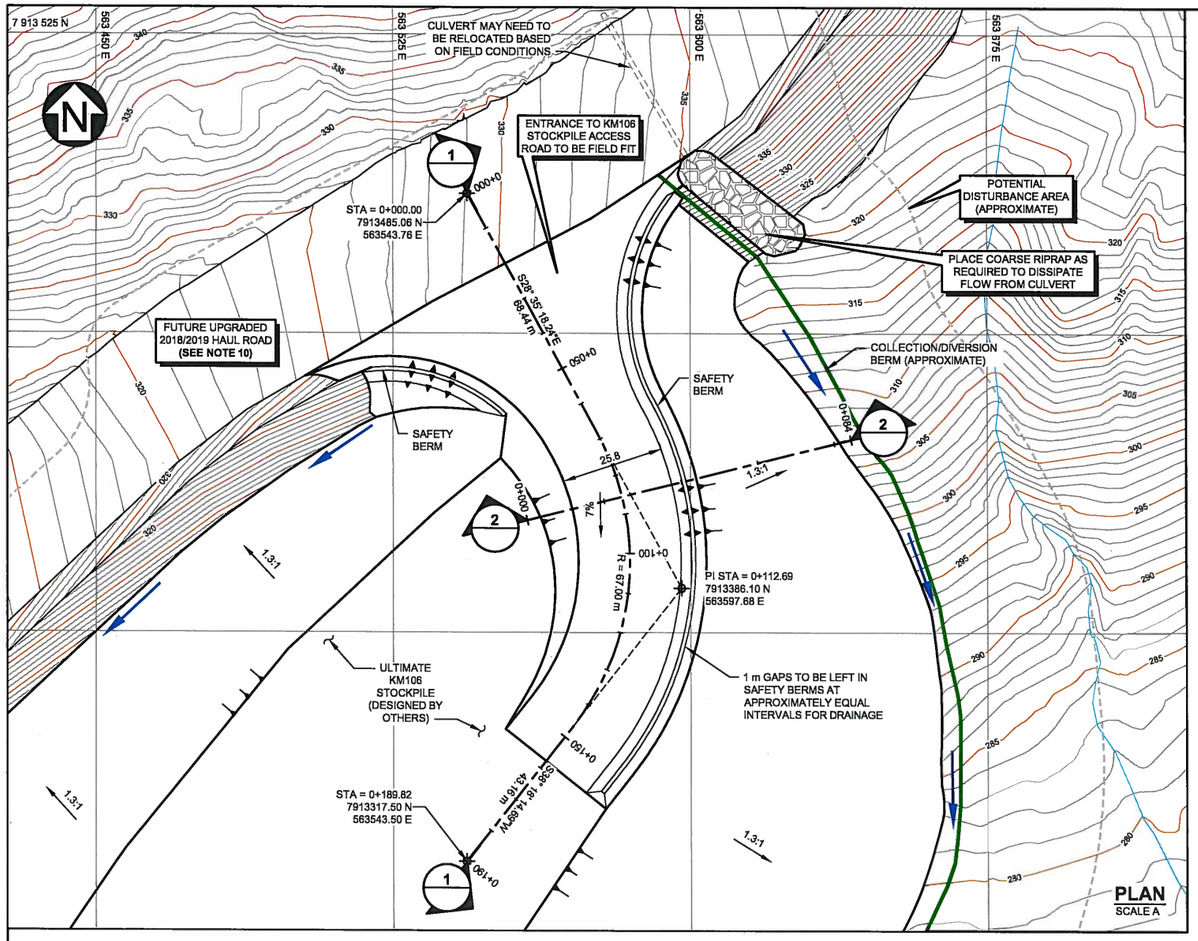
Knight Piésold CONSULTING

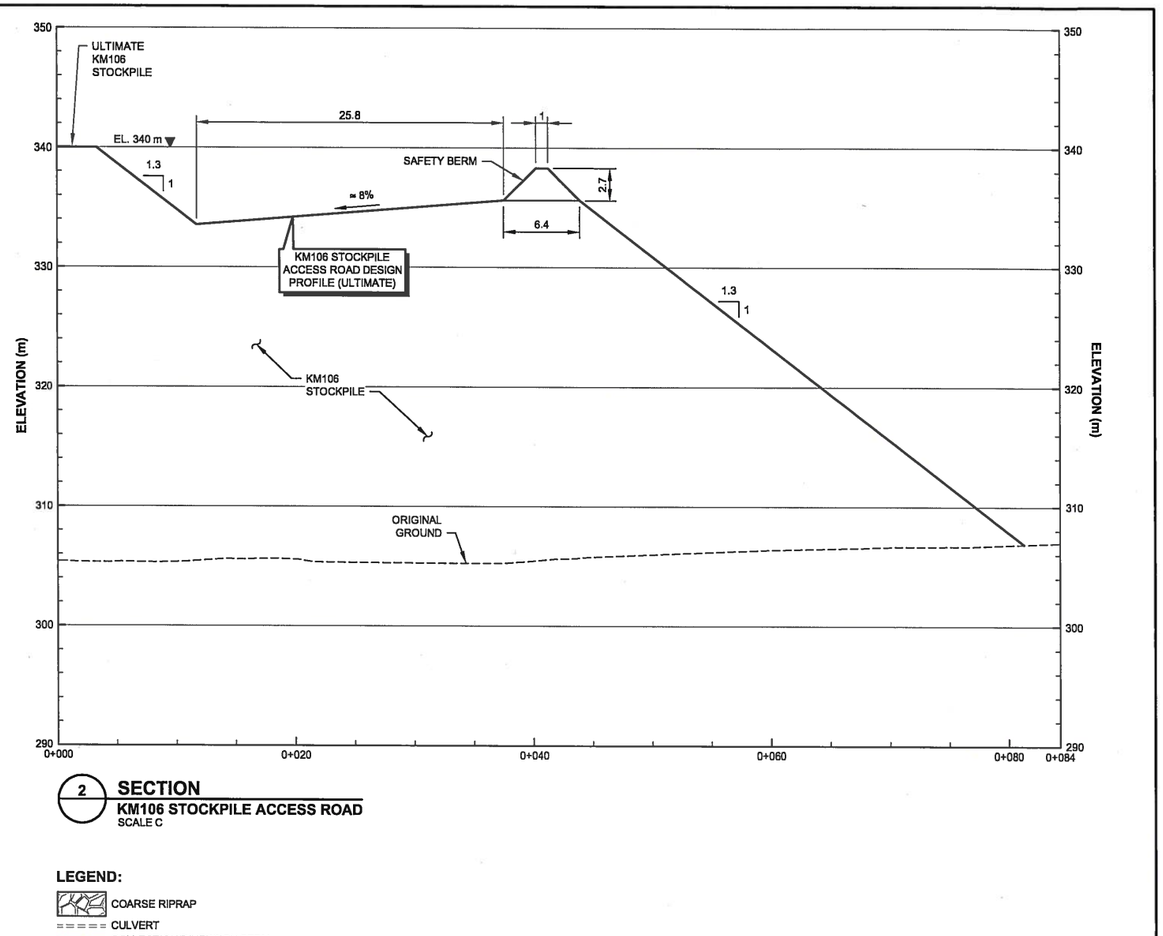
BAFFINLAND IRON MINES CORPORATION

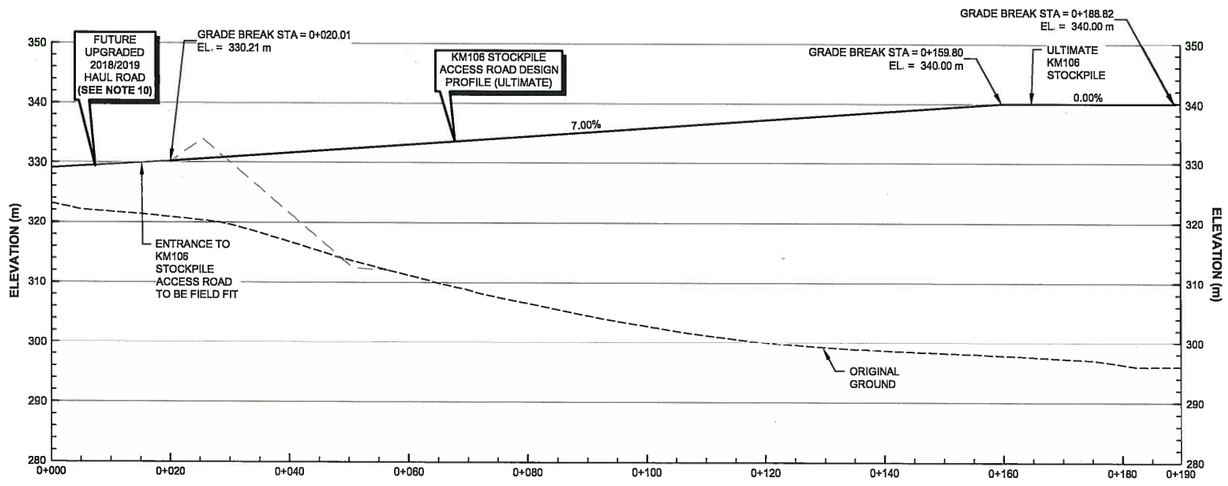
MARY RIVER PROJECT

KM106 STOCKPILE SPECIFICATIONS

P/A NO.	DRAWING NO.	REVISION
NB102-181/57	301	0







LEGEND:

- COARSE RIPRAP
- CULVERT
- COLLECTION/DIVERSION BERM
- ORIGINAL GROUND
- POTENTIAL DISTURBANCE AREA (APPROXIMATE)
- FLOW DIRECTION

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 17.
2. TOPOGRAPHY BASED ON INFORMATION PROVIDED BY EAGLE MAPPING (2008).
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 1 m.
4. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
5. ALL INFRASTRUCTURE SHOWN IS PROPOSED UNLESS NOTED OTHERWISE.
6. THE DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONTRACT DOCUMENTS AND APPLICABLE TECHNICAL SPECIFICATIONS.
7. FOUNDATION PREPARATION: PROVIDED THE AMOUNT OF ORGANICS AND UNSUITABLE MATERIAL ON THE GROUND IS NEGLIGIBLE, DISTURBANCE TO THE ORIGINAL GROUND (EXCAVATION, SCARIFYING, ETC.) SHOULD BE MINIMIZED SO AS NOT TO IMPACT CURRENT PERMAFROST CONDITIONS. ALTERNATIVE METHODS OF FOUNDATION PREPARATION MAY BE NECESSARY FOR SOME AREAS, AT THE DISCRETION OF THE OWNER'S REPRESENTATIVE. ALL FOUNDATIONS MUST BE MAINTAINED CLEAR OF SNOW, PONDED WATER AND ICE.
8. FINAL SLOPES SHALL BE TRIMMED TO THE LINES AND TOLERANCES INDICATED ON THE DRAWINGS AND IN THE TECHNICAL SPECIFICATIONS.
9. LOCATIONS AND DETAILS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT ACTUAL SITE CONDITIONS.
10. FUTURE UPGRADED 2018/2019 HAUL ROAD PROVIDED BY BAFFINLAND AUGUST 2018.
11. ACCESS ROAD FILL SLOPES TO BE AT ANGLE OF REPOSE FOR ROAD EMBANKMENT FILL. 1.3H:1V HAS BEEN ASSUMED BASED ON MATERIAL PROPERTIES.

ISSUED FOR CONSTRUCTION

SCALE A: 15 7.5 0 25 50 75 m
SCALE B: 10 5 0 10 20 30 40 50 m
SCALE C: 5 2.5 0 5 10 15 20 25 m

REGISTERED PROFESSIONAL ENGINEER
K.E. HAWTON
LICENSEE
June 2019
NWT/NU

Knight Piésold CONSULTING

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM106 STOCKPILE ACCESS ROAD PLAN AND SECTIONS

P/A NO.	DRAWING NO.	REVISION
NB102-181/57	310	0

DRG. NO.	DESCRIPTION
REFERENCE DRAWINGS	

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
REVISIONS						

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
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REVISIONS						

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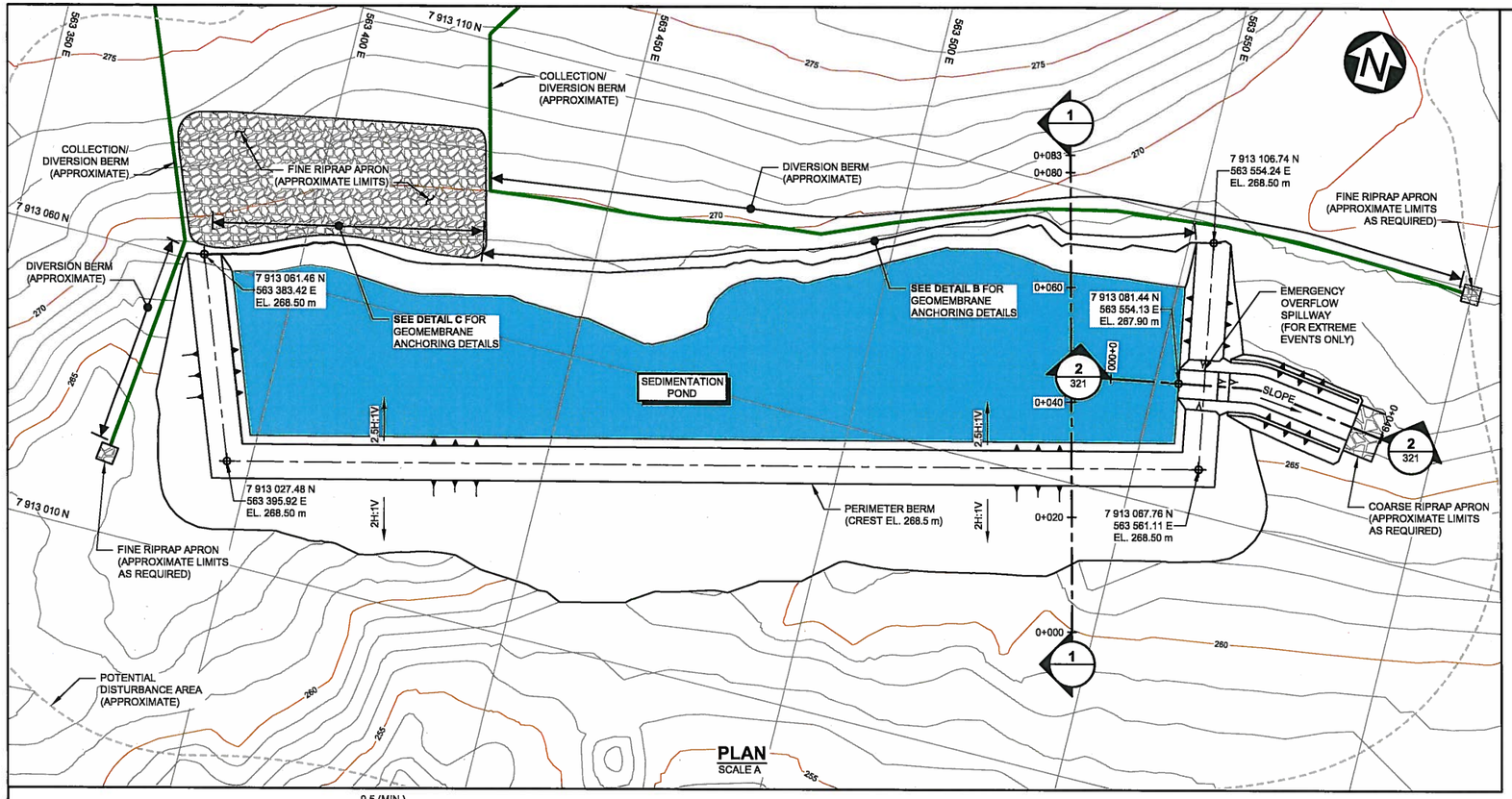
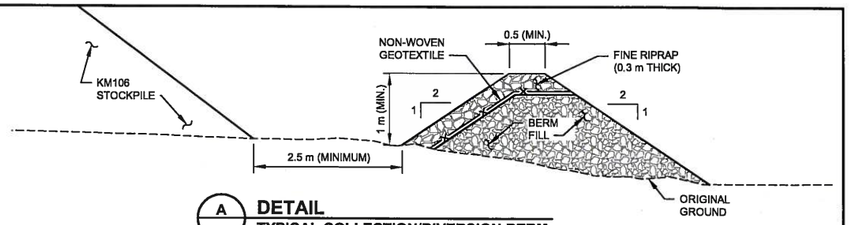




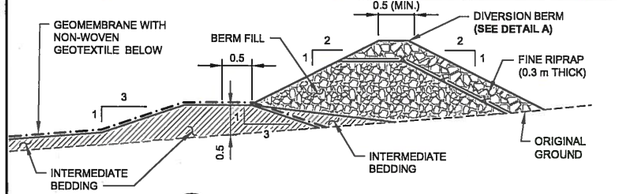
A DETAIL
TYPICAL COLLECTION/DIVERSION BERM
NTS

LEGEND:

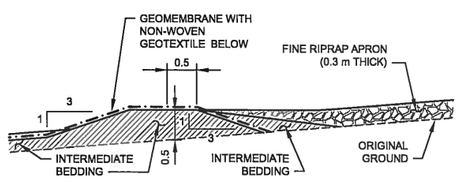
- WATER
- 500 mm MINUS ROCKFILL
- COARSE RIPRAP
- FINE RIPRAP
- BERM FILL
- INTERMEDIATE BEDDING
- GEOMEMBRANE WITH NON-WOVEN GEOTEXTILE BELOW
- NON-WOVEN GEOTEXTILE
- ORIGINAL GROUND
- COLLECTION/DIVERSION BERM
- POTENTIAL DISTURBANCE AREA (APPROXIMATE)

NOTES:

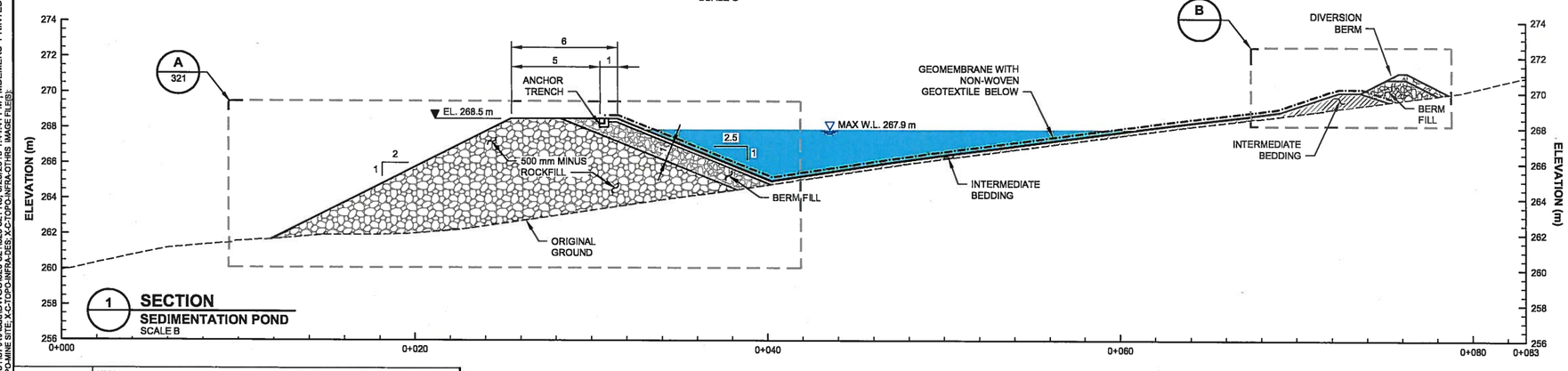
1. COORDINATE GRID IS UTM (NAD83) ZONE 17.
2. TOPOGRAPHY BASED ON INFORMATION PROVIDED BY EAGLE MAPPING (2008).
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 1 m.
4. ALL INFRASTRUCTURE SHOWN IS PROPOSED UNLESS OTHERWISE NOTED.
5. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
6. LOCATIONS AND DETAILS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT ACTUAL SITE CONDITIONS.
7. FOR MATERIAL AND GEOSYNTHETIC SPECIFICATIONS **SEE DRG 301.**
8. GEOMEMBRANE TO BE 40 mil ATARFIL LINEAR LOW DENSITY TEXTURED GEOMEMBRANE OR APPROVED EQUIVALENT AND TO BE INSTALLED AS PER THE MANUFACTURER'S SPECIFICATIONS.
9. NON-WOVEN GEOTEXTILE TO BE TEXEL 100P OR APPROVED EQUIVALENT WHEN PLACED ADJACENT TO GEOMEMBRANE. NON-WOVEN GEOTEXTILE TO BE 12 oz/yd^2 FOR ALL OTHER LOCATIONS. NON-WOVEN GEOTEXTILE TO BE INSTALLED AS PER THE MANUFACTURER'S SPECIFICATIONS.
10. ANCHOR TRENCH TO BE EXCAVATED TO THE APPROXIMATE LIMITS SHOWN (0.5 m x 0.5 m IN SECTION). FOLLOWING GEOTEXTILE AND GEOMEMBRANE INSTALLATION, TRENCH TO BE BACKFILLED WITH COMPACTED INTERMEDIATE BEDDING MATERIAL.
11. DOWNSTREAM SLOPE OF BERM TO BE TRIMMED AND NOMINALLY COMPACTED. UPSTREAM SLOPE OF BERM TO BE PREPARED FOR GEOSYNTHETICS INSTALLATION AS PER THE TECHNICAL SPECIFICATIONS.
12. EXCAVATION SLOPES ARE THE CONTRACTOR'S RESPONSIBILITY.
13. COLLECTION/DIVERSION BERMS TO BE GRADED AT 1% (MINIMUM) IN DIRECTION OF FLOW.
14. FOUNDATION PREPARATION: PROVIDED THE AMOUNT OF ORGANICS AND UNSUITABLE MATERIAL ON THE GROUND IS NEGLIGIBLE, DISTURBANCE TO THE ORIGINAL GROUND (EXCAVATION, SCARIFYING, ETC.) SHOULD BE MINIMIZED SO AS NOT TO IMPACT CURRENT PERMAFROST CONDITIONS. ALTERNATIVE METHODS OF FOUNDATION PREPARATION MAY BE NECESSARY FOR SOME AREAS, AT THE DISCRETION OF THE OWNER'S REPRESENTATIVE. ALL FOUNDATIONS MUST BE MAINTAINED CLEAR OF SNOW, PONDED WATER AND ICE.
15. THE DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONTRACT DOCUMENTS AND APPLICABLE TECHNICAL SPECIFICATIONS.
16. FINAL SLOPES SHALL BE TRIMMED TO THE LINES AND TOLERANCES INDICATED ON THE DRAWINGS AND IN THE TECHNICAL SPECIFICATIONS.
17. RIPRAP TO BE CLEAN, DURABLE AND ANGULAR. RIPRAP TO BE TIGHTLY PLACED AND SPREAD IN MAXIMUM LAYERS AS NOTED ON **DRG 301.**



B DETAIL
GEOMEMBRANE ANCHORING DETAIL
SCALE C



C DETAIL
GEOMEMBRANE ANCHORING DETAIL
SCALE C



1 SECTION
SEDIMENTATION POND
SCALE B

ISSUED FOR CONSTRUCTION

SCALE A: 10 5 0 10 20 30 40 50 m
SCALE B: 3 1.5 0 5 10 15 m
SCALE C: 1 0.5 0 1 2 3 4 5 m

DRG. NO.	DESCRIPTION
321	KM106 STOCKPILE - SEDIMENTATION POND AND RUNOFF MANAGEMENT MEASURES - SECTIONS AND DETAIL
301	KM106 STOCKPILE - SPECIFICATIONS

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	20JUN'19	ISSUED FOR CONSTRUCTION	DMMD	MMD	MA	

REVISIONS

REGISTERED PROFESSIONAL ENGINEER
K.E. HAWTON
LICENSEE
June 20/19
NWT/NU

Knight Piésold CONSULTING

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM106 STOCKPILE SEDIMENTATION POND AND RUNOFF MANAGEMENT MEASURES PLAN, SECTION AND DETAILS

REF. NO.	DRAWING NO.	REVISION
NB102-181/57	320	0

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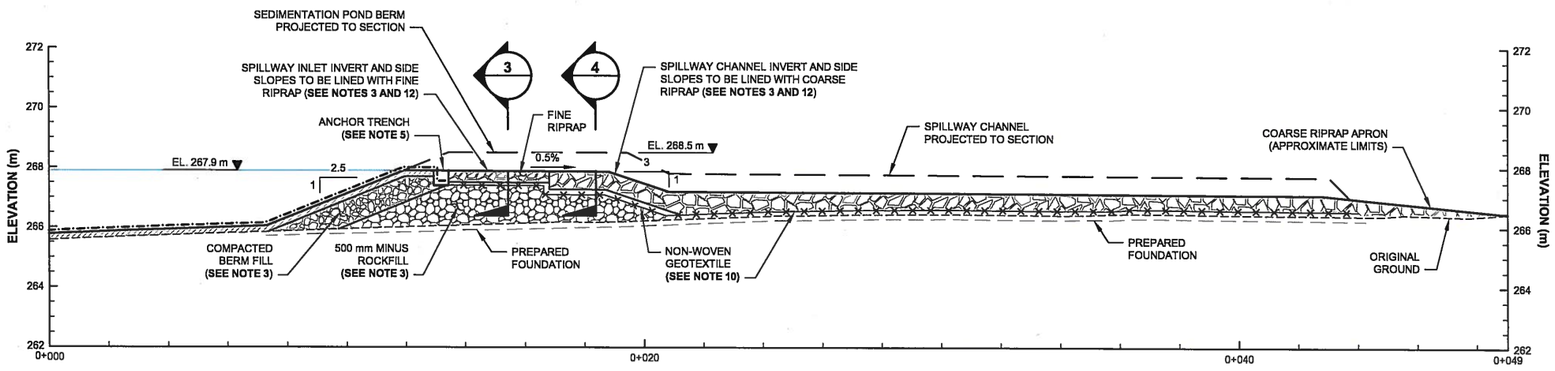
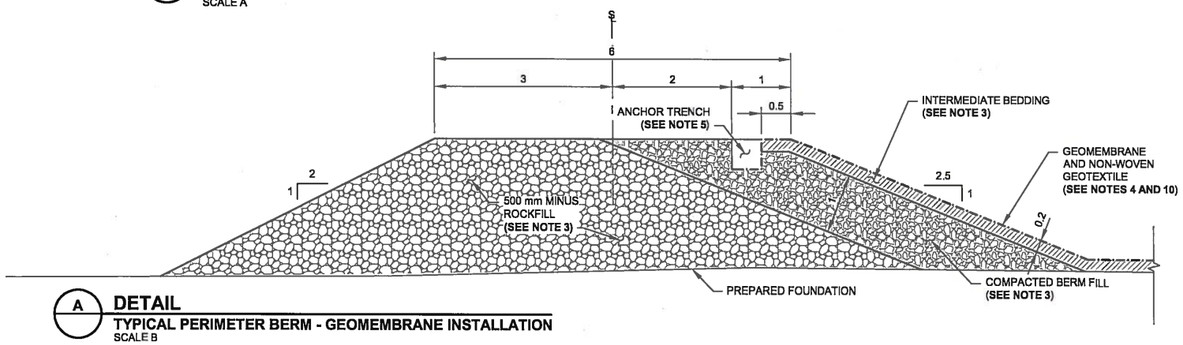
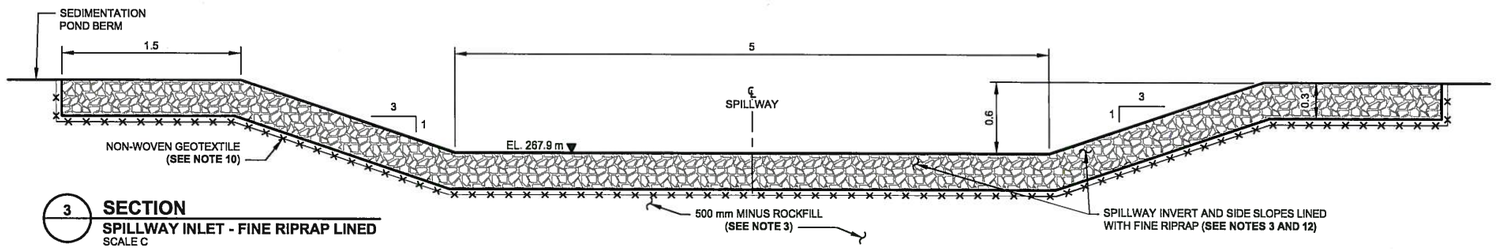


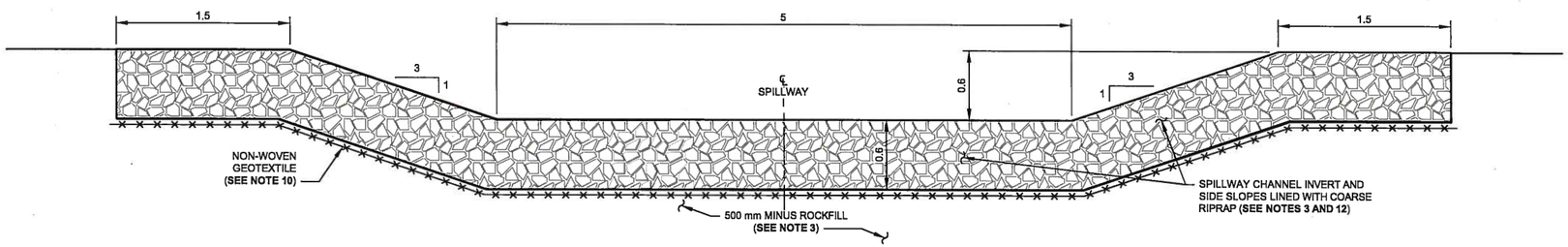
2 / 320 SECTION
EMERGENCY OVERFLOW SPILLWAY
SCALE A



A DETAIL
TYPICAL PERIMETER BERM - GEOMEMBRANE INSTALLATION
SCALE B



3 SECTION
SPILLWAY INLET - FINE RIPRAP LINED
SCALE C



4 SECTION
SPILLWAY CHANNEL - COARSE RIPRAP LINED
SCALE C

LEGEND:

- BERM FILL
- FINE RIPRAP
- COARSE RIPRAP
- 500 mm MINUS ROCKFILL
- INTERMEDIATE BEDDING
- NON-WOVEN GEOTEXTILE
- GEOMEMBRANE WITH NON-WOVEN GEOTEXTILE ABOVE AND BELOW
- ORIGINAL GROUND
- PREPARED FOUNDATION
- SEDIMENTATION POND / SPILLWAY CHANNEL PROJECTED TO SECTION

NOTES:

1. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. LOCATION AND DETAILS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT SITE CONDITIONS.
3. FOR MATERIAL AND GEOSYNTHETIC SPECIFICATIONS **SEE DRG 301**.
4. GEOMEMBRANE TO BE 40 mil ATARFIL LINEAR LOW DENSITY TEXTURED GEOMEMBRANE OR APPROVED EQUIVALENT AND TO BE INSTALLED AS PER THE MANUFACTURER'S SPECIFICATIONS.
5. ANCHOR TRENCH TO BE EXCAVATED TO THE APPROXIMATE LIMITS SHOWN (0.5 m x 0.5 m IN SECTION). FOLLOWING GEOTEXTILE AND GEOMEMBRANE INSTALLATION, TRENCH TO BE BACKFILLED WITH COMPACTED INTERMEDIATE BEDDING MATERIAL.
6. DOWNSTREAM SLOPE OF BERM TO BE TRIMMED AND NOMINALLY COMPACTED. UPSTREAM SLOPE OF BERM TO BE PREPARED FOR GEOSYNTHETICS INSTALLATION AS PER THE TECHNICAL SPECIFICATIONS.
7. EXCAVATION SLOPES ARE THE CONTRACTOR'S RESPONSIBILITY.
8. FOUNDATION PREPARATION: PROVIDED THE AMOUNT OF ORGANICS AND UNSUITABLE MATERIAL ON THE GROUND IS NEGLIGIBLE, DISTURBANCE TO THE ORIGINAL GROUND (EXCAVATION, SCARIFYING, ETC.) SHOULD BE MINIMIZED SO AS NOT TO IMPACT CURRENT PERMAFROST CONDITIONS. ALTERNATIVE METHODS OF FOUNDATION PREPARATION MAY BE NECESSARY FOR SOME AREAS, AT THE DISCRETION OF THE OWNER'S REPRESENTATIVE. ALL FOUNDATIONS MUST BE MAINTAINED CLEAR OF SNOW, PONDED WATER AND ICE.
9. THE DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONTRACT DOCUMENTS AND APPLICABLE TECHNICAL SPECIFICATIONS.
10. NON-WOVEN GEOTEXTILE TO BE TEXEL 100P OR APPROVED EQUIVALENT WHEN PLACED ADJACENT TO GEOMEMBRANE. NON-WOVEN GEOTEXTILE TO BE 12 oz/yd^2 FOR OTHER LOCATIONS. NON-WOVEN GEOTEXTILE TO BE INSTALLED AS PER MANUFACTURER'S SPECIFICATIONS.
11. FINAL SLOPES SHALL BE TRIMMED TO THE LINES AND TOLERANCES INDICATED ON THE DRAWINGS AND IN THE TECHNICAL SPECIFICATIONS.
12. RIPRAP TO BE CLEAN, DURABLE AND ANGULAR. RIPRAP TO BE TIGHTLY PLACED AND SPREAD IN MAXIMUM LAYERS, AS NOTED ON **DRG 301**.

ISSUED FOR CONSTRUCTION

SCALE A: 2 1 0 2 4 6 8 10 m
SCALE B: 1 0.5 0 1 2 3 4 5 m
SCALE C: 0.5 0.25 0 0.5 1.0 1.5 2.0 2.5 m

DRG. NO.	DESCRIPTION
320	KM106 STOCKPILE - SEDIMENTATION POND AND RUNOFF MANAGEMENT MEASURES - PLAN, SECTION AND DETAILS
301	KM106 STOCKPILE - SPECIFICATIONS

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	20JUN'19	ISSUED FOR CONSTRUCTION	DMMD	MMD	AA	KH

REVISIONS

REGISTERED PROFESSIONAL ENGINEER
K.E. HAWTON
LICENSEE
June 20/19
NWT/NU

Knight Piésold CONSULTING

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM106 STOCKPILE SEDIMENTATION POND AND RUNOFF MANAGEMENT MEASURES SECTIONS AND DETAIL

PA NO.	DRAWING NO.	REVISION
NB102-181/57	321	0

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XREF FILES): X-C-TOPO-MINE SITE; X-C-TOPO-INFRA DES; X-C-TOPO-INFRA-OTHRS; IMAGE FILES):

APPENDIX A

Geomembrane and Non-Woven Geotextile Information

(Pages A-1 to A-29)

ATARFIL LLD V1

Raw Material	Linear Low Density Polyethylene

ATARFIL LLD is a geomembrane manufactured from maximum quality linear low density polyethylene LLDPE resins, duly contrasted, that comply with the most rigurous requirements established for their use.
ATARFIL LLD contains 97,5% of pure polymer, and approximately 2,5% of Carbon Black, antioxidants and thermal stabilizers. The product does not contain plasticizers or fillers that can migrate over time.
The geomembrane **ATARFIL** LLD is manufactured under permanent quality controls.

Surface	Smooth	Colour	Black
		RAL Code	-

Raw Material Identification

Tested Property	Unit	Test Method	Value
Density of Raw Material	g/cm^3	ASTM D 792	0.915-0.926
Density of Geomembrane	g/cm^3	ASTM D 792	0.925-0.939
Melt Flow Index	g/10 min	ASTM D 1238 (190ºC/2,16 Kg)	< 1,0
Carbon Black Content	%	ASTM D 4218	2,0 - 2,5
Carbon Black Dispersion	-	ASTM D 5596	Note (3)

Durability

Oxidative Induction Time (OIT) Standard OIT High Pressure OIT	min	ASTM D 3895 (200ºC) ASTM D 5885	≥ 100 ≥ 400
Oven aging at 85ºC HP O.I.T, % retained after 90 days	%	ASTM D 5721 ASTM D 5885	≥ 60
UV Resistance. HP OIT, % retained after 1600 hrs	%	ASTM D 5885	≥ 35

Functional Properties

Tested Property	Unit	Test Method	Value
Low Temperature Brittleness (tª: -40ºC)	-	ASTM D 746	No cracks
Water Permeability	m^3/m^2·day	EN 14150	< 1·10^{-6}
Coefficient of Linear Thermal Expansion	1/K	ASTM D 696	2,15·10^{-4}
Water Absorption	%	ASTM D 570 (24h)	≤ 0,2
		ASTM D 570 (6 days)	≤ 1

Strength Characteristics Quality of Final Product

Tested Property	Unit	Test Method	Value					
Thickness	mils	ASTM D 5199	30	40	60	80	100	120
Tolerance	%		-10					
Mechanical Properties								
Tensile strength at Break[1]	lb/in	ASTM D 6693 (Type IV), lo 2 in	125 (108)	171 (148)	256 (222)	342 (296)	428 (371)	513 (445)
Elongation at Break	%		≥ 800					
Tear Resistance	lb	ASTM D 1004	≥ 15	≥ 21	≥ 32	≥ 43	≥ 53	≥ 64
Puncture Resistance	lb	ASTM D 4833	≥ 42	≥ 56	≥ 84	≥ 112	≥ 140	≥ 168
2% Modulus	lb/in	ASTM D 5323	≤ 1800	≤ 2400	≤ 3600	≤ 4800	≤ 6000	≤ 7200
Axi-Symmetric Break Resistance Strain	%	ASTM D 5617	≥ 30					
Dimensional Stability	%	ASTM D 1204 (100ºC, 1h)	± 1.5					

PRESENTATION (Standard Sizes)

Parameter	Units	30	40	60	80	100	120
Roll width[4]	ft	19.7					
Roll Length[4]	ft	1,332	999	666	498	399	333
Surface	ft^2	26,240.4	19,680.3	13,120.2	9,810.6	7,860.3	6,560.1

280717

[1] Values indicated are medium. In brackets minimum values.
[2] Certificates belonging to the Environmental and Quality Integrated System of Atarfil.
[3] Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3.
[4] Roll lengths and widths have a tolerance of ±l%.

Headquarters: Ctra. de Córdoba, Km 429 - Complejo El Rey – E-18230 Atarfe – GRANADA – SPAIN – Tel.: +34 958 439 200 – Fax: +34 958 439 128
Middle East: P.O. Box 263 122 - Jebel Ali - DUBAI - U.A.E.
USA Branch: Tel/fax: 2078483431
www.atarfil.com

TEXEL 100P

TECHNICAL DATASHEET

Product	Needle-punched nonwoven, short staple fibers
Composition	Polyester
Main function	Protection

Property	Test Method	Metric	Imperial
Physical			
Weigth (typical)	ASTM D5261	339 g/m²	10 oz/yd²
Thickness	ASTM D5199	2.4 mm	94.5 mils
Mechanical			
Trapezoid Tear	ASTM D4533	170 N	38 lbs
Grab Tensile	ASTM D4632	505 N	114 lbs
Grab Elongation	ASTM D4632	50 %	50 %
CBR Puncture	ASTM D6241	1 355 N	305 lbs
Dimensions			
Width	-	4.57 m	15 ft
Length	-	91.44 m	300 ft

All values are MARV.
Our quality management system is certified by ISO-9001 standard.
Our internal laboratory is certified by the Geosynthetic Accreditation Institute - Laboratory Accreditation Program (GAI-LAP).

According to our fibers suppliers, Polyester in general is considered highly UV resistant and much better than other fibers such as, nylon or polypropylene. Polyester is commonly used for UV exposure such as awnings or boat sails or rope. According once again to one of our fibers suppliers, it is generally known that polyester loses 10% of strength after two years of light exposure.

Please note this statement is only based on polyester fiber, not the needlepunched nonwoven structure which influences the residual tensile strength of the material. If this characteristic is critical, we highly recommend to perform a recognized UV exposure test based on ASTM-D4355 standard to estimate and validate the proposed material resistance to UV exposure.

Revision : 01-13-2016

WESTERN TANK & LINING LTD.

YOUR CONTAINMENT **SPECIALISTS** SINCE **1985**

QUALITY CONTROL MANUAL

P.E. GEOMEMBRANE INSTALLATION
(Geo Textile)
(Draintube)
(Geo Composite)
(Geo Net)
(GCL)
(Petrogard 6)

WESTERN TANK & LINING LTD.
YOUR CONTAINMENT SPECIALISTS SINCE 1985

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INTRODUCTION

This manual details the practices and procedures used by Western Tank and Lining Ltd.'s crews during installation of PE liners to ensure a quality installation and to produce the quality control report. We also included Geotexile, Geonet, Geocomposite, and Draintube manual.

1. SUBGRADE PREPARATION

1.1 Requirements for Soil Subgrade

The Owner, General Contractor, or Earthworks Contractor shall be responsible for preparing and maintaining the subgrade in a condition suitable for installation of the liner unless specifically agreed otherwise. WTL and others install geosynthetic lining materials on earth surfaces prepared for liner installation by others. No liner shall be placed on surfaces not previously found acceptable by the WTL site supervisor. On projects installed by WTL, it is our practice to require written "Subgrade Surface Acceptance" documentation.

Surfaces to be lined shall be smooth and free of all rocks, stones, sticks, roots, sharp objects, or debris of any kind. No stones or other hard objects that will not pass through a 3/8" screen shall be present in the top 4" of the surfaces to be covered. All fill shall consist of well-graded material free of organics, trash, clay balls, sharp stones or any other deleterious material that may cause damage to the liner.

The surface should provide a firm, unyielding foundation for the membrane with no sudden, sharp or abrupt changes or break in grade.

The subgrade shall be compacted in accordance with design specifications but in no event below the minimum required to provide a firm unyielding foundation sufficient to permit the movement of vehicles and welding equipment over the subgrade without causing rutting or other deleterious effects. The subgrade shall have no sudden sharp or abrupt changes in grade, especially at pipes or concrete structures.

Typical preparation sequence involves trimming of the compacted excavation as smooth as possible with heavy equipment, hand raking and rock picking, and rolling of the surface with a smooth drum compactor. Rule of thumb for acceptable surface is "ready to lay sod". Under no circumstances will the integrity of the liner be compromised due to the presence of rocks, lumps, or incomplete subgrade preparation.

(1) **Surface Acceptance:** Upon request, Western Tank and Lining shall provide the Owner/Inspector with a written acceptance of the surface to be lined that day.

1.2 Geotextile Liner Cushion

In the event that suitable soils are not readily available at the construction site, soils containing smooth rocks up to 1-1/2 inches in diameter or angular rocks up to ¾ inches may be utilized if covered with geotextile cushion having a minimum weight of 8 oz/yd^2. The weight of geotextile selected will depend on the actual soil used, thickness of liner, and service life or design considerations, but may be as high as 16 oz/yd^2.

See Appendix A for installation procedures.

1.3 Geonet Drainage Layer

See Appendix B for installation procedures.

2. PLACING COVER SOILS ON TOP OF PE GEOMEMBRANES

Cover soils deployed over synthetic liners should be free of all sharp objects--sharp rocks, and sharp sticks. The stones present in the soil should be rounded and smooth and no larger than 3/4 inch in diameter. Cover materials should be deployed using bulldozers separated from the membrane by at least one foot of cover soil for the smallest size dozers, and at least 18 inches of cover soil separation for the larger size dozers. The spreading operation should begin with placement of a mound of soil such that as the dirt covers the liner, it must ascend up the mound and then down the mound suppressing the formation of wrinkles. The movement of the soil must have this vertical descent to it as the dirt is spread over the membrane, rather than be pushed horizontally across the membrane. This type of action will suppress the formation of wrinkles in the path of the cover soil as it is being spread over the membrane and avoid burying wrinkles in the liner. Alternatively, a front-end loader can be used to place the cover soil out ahead of the path of the dozer to minimize spreading of the dirt and suppress wrinkle formation. If these procedures are followed, there should be no threat of puncture to the membrane due to cover soil operations, and buried wrinkles should be minimized.

In the event that suitable soils are not readily available at the construction site, soils containing smooth rocks up to 1-1/2 inches in diameter or angular rocks up to ¾ inches may be utilized if a cushion geotextile having a minimum weight of 8 oz/yd^2. The weight of geotextile selected will depend on the actual soil used, thickness of liner, and service life or design considerations, but may be as high as 16 oz/yd^2.

The following are recommended procedures for placing of soil cover layers on top of HDPE Geomembrane liners using heavy equipment:

2.1 Liner Temperature

The liner must always be covered during the coolest portion of the day. As HDPE geomembrane is black and has a high coefficient of thermal expansion many "slack wrinkles" will form during sunlight hours. If the membrane is covered when it is warm these slack wrinkles will fold over or the slack will be displaced causing undue stresses on the liner.

2.2 Anchor Trenches

Anchor trenches should only be backfilled after the liner has undergone at least one nighttime contraction cycle after deployment and welding. The backfilling must take place when the membrane temperature is at its lowest - i.e. not at midday with the sun causing solar heating and expansion of the material.

2.3 Covering Sequence

When covering sloped areas, the covering must always proceed from the bottom of the slope to the top of the slope. This will avoid "dragging" the liner down the slope, which will stress the liner, of "sloughing" of the cover soils and heavy equipment.

2.4 Ground Pressure

No vehicles except balloon tire UTV's are allowed directly on the liner. Only low ground pressure equipment can be used near the leading edge of the soil cover. The depth of soil cover required under high ground pressure equipment will depend on the subbase, types of soils, and type of liner protection and must be determined by the project engineer.

2.5 Dozers

Dozers can be used to spread the cover material but cannot be the only method used at the leading edge of the cover material. Pushing with a dozer pushes membrane slack in front of the leading edge into a slack wave which will accumulate causing stresses in the liner. To avoid this an excavator or similar must be used to dump material in front of the leading edge and trap the liner slack before it accumulates.

2.6 Inspection

A responsible person must inspect the liner as the cover material is placed. If damage to the liner is noted it must be marked and cleaned by hand using a plastic shovel for repair.

3. LAYOUT PLAN & RECORD DRAWINGS

3.1 Layout Plan

Wherever possible a proposed layout plan will be prepared before mobilizing to the site. The layout plan will show:

(1) slope lines
(2) seams
(3) panel numbers and dimensions
(4) pipes of other penetration locations

3.2 Record Drawing

As installation progresses the following information will be recorded for the record drawing.

(1) changes to the layout plan's panels, seams and penetrations
(2) roll number for each panel
(3) locations and extrusion #'s of destructive tests, patches, repairs and extrusion beads
(4) seam numbers
(5) the approximate length of main panels

NOTE: The intent of the record drawing is to show the correct number and orientation of panels, seams and details and their approximate location. The locations are not surveyed as would be done for a true "asbuilt" drawing.

4. LINER DEPLOYMENT

Unloading, handling and deployment of the liner is completed using slings and axles without contacting the roll directly with heavy equipment to minimize the potential for damage to the liner.

Panels and seams are oriented parallel to the slope unless approved otherwise by Western Tank and Linings' design department for that particular application. The only vehicles allowed on the liner are low ground pressure ATV's.

As the liner is deployed the following quality control procedures will be performed:

(1) The roll number used is marked on the panel by the rollout crew.

(2) The panel number corresponding to the layout plan is marked on the panel by the rollout or Q.C. crews.

(3) A general visual inspection of the panel laid is performed by the rollout crew. A detailed visual inspection is performed by the Q.C. crew within 24 hrs. of deployment. Any defects in the sheet are circled with a permanent marker. A final visual inspection is performed at the completion of the installation.

(4) Any changes to the layout plan and any sheet defects are recorded on record drawings. Each sheet defect will also receive an extrusion number.

(5) No geomembrane materials shall be deployed if the material temperatures are lower than 0 degrees C (32 degrees F) unless otherwise approved by the Owners Represented. The specified minimum temperature for material deployment may be adjusted by the Owners Representative. Temperature limitations should be defined in the preconstruction meeting. Typically, only the quantity of geomembrane that will be anchored and seamed together in one day should be deployed

5. SEAM WELDING

5.1 Wedge Welding

To the maximum point practical all main seams will be produced using Western Tank and Linings' hot wedge welders. Once a wedge welder has passed a qualification weld (see 6.3) production seaming can proceed with the following quality control procedures performed and recorded on the attached wedge welder seamlog:

(1) The date, welder number, operator initials, welder speed, and sheet temperature will be recorded on the liner next to each seam with a permanent marker by the operator.

(2) The above information is recorded by a Q.C. technician.

(3) The operator cuts one specimen from the end of the weld and performs a "vice-grip peel test" (see 6.1.1) on both weld tracks at the end of each seam. The specimen must pass on both tracks before proceeding to the next seam. The tested specimen is left at the end of the seam for inspection by the Q.C. technician who records the result.

(4) The Q.C. technician cuts one specimen from the end of the seam and performs a tensometer peel test (see 6.1.2) on both tracks within 24 hrs. and records both values.

(5) The Q.C. technician performs the "Air Test" (see 6.2.2) on the completed seam as soon as possible and records the pressures and start and finish times.

(6) Any defects such as burnouts, single seams, etc. are marked on the liner by the operator and recorded and numbered on record drawings for extrusion repair.

(7) No geomembrane material shall be seamed when liner temperatures are less than 0 degrees C (32 degrees F) unless the following conditions are complied with:

1. Seaming of the geomembrane at material temperature below 0 degrees C (32 degrees F) if allowed if the Geomembrane installer can demonstrate to the Owner’s Representative, using pre-qualification test seams, that field seams comply with the project specifications, the safety of the crew is ensured, and the geomembrane material can be fabricated (i.e. pipeboots, penetrations, repairs. etc.) at subfreezing temperatures

2. The Geomembrane Installer shall submit to the Owner Presentative for approval, detailed procedures for seaming.

5.2 Extrusion Welding

Extrusion welding is used for penetration seals, detail welding, patches, butt seam “T” intersections and nip folds, capstrips, seam defects, and sheet defects or damage. Once an extrusion welder/operator combination has passed a qualification weld (see 6.3) extrusion welding can proceed with the following quality control procedures performed and recorded on the extrusion welding log.

(1) Each extrusion weld is given an identification number which is marked on the liner with a permanent marker and recorded on the record drawings. The section of extruding done on a butt seam may be marked using a single identification number from start to finish of that section.
(2) The date, operator and welder number is marked on the liner with a permanent marker by the extrusion crew and recorded by a QC technician.
(3) Each *extrusion weld is leak tested by vacuum testing (see 6.2.4) or in the case of butt seams (see 5.3) air tested or vacuum tested.
***NOTE:** Some extrusion welds cannot be leak tested due to the geometry; i.e. pipe boot sleeves or plate to pipe welds.
(4) Each extrusion weld is "pik tested" (see 6.2.5) to evaluate bond strength.
(5) Each extrusion weld is visually inspected for overgrind, heat distortion, thin bead, etc.
(6) Any welding defects found are marked and recorded for repair and retesting.

5.3 Butt Seams

Butt Seams (also known as "Tie-In Seams") are used to join main sections of liner that have seams oriented in more than one direction. Butt seams require a combination of wedge welding and extrusion welding to be leak free.
In general butt seams are not welded until the main sections of liner have undergone at least one thermal contraction cycle. Often additional slack is "built in" at the butt seams during wedge welding by using more than 6" of overlap. The overlap is measured and trimmed at cool times of the day.

A qualified wedge welder is used to weld the seam which is tested and documented according to 5.1 except that the "Air Test" must be performed after the extrusion welding is complete. A qualified extrusion welder is used to reinforce and seal the wedge weld at the nip folds and the "T" intersections on both tracks. Extrusion testing and documentation is as per 5.2 except that extrusion beads that pass the high pressure test are not vacuum tested. To the maximum point practical all butt seams will be high pressure air tested. If a section of seam is not high pressure tested it is vacuum tested for leaks.

6. WELD TEST PROCEDURES

6.1 Destructive Test Procedures

Destructive tests require cutting "coupons" from a trial weld or production weld or from the parent material for strength testing. If the coupon is cut from a production weld within the finished seam length or installed liner it requires a patch using extrusion welding. Western tank and Linings' philosophy is to minimize coupon cutouts requiring extrusion weld patches by using data from non-destructive testing, especially our "High Pressure Air Test", qualification weld destructive testing, and gathering production seam destructive test data from small coupons that are outside

the finished seam length (i.e. in the anchor trench or at the tie-in seams excess overlap).

6.1.1 Vice Grip Peel Test

Weld specimens cut perpendicular to the weld track(s) approximately 1 inch wide are tested for peel adhesion by placing one flap from each sheet of the weld into two vice grip sheet metal pliers and applying peel stress by levering the backs of the pliers against each other until break occurs. A Film Tear Bond and good visual appearance are the criterion for a pass. A Film Tear Bond indicates good fusion. Visually the break should be ductile with a consistent clean appearance; i.e. no unfused spots.

6.1.2 Tensometer Peel Test

Weld specimens are cut using a coupon cutter with 1" x 8" die. Care must be taken to cut the specimens perpendicular and centred on to the weld tracks. Specimens are placed in a field tensometer in the peel mode with the grips approximately 2 from either side of the weld and the specimen perpendicular to the jaws. Specimens are pulled at 2"/minute until break occurs (for both weld tracks for wedge welds). The peak load in pounds is displayed on the tensometer and recorded for determining acceptance. A Film Tear Bond is also required on all specimens. If some peel separation should occur the % incursion is determined by dividing the area of separation by the total weld area (nominally 2" x 1" = 2 in5) x 100.

NOTE: The peel strength is related to parent material break strength and should not be compared to parent material yield strength.

6.1.3 Tensiometer Tensile Test

Parent material tensile yield strength as well as weld tensile strength (also known as the shear test) and elongation are determined using a tensiometer. Specimens are cut using a coupon cutter with a 1" x 8" die.

The purpose of testing the parent material is to gauge the effects of field testing temperature (strengths will be higher at less than 20°C and lower at higher than 20°C). Parent material specimens are pulled at a speed of 2"/minute and an initial grip separation of 2" with the specimen perpendicular to the jaws. The initial peak load is recorded. The test is terminated after the initial peak load is reached. This test is only performed if the temperature effects on the test results are deemed significant.

When testing weld specimens the specimens must be cut perpendicular to the weld track(s) and placed in the tensometer square to the jaws. Also note that nicks in the cutter die can cause premature breaks. The specimens are marked at 1" outside the weld edge on both sides of the weld for grip placement. Testing speed is 2"/minute. The initial peak load is recorded and the distance the grips travel after the grips first pull tight is monitored. The % elongation is defined as the grip travel/1" x 100 (as almost all the elongation occurs on one side of the weld the initial gauge length is defined as 1" = the distance from the grip to the edge of the weld). The test is terminated after the minimum elongation specified has been achieved.

6.2 Non-destructive Testing

The following tests are performed to evaluate the continuity and bond strength of completed seams and detail welds in a non-destructive manner. The "High Pressure Air Test" and "Pick Test" can become destructive tests only if the weld bond strength is inferior. These tests can detect areas of poor strength that would not be located by other test procedures.

6.2.1 Visual Inspection

Visual inspections are performed by both the welder operators and the QC technicians. Wedge welds are inspected for burnouts, spinouts, single seams, inclusions, etc. Extrusion welds are inspected for overgrind, excessive heat distortion, thin bead, etc. Any welding defects found are marked on the liner and recorded on record drawings for repair and testing.

6.2.2 High Pressure Air Test

Purpose The air test was developed to provide a non destructive test to evaluate the bond strength of double wedge welded seams.

Description The pressurized air channel forms a tube which is then visually inspected. Areas of the seam with partial fusion will show up as a bulge or widening of the air channel, or a weld separation resulting in a complete loss of pressure.

Specification

(1) Pressurize the seam to a minimum of 30 psi

(2) Allow the pressure to stabilize for 5 minutes while performing a visual inspection.

(3) Record the pressure at the beginning and the end of the next 5 minutes. There should be no more than a 10% pressure drop.

Test Procedure

(1) Seal off both ends of the seam.

(2) Connect the WTL pressure gauge assembly to the air channel.

(3) Pressurize the air channel with a compressor to a minimum pressure of 30 psi

(4) Allow the pressure to stabilize in the air channel for 5 minutes. While the seam is pressurized perform a visual inspection of the air channel to look for bulges which would indicate incomplete fusion.

(5) There should be no more that 10% pressure drop for a period of 5 minutes.

(6) If a rapid pressure drop occurs, perform a visual inspection of the seam. If a flaw is detected in the seam, pressure test the seam on either side of the flaw. Record and repair the flaw using extrusion welding and test the extrusion weld using the vacuum test. If the entire weld is suspect, replace the weld.

(7) Record the results of the test on the seam log.

6.2.3 Vacuum Box Soap Test

The vacuum box test is used to check extrusion welds (or wedge welds that cannot be practically tested using the High Pressure Test) for leaks.

Vacuum Test Procedure

(1) Trim off any flaps on the wedge weld and coat the seam with a strong soap solution.
(2) Place the vacuum chamber over the test area and depressurize to 5 inches of mercury.
(3) Observe the weld inside the vacuum chamber. Any leaks will allow atmospheric pressure air from beneath the liner to enter the vacuum chamber. Soap bubbles will form at the leak.
(4) Mark any leaks that are found, repair and retest.
(5) Record the results of the test.

NOTE: Some extrusion welds such as at boots, etc. cannot be vacuum tested due to the geometry involved.

6.2.4 Pick Test

The pick test is used to evaluate the bond strength of extrusion welds. The test is performed by welder operators and QC technicians by prying at the edges of an extrusion weld using a blunt screwdriver. Areas of weakly bonded extrudate can be pried off the parent material. Any flaws are marked and recorded for repair and testing.

6.3 Welder Qualification Seams

Each welding machine for wedge welders, and each welder/operator combination for extrusion welding, produces qualification seams each day before starting production welding. Qualification seams are made using strips of material approximately 300 mm wide and are a minimum of 1 m long for extrusion welding and 3 m long for wedge welding. These seams are destructively tested and the results recorded on the welder qualification data sheets attached.

7. MINIMUM ACCEPTANCE CRITERIA

The following limits are the minimum acceptable for a completed installation.

7.1 Destructive Weld Testing

TEST		MINIMUM ACCEPTANCE CRITERIA				
Thermally Bonded Smooth and Textured High Density Polyethylene (HDPE) Geomembranes						
Vice Grip Peel Test		FTB (on both tracks for wedge welds)				
Material Thickness		30 mils	40 mils	60 mils	80 mils	100 mils
Peel Strength, lb/in	Wedge	45	60	91	121	151
	Extrusion	39	52	78	104	130
Peel Separation (Incursion)		- FTB for all specimens - Avg of 5 must be less than 25% - Single specimen test for production end coupon – less than 10%				
Shear Strength, lb/in (Wedge/Extrude)		57	80	120	160	200
Shear Elongation at break, %		50	50	50	50	50
Thermally Bonded Smooth and Textured Linear Low Density Polyethylene (LLDPE) Geomembranes						
Vice Grip Peel Test		FTB (on both tracks for wedge welds)				
Material Thickness		30 mils	40 mils	60 mils	80 mils	100 mils
Peel Strength, lb/in	Wedge	38	50	75	100	125
	Extrusion	34	44	66	88	114
Peel Separation (Incursion)		- FTB for all specimens - Avg of 5 must be less than 25% - Single specimen test for production end coupon – less than 10%				
Shear Strength, lb/in (Wedge/Extrude)		45	60	90	120	150
Shear Elongation at break, %		50	50	50	50	50

7.2 Non-Destructive Weld Testing

TEST	MINIMUM ACCEPTANCE CRITERIA
Visual Inspection	No unrepaired flaws.
Air Lance	Produce a steam of continuous air along the flap of the weld edge
High Pressure Air Test	No more than 10% pressure drop for 5 minutes at 1.0 PSI/mil thickness/inch of air channel width.
Vacuum Box Test	Produce up to 4 inches of Hg (2psi)
Pick Test	Non unbonded areas.
Each welder will produce a minimum of 1 qualification seam for each day that welder is used for production.	

8. MINIMUM TEST FREQUENCIES

The following test frequencies are the minimum required for a complete installation.

8.1 Wedge Weld Qualification Seams

TEST	FREQUENCY
Vice Grip Peel	2 specimens / qualification tested on both tracks
Tensiometer Peel	5 specimens / qualification tested on both tracks
Weld Tensile (Shear)	2 specimens / qualification

Each welder will produce a minimum of 1 qualification seam for each day that welder is used for production.

8.2 Extrusion Welder / Operator Qualification Seams

TEST	FREQUENCY
Vice Grip Peel	2 specimens / qualification
Tensiometer Peel	5 specimens / qualification
Weld Tensile (Shear)	2 specimens / qualification
Each welder will produce a minimum of 1 qualification seam for each day that welder is used for production.	

8.3 Wedge Weld Production Seams

TEST	FREQUENCY
Vice Grip Peel	1 specimen tested on both tracks / seam (except panel width cross seams). Specimen to be taken from the end of the seam – no repair patch required.
Visual Inspection	Full seam length.
Air Lance	Only used when the seam is welded with a full wedge assembly
High Pressure Air Test	Full length of all seams to the maximum point practical.
Vacuum Test	Only used where High Pressure Testing is impractical.

8.4 Extrusion Weld Seams or Beads

TEST	FREQUENCY
Visual Inspection	Full seam length.
Vacuum Test	Full seam length except for beads previously pressure tested which are not vacuum tested.
Pick Test	1 pick / lineal foot of seam.
High Pressure Air Test	Only applies to butt seam, “T’s”.

9. FAILED TEST PROCEUDRES

If a weld or seam fails one or more of the required tests the following procedures are performed.

TEST	FREQUENCY
Welder Qualification Seam	Adjust welder, reweld, and retest.

(wedge or extrusion)	
Visual Inspection and Vacuum Box Test	Mark liner, record defect, repair and retest. If the defect already has an extrusion number renumber as 47A (initial extrusion #47) for records.
Pick Test	Mark, record and repair as above. If the weld is suspect due to many flaws, cap or replace the weld.
High Pressure Air Test	Retest on either side of the defect. Mark, record and repair as above. If there are more bulges than 1/20' of seam length (average) replace the weld.
Production Wedge Weld Vice Grip Peel Test or Tensiometer Peel Test	If single specimen fails track along the seam and retest using 3 specimens. If 1 (or more) of the 3 specimens fail track along the seam and retest using 5 specimens (or replace the seam). If the 5 specimens test fails the acceptance criteria track to obtain a 5 specimen coupon that passes the acceptance criteria and repair the area to the passing sample or place the seam and retest.

10. PENETRATIONS

Any structures such as pipes, sumps, concrete, etc. that penetrate the liner require mechanical attachment and/or welding are an anchor point and can result in stresses on the liner under some conditions. For stress considerations and possibilities of leakage the number of penetrations should be minimized where practical. In addition, the final liner penetration detail should be considered during design and construction of the earthworks and piping. Please consult Western Tank and Lining during the design phase to optimize the end product. Attention to compaction around pipes or structures is a must to avoid shear or tensile forces on the liner due to subsidence. Western Tank and Lining takes careful consideration of penetration location during panel layout design, panel deployment, and slack incorporation.

10.1 HDPE Pipe

Where possible HDPE piping should be used for pipelines, or for the last section of pipe, penetrating the liner. For all but the highest molecular weight pipe resins (Drisco 8600), geomembrane and pipe resins are compatible for welding. Typical methods include cutting the HDPE pipe flush with the side slope and welding geomembrane or HDPE plate, directly to the pipe.

The resulting weld is more reliable than boots and does not require any steel banding or rubber gaskets. Pump out sumps can also be constructed of HDPE pipe or plate and welded directly to the liner.

10.2 Concrete

Sealing to concrete structures of pipe collars are accomplished with anchor bolts, clamping bar, and rubber gaskets. Clamping to vertical surfaces is not recommended. To ensure a complete seal, using horizontal (or flush with slope) concrete surfaces which are smooth and stringline flat. Rebar should be located away from the anchor bolt line or more than 4 inches below the surface. Concrete pipe collars should include anchor rings and/or waterstops on the pipe. Satisfactory pipe seals for many applications can be constructed using a concrete collar with waterstop and a liner to concrete clamp seal. Some applications involving new concrete are best handled using cast-in HDPE inserts.

10.3 Pipe Boots

Pipe boots can be field or factory fabricated from HDPE geomembrane and sealed to piping or round pilings using stainless steel bands and neoprene gaskets. A 90degree pipe boot is always preferred to a slope angle boot for a pipe entering near the bottom of a reservoir. Pipe boots should be avoided for horizontal pipes penetrating the sideslopes.

10.4 Corrugated Culverts

Corrugated Culverts should be avoided as the only method of sealing is a concrete collar with waterstop, but the waterstop is very difficult to construct.

10.5 Pipe Support Pilings

Pipe Support Pilings should be cylindrical concrete or pipe to facilitate boot seals. Rectangular or "I" beam shapes pose serious sealing problems and should be avoided.

11. SLACK INCORPORATION

Most HDPE liner installations require some slack incorporation due to the materials high coefficient of thermal expansion (approximately 1% / 75°C), solar heating that takes place during construction due to its black colour, and the minimum temperature the liner will see during its service life.

In general, exposed liners will require more slack than buried applications. In all cases slack incorporation is a compromise between too little slack which will result in bridging at corners or toes of slopes, or excessive stresses at fixed points during cold temperatures, and too much slack resulting in slack "wrinkles" that will fold over when covered with soils or fluids, with resultant stresses at the folds. Covered applications should be built to fit the subgrade at the temperature that the liner will be covered at. Exposed applications should be built so that no significant stresses are developed at the minimum service temperature.

The following techniques are used to "size" the liner:

(1) The main sections of liner must be allowed to undergo at least one thermal contraction cycle before the anchor trench is backfilled or the butt seams are welded or liner is covered.
(2) The butt seam(s) overlaps are measured and trimmed at the cool times (early morning or evening) of the day.
(3) If additional slack is required it can be placed at the anchor trench before backfilling or at the butt seams (or seams between fixed points) by using extra overlap.
(4) The project superintendent determines the amount of slack to be incorporated based on field experience, calculations, and the expected service life of the liner.

12. QUALITY CONTROL REPORT

A quality control report is produced after the project is completed. The report contains the following information:

(1) The manufacturing material certifications.
(2) The wedge welder and extrusion welder / operator qualification data sheets.
(3) The wedge welding and extrusion welding seam logs.

(4) The record drawing showing:
   a. approximate location of all panels and seams;
   b. the panel numbers;
   c. the seam numbers;
   d. the roll number used for each panel;
   e. the approximate lengths of main panels;
   f. the approximate location of all penetrations; and
   g. the extrusion weld number and approximate location of all extrusion weld patches, beads, and repairs.

13. STANDARD INSTALLATION WARRANTY

WESTERN TANK & LINING LTD.

12180 Vickers Way
Richmond, B.C., V6V-1H9
PHONE (604) 241-9487
FAX (604) 241-9485

WORKMANSHIP WARRANTY

PURCHASER/USER	
LOCATION OF INSTALLATION	
DESCRIPTION OF INTENDED USE	

WESTERN TANK & LINING LTD. (the "**Installer**") warrants to the party named above as the Purchaser/User ("**Purchaser**") that the tank and/or lining membrane system ("the "Liner System") as installed by the Installer will be free from installation-related defects for normal use in approved applications, on the terms and conditions set forth in this Workmanship Warranty (the "**Warranty**"). This Warranty shall be in effect from the above noted **Acceptance Date** for the above noted **Warranty Period**.

The term "**normal use**" means uses reasonably consistent with the above noted Description of Intended Use, and does not include, among other things, the exposure of the Liner System to harmful chemicals; abuse of the Liner System by machinery, equipment or people; excessive pressures or stresses from any source; subsurface or overburdened soil conditions; and total or differential soil settlements and the effect those settlements may have on the Liner System. The Purchaser acknowledges that the sale of the Liner System is for commercial or industrial use only.

This Warranty does **not** include damages or defects in the Liner System resulting from: (i) acts of God, casualty or catastrophe, including earthquakes, floods, weather, tornadoes, explosion, war, acts of any public authority, or any other cause beyond the Installer's reasonable control; (ii) faulty materials, or any defects in the workmanship, design or manufacturing of the materials comprising the Liner System; (iii) defects arising on account of third party action; (iv) defects arising from improper maintenance, use, repair, replacement or alteration of the Liner System by the Purchaser; (v) subsidence of the land around the Liner System; or (vi) surface defects in workmanship and materials apparent and accepted by the Purchaser at the date of delivery.

Any claim for an alleged breach of this *Warranty* must be made in writing, by registered mail or fax, to the President of the Installer at the address above within thirty (30) days of the Purchaser becoming aware of the alleged defect. If the Purchaser fails to deliver notice as required under this Warranty, the defect and all warranties shall be deemed to have been waived and the Purchaser will have no right of recovery against the Installer. Should defects within the scope of the above Warranty occur, the Installer will, at its option, repair or replace the Liner System or defective portion thereof. The Installer will have the right to inspect and determine the cause of any alleged defect in the Liner System and to take appropriate steps to repair or replace the Liner System if a defect exists for which the Installer is liable under the terms of this Warranty. The Installer will not be required to make such repairs and/or replacements until the Purchaser has ensured that the area surrounding the Liner System is clean, dry, and in an unencumbered condition, including without limitation free from all water, dirt, sludge, residuals, and liquids of any kind.

The Installer's liability under this Warranty shall in no event exceed the lesser of: (i) the replacement cost of the Liner System or defective portion thereof; or (ii) the total amount paid by the Purchaser to the Installer in respect of the Liner System. Further, under no circumstances shall the Installer be liable to the Purchaser or any other party for any special, direct, indirect, or consequential damages arising from any defect in the installation of the Liner System. This Warranty is given in lieu of all other possible warranties by the Installer in respect of the Liner System and by accepting delivery of the Liner System, the Purchaser waives all other such possible warranties, except those specifically given.

THE INSTALLER MAKES NO WARRANTY OF ANY KIND OTHER THAN AS EXPRESSLY SET OUT HEREIN, AND HEREBY DISCLAIMS ALL OTHER WARRANTIES, BOTH EXPRESSED AND IMPLIED, OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THIS WARRANTY IS NOT EFFECTIVE AND THE INSTALLER IS NOT BOUND BY THE TERMS HEREOF UNTIL RECEIPT OF FULL AND FINAL PAYMENT FOR THE LINER SYSTEM FROM THE PURCHASER.

I hereby state I have read and understand the above and foregoing Warranty and agree to such by signing hereunder.

	PURCHASER/USER	WESTERN TANK & LINING LTD.
NAME		
SIGNATURE		
TITLE		
DATE (dd/mm/yy)		

APPENDIX "A"

GEOTEXTILES

Handling and Placement

All geotextiles shall be handled in a manner to ensure they are not damaged. The following special handling requirements shall be adhered to:

- On slopes, the geotextiles shall be secured in the anchor trench and then rolled down the slope when practical. In any event it should be deployed in such a manner as to continually keep the geotextile sheet in sufficient tension to reduce folds and wrinkles.

- In presence of wind, all geotextiles shall be weighted with sandbags or the equivalent.

- Geotextiles shall be cut using an approved cutter. If the material is being cut in place, special care must be taken to protect other geosynthetic materials from damage.

- Care shall be taken not to entrap stones or excessive dust that could damage the geomembrane, or generate clogging of drains or filters.

Seams and Overlaps

Geotextiles may be seamed by thermal bonding or by sewing.

- On slopes steeper than ten (10) horizontal to one (1) vertical, it is recommend that geotextiles be continuously seamed along the entire length of the panel. Geotextiles shall be overlapped approximately four (4") inches prior to seaming.

- On bottoms and slopes shallower than ten (10) horizontal to one (1) vertical, geotextiles can be either seamed, as indicated above or overlapped. If not thermally bonded the geotextile shall be overlapped a minimum of twelve (12") inches prior to seaming.

Repairs

Any holes or tears in the geotextile shall be repaired as follows:

- On Slopes - a patch made from the same geotextile shall be seamed into place.

- Horizontal Areas - a patch made from the same geotextile shall be spot seamed in place with a minimum of twelve (12") inches overlap in all directions.

APPENDIX "B"

GEONET

Handling and Placement

The geonets shall be handled in such a manner as to ensure the geonets are not damaged in any way.

- On slopes, the geonets shall be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geonet sheet in tension. If necessary, the geonet shall be positioned by hand after being unrolled to minimize wrinkles. Geonets can be placed in the horizontal direction (i.e. across the slope) in some special locations (i.e. where extra layers are required or where slope is less than 10:1).

- Such locations shall be identified by the Design Engineer in the project drawings.

- Geonets shall not be welded to geomembranes. Geonets shall be cut using approved cutters, i.e. hook blade, scissors, etc. Care should be taken to prevent damage to underlying layers.

- Care must be taken not to entrap dirt in the geonet that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane.

Layering and Tying of Geonet

When several layers of geonets are installed, care should be taken to prevent the strands of one layer from penetrating the channels of the next layer. Adjacent geonets shall be joined according to the following requirements.

- Adjacent rolls shall be overlapped by at least four (4") inches and securely tied.

- Tying can be achieved by plastic fasteners. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.

- Tying shall be five (5') feet to ten (10') feet along the bottom, every five (5') feet along the slope every two (2') feet across the slope and at top of berm and into anchor trench at least with one (1') foot intervals.

- In the corners of the side slopes where overlaps between perpendicular geonet strips are required, an extra layer of geonet shall be unrolled along the slope, on top of the previously installed geonets, from top to bottom of the slope.

- When more than one layer of geonet is installed, overlaps must be staggered and layers tied together.

Repairs

Any holes or tears in the geonet shall be repaired by placing a patch extending two (2') feet beyond edges of the hole or tear. The patch shall be secured to the original geonet by tying every twelve (12") inches. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area shall be cut out and the two (2) portions of the geonet shall be joined.

APPENDIX "C"

GEOCOMPOSITE

Handling and Placement

All geocomposite shall be handled in a manner to ensure they are not damaged.

- On slopes, the geocomposite can be secured in the anchor trench and then rolled down the slope when practical. The geocomposite shall be deployed in a manner to continually keep the geocomposite sheet in sufficient tension to reduce folds and wrinkles.

- In the presence of high wind, all geocomposite shall be weighted with sandbags or the equivalent.

- Geocomposite shall be cut using an approved cutter. If material is being cut in place, special care should be taken to protect other geosynthetic materials from damage.

- Care should be taken not to entrap stones or excessive dust that could damage the geomembrane, or generate clogging of drains or filters.

Seams and overlaps

- Geocomposite shall be seamed by thermal bonding or by sewing.

- No horizontal seams shall be allowed on side slopes greater than 4H:1V. Owners Represented. The horizontal seams on side slopes greater than 4H:1V can be adjusted by the Owners Representative to utilize material to its entirety.

- Tying of the geonet shall be with plastic fasteners. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.

- Tying shall be every 1.5 m across the cell floor, every 1.5 m along the side slopes and every 750 mm at the top of berms and into anchor trenches. End to end joints on the cell floor shall be overlapped 600 mm. Tying shall be every 0.3 m across the end to end joint. All tying shall be covered with geotextile, sewn or heat bonded.

Repairs

The damage shall be observed, and if smaller than one (1) m by one (1) m, the geocomposite shall be repaired. If the tear or hole is larger, then the roll shall be cut to remove the damaged area, fasteners shall be used to attach the geonet with the geotextile being heat seamed. Minimum overlaps to be as specified.

- If the geonet is undamaged, and the geotextile is damaged, a patch of geotextile shall be placed. The geotextile patch shall be thermally bonded in place with a minimum of 300 mm overlap in all directions.

- If the geonet is damaged, the geonet shall be removed. A section of geonet shall be cut to replace the removed section. The geonet shall be tied to the existing geonet using plastic fasteners placed at least every 150 mm. A geotextile patch shall be placed over the repaired geonet section. The geotextile patch shall be thermally bonded in place with a minimum of 300 mm overlap in all directions.

APPENDIX "D"

GEOSYNTHETIC CLAY LINER (GCL)

Handling and Placement

All rolls GCL shall be handled in a manner to ensure they are not damaged.

- GCL rolls should be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging should be carefully removed without damaging the GCL. The orientation of the GCL should be in accordance with the Engineer's or manufacturer's recommendations.

- Proper equipment, spreader-bar and core-bar assembly and/or a forklift with stinger attachment shall be used during handling and deployment as per manufacturer's recommendations.

- Equipment which could damage the GCL shall not be allowed to travel directly on it. If the installation equipment causes rutting of the sub-grade, the sub-grade must be restored to its originally accepted condition before placement continues.

. The GCL shall be placed so that seams are parallel to the direction of the slope. Seams should be located at least 1 m from the toe and crest of slopes steeper than 4H:1V. The horizontal seams on side slopes greater than 4H:1V can be adjusted by the Owners Representative to utilize material to its entirety.

- Placement shall be from highest elevation to the lowest elevation to facilitate drainage in the event of precipitation unless the Engineer and or the Owners Representative assure that the subgrade is porous and free draining.

- All GCL panels should lie flat on the underlying surface, with minimal wrinkles and no folds, especially at the exposed edges of the panels. Panels shall be placed with non-woven side up.

- Only as much GCL shall be deployed as can be covered with soil, a geomembrane, or a temporary waterproof tarpaulin at the end of the working day.

- The GCL shall be placed in an anchor trench at the top of the slope as per the drawings. The front edge of the trench should be rounded so as to eliminate any sharp corners. Loose soil should be removed from the floor of the trench. The GCL should cover the entire trench floor, but not the rear trench wall.

Field Seams

- The GCL seams are constructed by overlapping their adjacent edges. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris. Supplemental bentonite is required in the overlap zone.

- The minimum dimension of the longitudinal overlap should be 225 mm. End-of-roll overlapped seams should be similarly constructed, but the minimum overlap should measure 600 mm.

- Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone.

- Where the GCL product requires bentonite-enhanced seams as recommended by the GCL manufacturer, bentonite-enhanced seams shall be constructed by overlapping adjacent panels as instructed above, exposing the underlying edge and then applying a continuous bead of granular sodium bentonite along a zone defined by the edge of the

underlying panel and the 150 mm line. The bentonite shall be applied at a minimum application rate of 0.4 kg/m. Where bentonite-enhanced seams are not required by the GCL product as recommended by the GCL manufacturer, GCL installer shall receive approval from the Engineer.

- GCL may be seamed by thermal bonding to prevent the movement of material while covering it with a geomembrane, covering it with soil or a temporary waterproof tarpaulin

Detail Work

- The GCL shall be sealed around penetrations and embedded structures embedded in accordance with the drawings.

- Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are required to avoid damage to the geotextile components of the GCL during the cutting process.

Repair

- If the GCL is damaged (torn, puncture, perforated, etc.) during installation, it may be possible to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll or scrape peice and shall be cut to size such that minimum overlap of 300 mm (12 inches) is achieved around all of the damaged area. Dry bentonite or bentonite mastic should be applied around the damaged area prior to placement of the patch. It may be desirable to use an adhesive or heat bonded to affix the patch in place so it is not displaced during cover placement.

- Any solvent or adhesive in contact with the GCL must be approved by the Manufacturer.

APPENDIX "E"

DRAIN TUBE

Handling and Placement

Rolls of Draintube shall be handled in a manner to ensure they are not damaged.

- Draintube Drainage Geocomposite shall not be placed, seamed/joined, or repaired during periods of heavy precipitation, excessively high winds, or in areas of ponded water or excessive moisture.

- Draintube Drainage Geocomposite shall be installed in accordance with manufacturer's recommendations, and as shown on the Drawings and specified herein.

- Draintube Drainage Geocomposite shall be installed in the direction of the slope such that the pipe components are oriented with the intended flow direction (typically perpendicular to the contours) unless otherwise specified by the ENGINEER.

- The Draintube Drainage Geocomposite shall be kept clean prior to and during installation.

- Folds or excessive wrinkling of deployed Draintube Drainage Geocomposite shall be removed to the extent practicable.

- Installs shall exercise care not to entrap stones, excessive dust, or foreign objects in the material.

- Draintube Drainage Geocomposite shall be adequately weighted, using sand bags or equivalent until the subsequent soil or geosynthetic layer is placed. In the presence of wind, the sandbags or the equivalent shall be placed along the leading edge and removed once cover material is placed.

- If the project contains slopes steeper than 5 horizontal to 1 vertical, special care should be taken to use full length rolls from the top of the slope. If the roll length cannot cover entire slope, then the next roll should be situated towards the toe of the slope. The locations of horizontal connections of adjacent panels should be staggered at least 10 feet apart.

- Overlaps shall be singled down the slope and/or in the direction that backfilling will occur.

- If the project includes an anchor trench to secure the Draintube Drainage Geocomposite, then the panels shall be secured in the anchor trench as indicated on the Drawings.

Field Seams

Adjacent sheets of Draintube Drainage Geocomposite shall be overlapped as described below.

- Connections at along the side of the Draintube Drainage Geocomposite roll shall be overlapped 4 inches, and shall be secured using sewn seams, additional overlap, or welds (hot air or flame) [*ENGINEER to select one or more alternatives*].

- Connection at the leading or terminating edge of the Draintube Drainage Geocomposite shall be overlapped such that the upper geotextile layer can be rolled back 12 to 18 inches and the end of the next roll inserted into the opening. Pipes shall be connected either using a snap coupler fitting supplied by the geocomposite manufacturer or by overlapping the pipes by 12 to 18 inches [*ENGINEER to select the alternative*].

Connections to an interceptor drain and/or vacuum pipe shall conform to the Drawings and be at the direction of ENGINEER.

Repair

Prior to covering the deployed Draintube Drainage Geocomposite, each roll shall be inspected for damage.

- Any rips, tears or damaged areas on the geocomposite shall be removed and patched.

- If a section of pipe is damaged during installation, add a piece of undamaged pipe of the same diameter next to the damaged pipe, extending a minimum of 8 inches beyond each end of the damaged section of pipe.

- If the geotextile is ripped or torn, install an undamaged piece of the same material under the hole that extends a minimum of 6 inches beyond the hole in all directions to insure that protection of the geomembrane is maintained.

- If the area to be repaired is more than 50 percent of the width of the panel, then the damaged area shall be cut out and replaced with undamaged material. Damaged geotextile shall replaced by the same type of geotextile.

APPENDIX "F"

PETROGARD VI

Preparation

- Ensure subgrade is compacted and surface finished to not impair installed membrane.
- Subgrade to provide firm, unyielding surface with no sharp changes or abrupt breaks in grade. A smooth drum rolled surface is preferable.
- Ensure surfaces to be lined are smooth, free of foreign and organic material, sharp objects, or debris of any kind.
- If a suitable sub-grade is not available, then a cushion layer of clean sand or non woven geotextile shall be placed prior to liner placement.
- Excavate anchor trench to line, grade, and width indicated on drawings, prior to liner placement. Provide slightly rounded corners in the trench to avoid sharp bends in the geomembrane.
- Prepare mechanical attachments according to ASTM D6497 Standard Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures.
- All concrete surfaces to which the liner will attach shall have “smooth trowel” finish. All the corners should have radius to a minimum 25mm as per the drawing.
- Compaction at pipe penetrations and areas of mechanical attachment will be inspected carefully as these are areas where differential settlement can occur.
- A certificate of subgrade acceptance will be prepared by the liner installation contractor prior to liner installation.

Handling and Placement

- Installation of the geomembrane shall be performed in a logical sequence.
- Place panels according to the drawings, the panel layout, and the label on each panel.
- Sufficient thermal slack shall be incorporated during placement to ensure that harmful stresses do not occur in service.
- Ensure personnel working on geomembrane do not use damaging footwear.
- Protect completed panels from damage; handle carefully to avoid damaging the liner.
- Equipment and methods used to unroll liner panels should not damage the prepared subgrade.
- Ballast used to prevent uplift by wind must not damage the geomembrane. A continuous load is recommended along the edges of panels to eliminate the risk of wind uplift.

Weather Conditions at Time of Installation

- Site welding may proceed at any temperature providing a suitable qualification weld can

be prepared at site conditions using the operator, equipment, and materials intended for the project.

- Installation of membrane in winds above 20 km/h can proceed only if the installer can demonstrate that the liner will not be at risk of damage.

- Do not install membrane during precipitation or in the presence of excessive moisture.

- Do not install in weather conditions that may be detrimental to the function of the membrane.

Qualification

- A qualification seam will be run prior to any field seams.

- A qualification seam is made with separate pieces of geomembrane using the same material and equipment that will be used for production welding.

- Machine conditions, and operator used for welding must be the same as those used for the qualification weld.

- Qualification seam must be tested in shear and peel, and meet the specified requirements for the material.

- A qualification seam must be rerun whenever the operator is changed, the equipment adjusted, or at least every 4 hours.

Seaming

- Cleaning solvents shall not be used unless product is approved by membrane manufacturer.

- Use water and rags for all cleaning. If soap is used for cleaning rinse with clean water and dry before welding.

- Over lap of a seam shall be a minimum of 150mm

- Technician shall record the machine number, date, technician initials and start the time of every wedge weld.

Destructive and Seam Testing

- Field seams will be sampled for testing in a way that does not compromise the installed liner One sample to be tested for every 150m of field seam

- Test samples are to be removed from the ends of seams, from the anchor trench, or other location that does not introduce a defect into the liner.

- Samples to be approximately 100 mm long to permit testing of one shear and two peel specimens (ASTM D6392).

- Test samples shall be taken with in 24hrs after seaming
  - Record date, location and pass/fail description

- Field seams must meet the specified requirements in peel and shear for the material.

- A written record will be maintained for all field seam tests.

All completed field seams will be 100% non-destructively tested using an air lance test (ASTM D4437 method 7.2).

- .

- Destructive Test Failure:
  - Cut out seam and re-weld; or,
  - Retrace welding path to <3 m> <<10 feet>> from location of failed test. Take sample for additional test. If passed - cap strip or extrusion weld between failed location and original failed location.

Repairs

- Inspect seams and non-seam areas for defects, holes, blisters, undispersed raw materials.
- Identify any sign of foreign matter contamination.
- Repair all through-thickness defects.
- Defective Seams: Cap strip or replace.
- Tears: Patch and seal round sharp ends of tears on slope or stressed area prior to patching.
- Repair blisters, large cuts and undispersed raw materials with patch.
- Secure Patches by Hot Air Welding:
  - Hot Air Welding
    - Hand hot air welding is permitted for patching liner.
    - Clean area to be patched.
    - Hand weld the patch with a hot air gun and suitable roller.
- Patches: Round or oval, of same geomembrane. Extend minimum 75 mm beyond the edge of the defect.
- Verification of Repairs: All repairs to be non-destructively tested using
  - Air Lance Test, ASTM D4437 Method 7.2
  - Vacuum Box Test ASTM D5641
- Redo failed repairs and re-test.
- Keep records of all repairs and the results of repair testing.

Cleaning solvents shall not be used unless product is approved by membrane manufacturer.
Use water and rags for all cleaning. If soap is used for cleaning rinse with clean water and dry before welding.

Attachment No. 2

Geotechnical Investigation

Knight Piésold CONSULTING

May 31, 2019

Mr. Allan Knowlton
Project Manager
Baffinland Iron Mines Corporation
#300-2275 Upper Middle Road East
Oakville, Ontario
Canada, L6H 0C3

Knight Piésold Ltd.
1650 Main Street West
North Bay, Ontario
Canada, P1B 8G5
T +1 705 476 2165
E northbay@knightpiesold.com
www.knightpiesold.com

Dear Allan,

RE: KM106 and KM107 Stockpile - 2019 Geotechnical Site Investigation Summary

1.0 INTRODUCTION

Baffinland Iron Mines Corporation (Baffinland) is developing a new stockpile at the Mary River Project, located on northern Baffin Island, Nunavut. Knight Piésold Ltd. (KP) completed geotechnical site investigations (SI) for the proposed KM106 and KM107 stockpiles in April and May 2019. This letter describes the 2019 SI programs and provides the SI results.

2.0 SI PROGRAM

2.1 GENERAL

The 2019 SI program was completed in two phases. The SI at the KM107 area was completed from April 4 to April 16, 2019. The SI at the KM106 area was completed from May 15 to May 16, 2019. All geotechnical field work was carried out under the oversight and full-time presence of a KP engineer. KP responsibilities included the following:

- Monitoring of all drilling activities
- Sample collection and geotechnical logging of all recovered material, including overburden and bedrock
- Selection of samples for laboratory testing and specification of the required testing
- Delivery of selected samples to the Baffinland on-site lab
- Delivery of selected samples to an external lab

The locations of the 2019 drillholes are shown on Figure 1.

2.2 SONIC DRILLING

A total of 113.8 metres of sonic drilling was completed in 10 drillholes. Sonic drilling is a rotary vibratory drilling method used to core and recover nearly continuous, disturbed soil samples. Boart Longyear completed the drilling using a 130C mini track-mounted sonic drill rig. Sonic drilling was completed using a 4-inch core barrel without the use of water or steel casing downhole. Upon completion, all drillholes were backfilled with sand to ground surface.

A summary of all 2019 drillholes is provided in Table 1. The geotechnical drillhole logs are provided in Appendix A. Photographs from each drill location are provided in Appendix B and core box photographs are provided in Appendix C.

2.3 GEOTECHNICAL LOGGING

Geotechnical logging of recovered materials was completed to assess the soil characteristics within the study areas. Materials recovered during drilling were characterized according to KP soil logging procedures, which combine elements from the Canadian Foundation Engineering Manual (CGS, 2006) and the Unified Soil Classification System (USCS) (ASTM D2488). Frozen soils were logged according to the procedures outlined in ASTM D4083.

Recovered materials were described based on the following characteristics.

- Soil type based on particle size
- Particle shape and angularity
- Gradation
- Plasticity
- Colour and odour
- Soil fabric and structure
- Compactness (for cohesionless soils) or consistency (for fine grained soils)
- Moisture content, and
- Presence of ice and habit of any segregated formations

The sonic drilling for the 2019 SI program was completed without the injection of drilling fluids, therefore, the measured moisture content is judged to be representative of the in situ conditions.

2.4 LABORATORY TESTING

Samples were collected by the KP site engineer for laboratory index testing. The index testing was completed by on-site and off-site laboratories as follows:

- On site testwork was completed by KP and Baffinland personnel and included the following:
  - Natural Moisture Content (ASTM D2216) - 58 tests were completed at the on-site laboratory to assess how in situ moisture content varies across the study area.
  - In situ Density - 4 estimates of in situ density were conducted by KP on intact sonic core.

- Off-site testwork was completed by the Golder Laboratory in Vancouver, British Columbia and included the following:
  - Natural Moisture Content (ASTM D2216) - 6 tests were completed to assess in situ moisture.
  - Particle Size Distribution (PSD) with Hydrometer Analysis (ASTM D6913/D7928) - 6 tests were completed to assess the gradation characteristics of the recovered materials. Hydrometer analyses were performed on all PSD samples.
  - Atterberg Limits (ASTM D4318) - 6 tests were completed to assess material plasticity and determine USCS classification.
  - Specific Gravity (ASTM D854) - 6 tests were completed to assess particle density.

A summary of the laboratory testing results is provided in Table 2. Plots of the moisture content, particle size, and plasticity results are included in Appendix D1. The detailed laboratory reports are provided in Appendix D2.

3.0 GEOTECHNICAL CHARACTERIZATION

3.1 KM107 AREA

Six sonic drillholes were completed in the KM107 area. The encountered surficial deposits ranged in depth from 0.6 mbgs in KM107-DH19-04 to 21.1 mbgs in KM107-DH19-06, with the shallower deposits on the hillsides and the deeper deposits on the gentler topography.

The overburden consists of a thin organic-rich topsoil overlying glacial deposits typically comprising SAND, some silt and gravel, trace to some clay, with cobbles and boulders. The surficial soils are generally well graded, non-plastic, medium greyish brown, massive, and frozen. The sandy materials were typically well-bonded with minor excess ice crystals (Nbe/Vx). Sections of massive ICE as well as ICE + SAND were encountered in four of the drillholes and were observed in thicknesses of up to 14 m (KM107-DH19-06). The encountered ice was dominantly hard with some soft and crumbly sections, clear to white in colour, and massive with some stratified sandy sections. Typical examples of ice rich layers are provided on Figure 2. The encountered bedrock was a very strong and fresh to slightly weathered gneiss. A 2.5 m thick weathered bedrock horizon with iron oxidation was encountered in drillhole KM107-DH19-04.

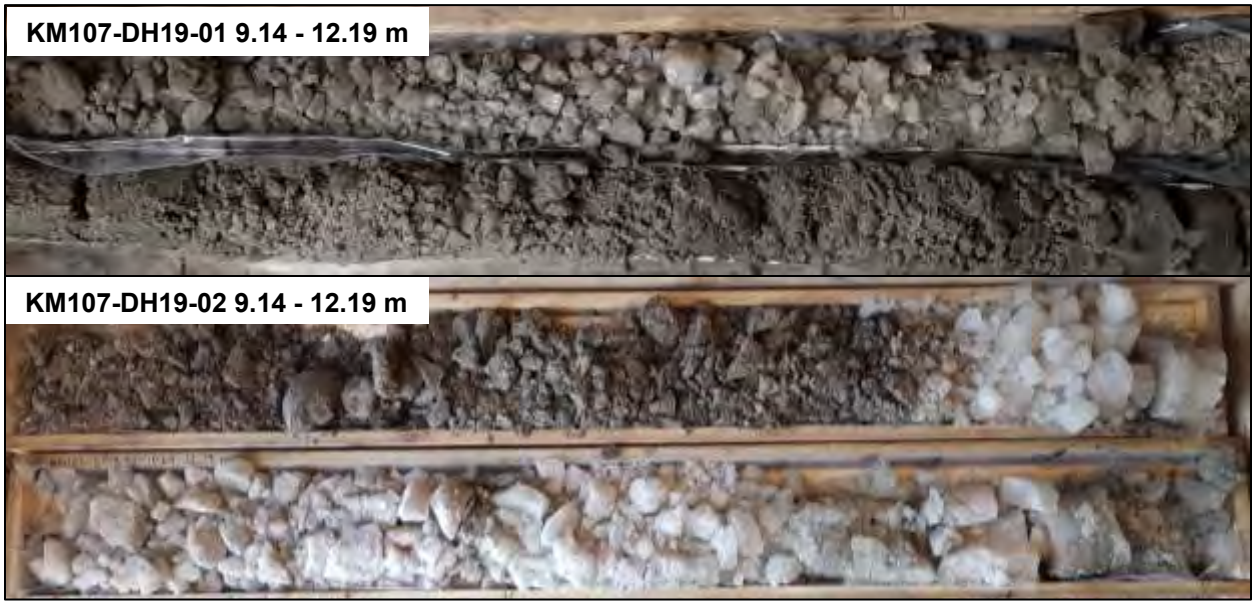

Figure 1 KM107 - Massive Ice Examples

Four (4) overburden samples from the KM107 area were sent off-site for laboratory index testing and 58 samples were tested for moisture content at the on-site laboratory. Cobbles and boulders (material greater than 76 mm diameter) were excluded from the samples. Field logging of recovered sonic core confirms the presence of cobbles and boulders in varying concentrations as indicated in the drillhole logs. An additional 4 samples were used to estimate in situ density in the field during drilling.

The moisture content, particle size, and plasticity results are provided in Appendix D1. The results indicate that the soil materials within the overburden consists of SAND, some silt, some gravel, trace to some clay material with the following geotechnical properties:

- Natural Moisture Content: Average of 38% (range of 4 to 100%)
- Specific Gravity: Average of 2.69 (range of 2.68 to 2.69)
- In situ Density: Average of 1.15 g/cm^3 (range of 0.92 to 1.56 g/cm^3)
- Particle Size Distribution:
  - Gravel: Average of 17% (range of 6 to 33%)
  - Sand: Average of 55% (range of 44 to 61%)
  - Silt: Average of 19% (range of 17 to 22%)
  - Clay: Average of 9% (range of 5 to 12%)
- Plasticity: non-plastic to low plasticity
- USCS Classification: silty sand (SM)

The overall geotechnical characteristics of the KM107 site will be dominated by the presence of ice rich soils and massive ice.

3.2 KM106 AREA

Four sonic drillholes were completed in the KM106 area. The encountered surficial deposits ranged in depth from 0.0 to 4.2 mbgs, but the area is generally characterized by shallow bedrock with many surface outcroppings and large boulders. The deepest overburden deposit was encountered in KM106-DH19-05 and appears to be isolated to a relatively small area, as outlined on Figure 3. The depth to the bedrock surface outside of the area illustrated on Figure 3 was observed at less than 1 mbgs.

The overburden consists of a 20 cm organic-rich topsoil overlying a glacial till comprising gravelly SAND, some silt, trace clay with cobbles and boulders. The surficial soils are generally well-graded, non-plastic, medium greyish brown, massive, and moist. Encountered bedrock was a very strong and fresh to slightly weathered gneiss. Frozen ground was not encountered in the KM106 area drillholes, however it is possible that the frozen ground was thawed by drilling activities .

Figure 2 KM106 Area - Overburden Distribution

Two overburden samples from the KM106 area were sent off-site for laboratory index testing. Cobbles and boulders (material greater than 76 mm diameter) were excluded from the samples. Field logging of recovered sonic core confirms the presence of cobbles and boulders in varying concentrations.

The moisture content, particle size, and plasticity results are provided in Appendix D1. The results indicate that the overburden consists of a gravelly SAND, some silt, trace clay material with the following geotechnical properties:

- Natural Moisture Content: Average of 9% (range of 8 to 10%)
- Specific Gravity: Average of 2.72 (range of 2.71 to 2.72)

- Particle Size Distribution:
  - Gravel: Average of 28% (range of 26 to 29%)
  - Sand: Average of 50% (range of 43 to 57%)
  - Silt: Average of 17% (range of 13 to 20%)
  - Clay: Average of 5% (range of 3 to 7%)
- Plasticity: low plasticity
- USCS Classification: silty sand (SM)

4.0 CLOSURE

The KM106 location is recommended for construction of a stockpile based on the absence of massive ice and the presence of near-surface bedrock in the foundations.

We trust that the information contained herein meets your needs at this time. Should additional information be required please do not hesitate to contact the undersigned.

5.0 REFERENCES

ASTM D854. *Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer.* ASTM International. West Conshohocken, PA. www.astm.org

ASTM D2216. *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*. ASTM International. West Conshohocken, PA. www.astm.org

ASTM D2487. *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System.* ASTM International. West Conshohocken, PA. www.astm.org

ASTM D2488. *Standard Practice for Description of Frozen Soils (Visual-Manual Procedure)*. ASTM International. West Conshohocken, PA. www.astm.org

ASTM D4083. *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).* ASTM International. West Conshohocken, PA. www.astm.org

ASTM D4318. *Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.* ASTM International. West Conshohocken, PA. www.astm.org

ASTM D6913. *Standard Test Method for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis*. ASTM International. West Conshohocken, PA. www.astm.org

ASTM D7928. *Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis*. ASTM International. West Conshohocken, PA. www.astm.org

Canadian Geotechnical Society (CGS), 2006. *Canadian Foundation Engineering Manual*. Fourth Edition.

Knight Piésold Ltd. (KP), 2019a. Letter to: Allan Knowlton, Baffinland Iron Mines Corporation. Re: *KM107 Stockpile - Site Investigations Technical Specifications*. March 25. North Bay, Ontario. Ref. No. NB19-00219 (NB102-181/55).

Yours truly,
Knight Piésold Ltd.

REGISTERED PROFESSIONAL ENGINEER
K.E. HAWTON
LICENSEE
May 31/19
NWT/NU

Prepared: _____
Jessica Galavan, P.Eng.
Project Engineer

Reviewed: _____
Kevin Hawton, P.Eng.
Specialist Engineer | Associate

Approval that this document adheres to the Knight Piésold Quality System: ☑

Attachments:

Table 1 Rev 0	Drillhole Summary
Table 2 Rev 0	Laboratory Testing Summary
Figure 1 Rev 0	KM106 and KM107 Stockpiles - Site Investigation Locations
Appendix A	Geotechnical Drillhole Logs
Appendix B	Drill Site Photographs
Appendix C	Core Box Photographs
Appendix D	Laboratory Data
Appendix D1	Laboratory Data Summary Plots
Appendix D2	Laboratory Data Reports

PERMIT TO PRACTICE
KNIGHT PIESOLD LTD.
Signature _____
Date May 31/2019
PERMIT NUMBER: P 547
The Association of Professional Engineers, Geologists and Geophysicists of NWT/NU

Copy To: Roger Doyle, Baffinland Iron Mines Corporation
Trevor Brisco, Baffinland Iron Mines Corporation
Simon Fleury, Baffinland Iron Mines Corporation
Matt Brown, Baffinland Iron Mines Corporation
Kevin Hawton, Knight Piésold Ltd.

/jg

Knight Piésold CONSULTING

TABLE 1

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

KM106 AND KM107 STOCKPILE - 2019 GEOTECHNICAL SITE INVESTIGATION SUMMARY
DRILLHOLE SUMMARY

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Drillhole ID	Location	UTM Coordinates			Total Depth (m)	Depth to Bedrock (m)	Start Date	Completion Date	Notes
		Easting (m)	Northing (m)	Elevation (masl)					
KM106-DH19-01	KM106 Sedimentation Pond	563,473	7,913,064	264	1.52	0.5	2019-05-16	2019-05-16	Backfilled with sand to surface
KM106-DH19-02	KM106 Stockpile	563,418	7,913,168	278	1.52	0.3	2019-05-16	2019-05-16	Backfilled with sand to surface
KM106-DH19-03	KM106 Stockpile	563,545	7,913,193	279	1.83	0.4	2019-05-16	2019-05-16	Backfilled with sand to surface
KM106-DH19-04	KM106 Stockpile	563,618	7,913,306	285	0.00	0.0	2019-05-16	2019-05-16	Drillhole not completed due to difficult access and bedrock outcrops at surface.
KM106-DH19-05	KM106 Sedimentation Pond	563,505	7,913,113	268	4.57	4.4	2019-05-16	2019-05-16	Backfilled with sand to surface
KM107-DH19-01	KM107 Sedimentation Pond	564,115	7,913,358	304	22.86	21.0	2019-04-08	2019-04-11	Backfilled with sand to surface
KM107-DH19-02	KM107 Stockpile	564,219	7,913,502	319	21.33	20.0	2019-04-12	2019-04-13	Backfilled with sand to surface
KM107-DH19-03	KM107 Stockpile	564,385	7,913,556	318	22.08	21.0	2019-04-15	2019-04-15	Backfilled with sand to surface
KM107-DH19-04	KM107 Stockpile	564,351	7,913,721	330	3.66	0.6	2019-04-15	2019-04-16	Backfilled with sand to surface
KM107-DH19-05	KM107 Access Road	563,874	7,913,618	334	11.58	9.4	2019-04-07	2019-04-08	Backfilled with sand to surface
KM107-DH19-06	KM107 Sedimentation Pond	564,307	7,913,350	308	22.86	21.1	2019-04-11	2019-04-12	Backfilled with sand to surface

I:\1\02\00181\57\A\Correspondence\NB19-00431 - 2019 KM106 and KM107 Stockpile Geotechnical SI\Tables and Figures\[Tables and Figures.xlsx]Table 1

NOTES:

1. COORDINATE SYSTEM IS UTM NAD83, ZONE 17W. COORDINATES WERE TAKEN WITH A HANDHELD GARMIN GPS WITH AN ACCURACY OF +/- 4 m.
2. REPORTED DEPTHS REFER TO VERTICAL DISTANCE BELOW GROUND SURFACE.
3. ALL HOLES DRILLED VERTICAL WITH SONIC CORING METHODS.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	31MAY'19	ISSUED WITH LETTER NB19-00431	JAG	ALA

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TABLE 2

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

KM106 AND KM107 STOCKPILE - 2019 GEOTECHNICAL SITE INVESTIGATION SUMMARY
LABORATORY TESTING SUMMARY

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Drillhole ID	Sample ID	Depth From	Depth To	Elevation	In-Situ Density	Moisture Content (ASTM D2216)	Particle Size Analysis (ASTM D6913/D7928)				Atterberg Limits (ASTM D4318)			Specific Gravity (ASTM D854)	USCS Classification (ASTM D2487) [4]	Material Description
							Gravel (>4.75 mm)	Sand (4.75 to 0.75 mm)	Silt (0.075 to 0.002 mm)	Clay (<0.002 mm)	Liquid Limit	Plastic Limit	Plasticity Index			
		(m)	(m)	(m)	(g/cm^3)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(-)	
KM106 Stockpile																
KM106-DH19-01	01-BU-01	0.3	0.5	263.60		10.0	26.3	57.4	13.4	2.9	19	16	3	2.72	SM	Gravelly SAND, some silt, trace clay
KM106-DH19-05	05-BU-01	1.6	1.8	266.30		8.2	29.0	43.2	20.4	7.4	17	14	3	2.71	SM	Silty, gravelly SAND, trace clay
KM107 Stockpile																
KM107-DH19-01	01-MC-01	0.6	0.9	303.25		12.5										
KM107-DH19-01	01-MC-02	2.2	2.5	301.65		87.1										
KM107-DH19-01	01-MC-03 / 01-DE-01	4.5	4.6	299.49	1.15	70.3										
KM107-DH19-01	01-MC-04	4.8	5.1	299.05		52.9										
KM107-DH19-01	01-MC-05	6.7	7.0	297.15		40.0										
KM107-DH19-01	01-MC-06	8.5	8.6	295.45		14.6										
KM107-DH19-01	01-MC-07	9.1	9.3	294.78		78.6										
KM107-DH19-01	01-MC-08	13.0	13.3	290.85		8.5										
KM107-DH19-01	01-MC-09	13.9	14.2	289.95		15.3										
KM107-DH19-01	01-MC-10	15.9	16.2	287.95		8.2										
KM107-DH19-01	01-MC-11	17.8	18.1	286.05		10.6										
KM107-DH19-01	01-MC-12	18.5	18.9	285.30		9.1										
KM107-DH19-01	01-MC-13	20.3	20.6	283.55		17.0										
KM107-DH19-01	01-EMC-01	10.9	11.3	292.90		100.0										
KM107-DH19-02	02-MC-01	0.6	0.8	318.30		8.6										
KM107-DH19-02	02-MC-02 / 02-DE-01	1.6	1.7	317.35	1.56	17.0										
KM107-DH19-02	02-MC-03	3.6	3.8	315.30		57.6										
KM107-DH19-02	02-MC-04	7.1	7.3	311.80		69.0										
KM107-DH19-02	02-MC-05	9.6	9.8	309.30		55.9										
KM107-DH19-02	02-MC-06	12.3	12.5	306.60		40.0										
KM107-DH19-02	02-MC-07	14.9	15.1	304.00		18.1										
KM107-DH19-02	02-MC-08	16.0	16.1	302.95		18.0										
KM107-DH19-02	02-MC-09	17.6	17.7	301.35		13.0										
KM107-DH19-02	02-MC-10	18.7	18.9	300.20		11.3										
KM107-DH19-02	02-EMC-01	4.7	5.1	314.10		100.0										
KM107-DH19-02	02-EMC-02	7.8	8.2	311.00		100.0										
KM107-DH19-02	02-EMC-03	11.0	11.5	307.75		100.0										
KM107-DH19-02	02-BU-01	1.2	1.5	317.65		9.5	6.2	60.1	22.2	11.5	12	9	3	2.68	SM	Silty SAND, some clay, trace gravel
KM107-DH19-03	03-MC-01	0.9	1.1	317.00		10.8										
KM107-DH19-03	03-MC-02	2.4	2.6	315.50		60.6										
KM107-DH19-03	03-MC-03 / 03-DE-01	4.4	4.6	313.51	0.96	77.9										
KM107-DH19-03	03-MC-04	5.3	5.5	312.60		69.0										
KM107-DH19-03	03-MC-05	6.8	7.0	311.10		68.8										
KM107-DH19-03	03-MC-06	8.4	8.6	309.50		56.8										
KM107-DH19-03	03-MC-07	10.1	10.3	307.80		75.8										
KM107-DH19-03	03-MC-08	11.6	11.8	306.30		80.0										
KM107-DH19-03	03-MC-09	13.3	13.5	304.60		12.8										
KM107-DH19-03	03-MC-10	14.7	14.9	303.20		16.9										
KM107-DH19-03	03-MC-11	16.1	16.2	301.85		7.6										
KM107-DH19-03	03-MC-12	17.6	17.8	300.30		9.5										
KM107-DH19-03	03-MC-13	19.3	19.5	298.60		11.0										
KM107-DH19-03	03-MC-14	20.8	21.0	297.10		10.7										
KM107-DH19-03	03-BU-01	1.0	1.3	316.85		9.5	13.5	61.2	16.8	8.5	NP	NP	NP	2.69	SM	SAND, some silt, some gravel, trace clay
KM107-DH19-04	04-MC-01	0.3	0.4	329.65		46.7										
KM107-DH19-04	04-MC-02	1.7	1.9	328.20		8.8										
KM107-DH19-05	05-MC-01	0.4	0.7	333.45		4.1										
KM107-DH19-05	05-MC-02	2.1	2.4	331.75		11.0										
KM107-DH19-05	05-MC-03	3.6	3.9	330.25		14.9										
KM107-DH19-05	05-MC-04	4.9	5.3	328.90		13.6										
KM107-DH19-05	05-MC-05	6.8	7.1	327.05		9.9										
KM107-DH19-05	05-MC-06	8.3	8.6	325.55		12.5										
KM107-DH19-05	05-MC-07	9.2	9.4	324.70		11.0										
KM107-DH19-05	05-BU-01	1.9	2.3	331.90		8.9	32.6	44.4	18.2	4.8	NP	NP	NP	2.69	SM	Gravelly SAND, some silt, trace clay

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TABLE 2

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

KM106 AND KM107 STOCKPILE - 2019 GEOTECHNICAL SITE INVESTIGATION SUMMARY
LABORATORY TESTING SUMMARY

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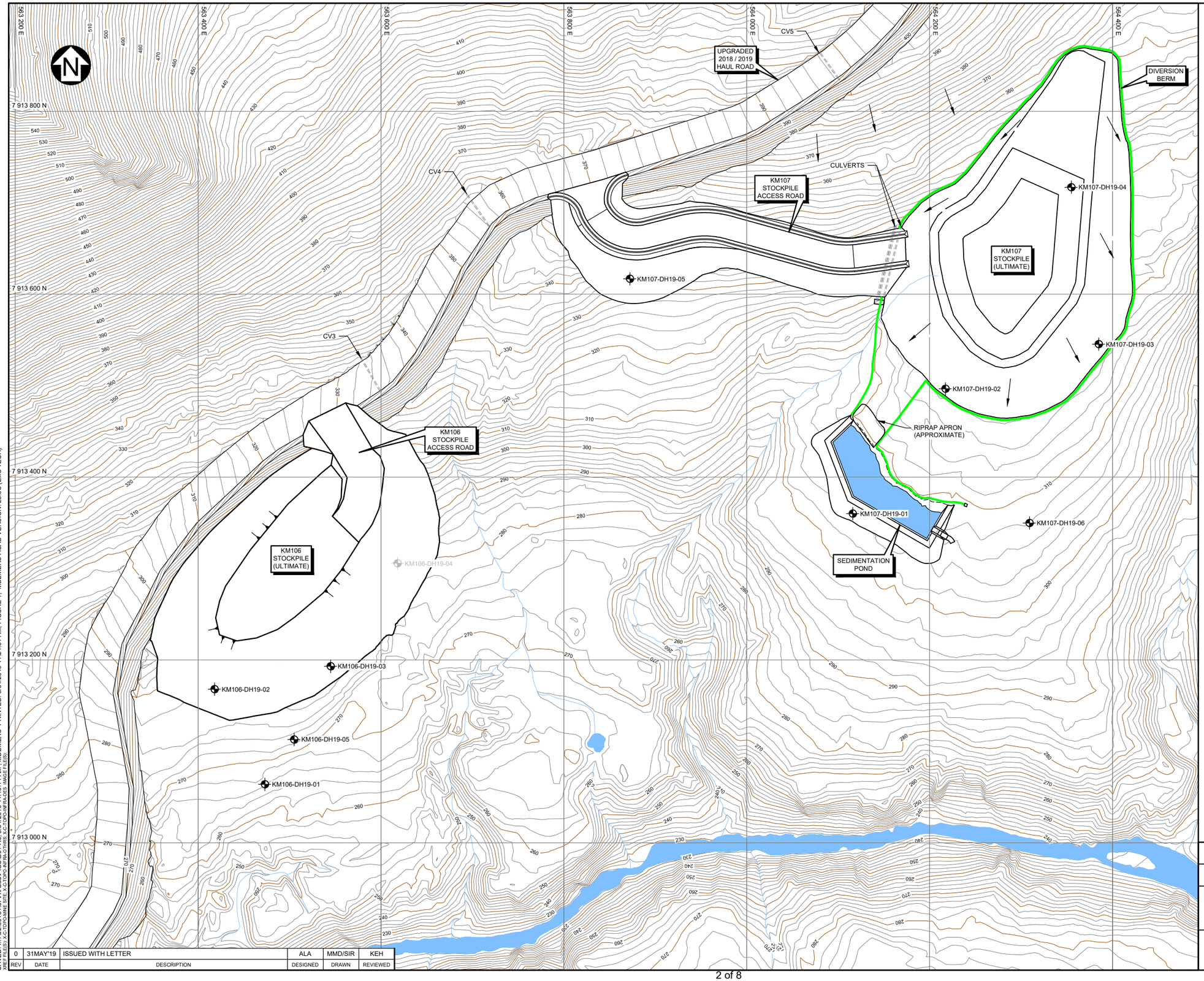
Drillhole ID	Sample ID	Depth From (m)	Depth To (m)	Elevation (m)	In-Situ Density (g/cm^3)	Moisture Content (ASTM D2216) (%)	Particle Size Analysis (ASTM D6913/D7928)				Atterberg Limits (ASTM D4318)			Specific Gravity (ASTM D854) (%)	USCS Classification (ASTM D2487) [4] (-)	Material Description
							Gravel (>4.75 mm) (%)	Sand (4.75 to 0.75 mm) (%)	Silt (0.075 to 0.002 mm) (%)	Clay (<0.002 mm) (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)			
KM107-DH19-06	06-MC-01	0.3	0.5	307.60		17.5										
KM107-DH19-06	06-MC-02	1.0	1.2	306.9		15.0										
KM107-DH19-06	06-MC-03	3.5	3.8	304.4		40.0										
KM107-DH19-06	06-MC-04 / 04-DE-01	5.9	6.1	302.00	0.92	79.5										
KM107-DH19-06	06-MC-05	6.8	7.0	301.1		80.0										
KM107-DH19-06	06-MC-06	8.3	8.6	299.6		25.0										
KM107-DH19-06	06-MC-07	9.2	9.4	298.7		81.3										
KM107-DH19-06	06-MC-08	14.0	14.3	293.9		20.0										
KM107-DH19-06	06-MC-09	16.3	16.5	291.6		63.0										
KM107-DH19-06	06-MC-10	17.1	17.3	290.8		38.9										
KM107-DH19-06	06-MC-11	19.3	19.5	288.6		12.2										
KM107-DH19-06	06-MC-12	20.4	20.6	287.5		14.3										
KM107-DH19-06	06-EMC-01	11.0	11.5	296.8		100.0										
KM107-DH19-06	06-EMC-02	12.5	12.9	295.3		100.0										
KM107-DH19-06	06-BU-01	0.8	1.1	307.1		7.1	15.1	53.2	20.5	11.2	14	10	4	2.68	SC-SM	Silty SAND, some clay, some gravel

I:\1\02\00181\57\A\Correspondence\NB19-00431 - 2019 KM106 and KM107 Stockpile Geotechnical SI\Tables and Figures\[Tables and Figures.xlsx]Table 2

NOTES:

1. MEASUREMENTS FOR SAMPLES WITH MOISTURE CONTENT, PARTICLE SIZE DISTRIBUTION, PLASTICITY, AND SPECIFIC GRAVITY TESTS WERE COMPLETED BY THE GOLDER LABORATORY IN VANCOUVER, BC.
2. MEASUREMENTS FOR SAMPLES WITH ONLY MOISTURE CONTENT TESTS WERE COMPLETED BY BAFFINLAND THROUGH THE MARY RIVER ON-SITE LABORATORY.
3. IN SITU DENSITY ESTIMATES WERE MEASURED BY KP PERSONNEL WHILE ON SITE.
4. SOIL CLASSIFICATION BASED ON THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) (ASTM D2487).

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	31MAY'19	ISSUED WITH LETTER NB19-00431	JAG	ALA



KM106 STOCKPILE
TABLE OF DRILLHOLE LOCATIONS

DESCRIPITON	NORTHING	EASTING	ELEVATION (m)
KM106-DH19-01	7,913,064.0	563,473.0	264.0
KM106-DH19-02	7,913,168.0	563,418.0	278.0
KM106-DH19-03	7,913,193.0	563,545.0	279.0
KM106-DH19-04	7,913,305.6	563,618.2	285.3
KM106-DH19-05	7,913,113.0	563,505.0	268.0

KM107 STOCKPILE
TABLE OF DRILLHOLE LOCATIONS

DESCRIPITON	NORTHING	EASTING	ELEVATION (m)
KM107-DH19-01	7,913,360.0	564,116.0	304.4
KM107-DH19-02	7,913,496.5	564,217.3	318.8
KM107-DH19-03	7,913,545.3	564,384.9	318.0
KM107-DH19-04	7,913,716.9	564,355.0	329.6
KM107-DH19-05	7,913,616.8	563,872.3	334.2
KM107-DH19-06	7,913,349.8	564,309.3	308.0

LEGEND:

- WATER
- CULVERT
- DIVERSION BERM
- GENERAL FLOW DIRECTION
- COMPLETED DRILLHOLE
- DRILLHOLE NOT COMPLETED

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 17.
2. TOPOGRAPHY BASED ON INFORMATION PROVIDED BY EAGLE MAPPING (2008).
3. ELEVATIONS ARE IN METRES. CONTOUR INTERVAL IS 2 m.
4. UPGRADED 2018 / 2019 HAUL ROAD, KM106 STOCKPILE, KM107 STOCKPILE AND ACCESS ROAD PROVIDED BY BAFFINLAND.
5. ALL INFRASTRUCTURE SHOWN IS PROPOSED UNLESS NOTED OTHERWISE.

SCALE A: 40 20 0 40 80 120 160 200 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	31MAY'19	ISSUED WITH LETTER	ALA	MMD/SIR	KEH

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MARY RIVER PROJECT

KM106 AND KM107 STOCKPILES
SITE INVESTIGATION LOCATIONS

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/57	NB19-00431

FIGURE 1 REV 0

APPENDIX A

Geotechnical Drillhole Logs

(Pages A-1 to A-19)

Contractor	Boart Longyear	**Drillhole No**	**KM106-DH19-01**	**Page**	1 of 1
Location	KM106 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	16/May/2019
Coordinates	563473E, 7913064N	**Total Depth**	1.52 m	**Date Completed**	16/May/2019
Coordinate System	17 W NAD83	**Elevation**	264 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%)					MC (%)
									COARSE	GRAVEL	SAND	FINES		
												SILT	CLAY	
			TOPSOIL (0 to 0.1 m) Peat and organics.											
			GRAVELLY SAND (0.1 to 0.5 m) Gravelly, fine to coarse, subangular; SAND, fine to coarse; some silt; well graded, medium orangish brown, loose, massive, moist.	100	01-BU-01	100	GB		0.0	26.3	57.4	13.4	2.9	10.0
1	263		**BEDROCK** (0.5 to 1.52 m) Bedrock. Very strong, fresh, dark bluish/greenish grey, dry.	100										
2	262		End of Drillhole: 1.52 m Confirmed bedrock											
3	261													
4	260													

GENERAL REMARKS:

Drillhole located in proposed KM106 stockpile seepage collection pond area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

Knight Piésold CONSULTING

P/A NO.	REF. NO.	REV
NB102-00181/57	NB19-00431	0

FIGURE A.1

Contractor	Boart Longyear	**Drillhole No**	**KM106-DH19-02**	**Page**	1 of 1
Location	KM106 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	16/May/2019
Coordinates	563418E, 7913168N	**Total Depth**	1.52 m	**Date Completed**	16/May/2019
Coordinate System	17 W NAD83	**Elevation**	278 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%)					MC (%)
									COARSE	GRAVEL	SAND	FINES		
												SILT	CLAY	
			GRAVELLY SAND (0 to 0.3 m) Gravelly, fine to coarse, angular to subangular; SAND, fine to coarse; some silt; some cobbles; well graded, dark reddish brown, loose to compact, massive, wet at surface then moist below 10 cm .	92										
1	277		**BEDROCK** (0.3 to 1.52 m) Bedrock. Very strong, fresh, dark bluish/greenish grey, dry.	100										
			End of Drillhole: 1.52 m Confirmed bedrock											
2	276													
3	275													
4	274													

GENERAL REMARKS:

Drillhole located at southwest toe of proposed KM106 stockpile area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

Knight Piésold CONSULTING

P/A NO.	REF. NO.	REV
NB102-00181/57	NB19-00431	0

FIGURE A.2

Contractor	Boart Longyear	**Drillhole No**	**KM106-DH19-03**	**Page**	1 of 1
Location	KM106 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	16/May/2019
Coordinates	563545E, 7913193N	**Total Depth**	1.83 m	**Date Completed**	16/May/2019
Coordinate System	17 W NAD83	**Elevation**	279 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%)					MC (%)
									COARSE	GRAVEL	SAND	FINES		
												SILT	CLAY	
			TOPSOIL (0 to 0.1 m) Peat and organics.											
			SAND (0.1 to 0.4 m) SAND, fine to coarse; some gravel, fine to coarse, subangular; some cobbles; trace silt; well graded; dark orangish brown, loose, massive, moist to wet.											
			BEDROCK (0.4 to 1.83 m) Bedrock. Very strong, fresh, dark bluish/greenish grey, dry.	99										
1	278			100										
			End of Drillhole: 1.83 m Confirmed bedrock											
2	277													
3	276													
4	275													

GENERAL REMARKS:

Drillhole located at south toe of proposed KM106 stockpile area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

Knight Piésold CONSULTING

P/A NO.	REF. NO.	REV
NB102-00181/57	NB19-00431	0

FIGURE A.3

Contractor	Boart Longyear	**Drillhole No**	**KM106-DH19-05**	**Page**	1 of 1
Location	KM106 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	16/May/2019
Coordinates	563505E, 7913113N	**Total Depth**	4.57 m	**Date Completed**	16/May/2019
Coordinate System	17 W NAD83	**Elevation**	268 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%)					MC (%)
									COARSE	GRAVEL	SAND	FINES		
												SILT	CLAY	
			TOPSOIL (0 to 0.2 m) Peat and organics.											
			GRAVELLY SAND (0.2 to 1.3 m) Gravelly, fine to coarse, angular to subangular; SAND, fine to coarse; some silt, trace boulders; well graded, dark orangish brown, compact, massive, moist.	100										
1	267													
			SILTY, GRAVELLY SAND (1.3 to 4.4 m) Silty; gravelly, fine to coarse, angular to subrounded; SAND, fine to coarse; some cobbles, trace clay; trace boulders; well graded, non-plastic to low plasticity, medium brown, dense, massive, moist to wet.	100	05-BU-01	100	GB	Driller notes material is dense and drills like rock.	0.0	29.0	43.2	20.4	7.4	8.2
2	266			100										
3	265			100										
4	264			100				Water downhole causing sloughing, can not advance without casing.						
			BEDROCK (4.4 to 4.57 m) Bedrock. Very strong, fresh, dark bluish/greenish grey, dry.											
			End of Drillhole: 4.57 m Confirmed bedrock											

GENERAL REMARKS:

Drillhole located in proposed KM106 stockpile seepage collection pond area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

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FIGURE A.4

Contractor	Boart Longyear	**Drillhole No**	**KM107-DH19-01**	**Page**	1 of 3
Location	KM107 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	08/Apr/2019
Coordinates	564115E, 7913358N	**Total Depth**	22.86 m	**Date Completed**	11/Apr/2019
Coordinate System	17 W NAD83	**Elevation**	304 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%) COARSE	GRAVEL	SAND	FINES SILT	FINES CLAY	MC (%)
			GRAVELLY SAND (0 to 0.3 m) Gravelly, fine to coarse, subangular to angular; SAND, fine to coarse; some silt; trace cobbles; subangular to angular; well graded, medium greyish brown, compact, massive, moist to wet. Surface frost layer of ice, weakly bonded (Nf).					Core is warm from drilling cobbles.						
1	303		**SAND (VX)** (0.3 to 1.7 m) SAND, fine to coarse; trace silt; trace gravel, fine to coarse, angular to subangular; trace cobbles; trace boulders, angular to subangular; poorly graded, non-plastic, reddish brown, dense, massive, frozen. Well bonded, very few visible ice crystals <1 mm diameter (Nbn/Vx).	100	01-MC-01	100	GB							12.5
2	302		**ICE + SAND** (1.7 to 3.6 m) ICE + SAND, fine to coarse; some silt; medium greyish brown, horizontally stratified. Ice layers are 0.5 cm thick, very hard, clear to white. Approximately 70 to 90% ice.	100	01-MC-02	100	GB							87.1
3	301													
4	300		**ICE + SAND** (3.6 to 4.8 m) ICE + silty; SAND, fine to coarse; medium greenish grey, stratified, organic sent. Ice is hard, granular, cloudy white to grey. Approximately 85% excess ice to 3.9 m, then reducing to 70 to 80% ice.	100	01-MC-03	100	GB							70.3
					01-MC-04	100	GB							82.9
5	299		**ICE** (4.8 to 5.5 m) ICE, friable, granular, cloudy light yellowish brown turning to white at 5.2 m. Approximately 95% ice.	95										
6	298		**ICE + SILTY SAND** (5.5 to 6.6 m) ICE + silty; SAND, fine to coarse; medium greenish grey, stratified. Ice is hard, granular, cloudy white to grey. Approximately 85% ice.											
7	297		**ICE + SAND** (6.6 to 7.2 m) ICE + SAND, fine to medium; some silt; poorly graded, medium brownish grey, stratified in 1 to 2 cm thick layers. Ice is hard, clear to grey. Approximately 40% ice.	93	01-MC-05	100	GB							40.0
8	296		**ICE** (7.2 to 8.4 m) ICE, hard, granular, cloudy to clear, colourless to grey. 100% ice.	100										
			SAND (VR) (8.4 to 8.6 m) SAND, fine to coarse; poorly graded, reddish brown, dense, massive, frozen. Well bonded, with excess ice crystals < 3mm diameter and 1 mm thick and randomly oriented ice lenses, very hard, clear (Nbe/VX/Vr).		01-MC-06	100	GB	9.14-10.67 m: Driller notes harder ground. 01-EMC-01: Moisture content estimated in field.						14.6
9	295			100	01-MC-07	100	GB							78.6
			ICE											

GENERAL REMARKS:

Drillhole located in proposed KM107 stockpile seepage collection pond area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

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FIGURE A.5

Contractor	Boart Longyear	**Drillhole No**	**KM107-DH19-01**	**Page**	2 of 3
Location	KM107 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	08/Apr/2019
Coordinates	564115E, 7913358N	**Total Depth**	22.86 m	**Date Completed**	11/Apr/2019
Coordinate System	17 W NAD83	**Elevation**	304 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%)					MC (%)
									COARSE	GRAVEL	SAND	FINES		
												SILT	CLAY	
			ICE (8.6 to 12.2 m) ICE, trace sand, fine to coarse; grey. Ice is hard, shattered, granular, mostly cloudy, colourless to grey. Approximately 95% ice. Few short (<10 cm) zones with 10% sand.	100				9.14-10.67 m: Driller notes harder ground. 01-EMC-01: Moisture content estimated in field.						
11	293				01-EMC-01	50	GB							100.0
				100										
12	292													
			ICE + SAND (12.2 to 13 m) ICE + SAND, fine to medium; some silt; poorly graded, medium greyish brown, massive. Ice is soft, friable, granular, greyish brown. Approximately 35% ice.											
13	291		**SILTY SAND** (13 to 13.9 m) Silty; SAND, fine to coarse; some gravel, fine to coarse, subangular; some cobbles; trace boulders; well graded, non-plastic to low plasticity, medium brownish grey, compact, massive, wet to saturated, not frozen.	98	01-MC-08	100	GB							9.5
14	290				01-MC-09	100	GB	14.48-16.76 m: Driller says ground feels frozen, but heat of drilling is melting ice.						15.3
			SAND (VX) (13.9 to 19.81 m) SAND, fine to coarse; trace gravel, fine to coarse, angular to subangular; trace silt; poorly graded, medium reddish brown, light beige from 18.0 to 19.2 m, dense, massive, frozen. Well bonded with excess ice, crystals < 2 mm diameter (Vx).	97										
15	289													
				97										
16	288				01-MC-10	100	GB							8.2
17	287			100										
18	286				01-MC-11	100	GB							10.6
					01-MC-12	100	GB							9.1
19	285			100										
			ICE + SAND (19.81 to 20 m) ICE + SAND, fine to coarse; some silt; some gravel, fine to coarse; medium greyish brown. Ice is hard. Approximately 50% ice.	100										

GENERAL REMARKS:

Drillhole located in proposed KM107 stockpile seepage collection pond area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

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FIGURE A.5

Contractor	Boart Longyear	**Drillhole No**	**KM107-DH19-01**	**Page**	3 of 3
Location	KM107 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	08/Apr/2019
Coordinates	564115E, 7913358N	**Total Depth**	22.86 m	**Date Completed**	11/Apr/2019
Coordinate System	17 W NAD83	**Elevation**	304 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%) COARSE	GRAVEL	SAND	FINES SILT	FINES CLAY	MC (%)
21	283		**SANDY SILT** (20 to 21 m) Sandy, fine to coarse; SILT; some clay; some gravel, fine to coarse; well graded, angular to subangular, medium plasticity, medium greenish grey, stiff, massive, wet, not frozen.	100	01-MC-13	100	GB	Very soft to drill.						17.0
22	282		**BEDROCK** (21 to 22.86 m) Bedrock. Strong to very strong, fresh, dark bluish/greenish grey.	100										
23	281		End of Drillhole: 22.86 m Confirmed bedrock											
24	280													
25	279													
26	278													
27	277													
28	276													
29	275													

GENERAL REMARKS:

Drillhole located in proposed KM107 stockpile seepage collection pond area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

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FIGURE A.5

Contractor	Boart Longyear	**Drillhole No**	**KM107-DH19-02**	**Page**	1 of 3
Location	KM107 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	12/Apr/2019
Coordinates	564217E, 7913497N	**Total Depth**	21.33 m	**Date Completed**	13/Apr/2019
Coordinate System	17 W NAD83	**Elevation**	319 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%) COARSE	GRAVEL	SAND	FINES SILT	FINES CLAY	MC (%)
			SILTY SAND (VX) (0 to 2 m) Silty; SAND, fine to coarse; some gravel, fine to medium, angular to subangular; trace to some clay; well graded, reddish brown, compact, massive, partly frozen (possibly melted from drilling). Well bonded, very small amounts of excess ice, clear crystals up to 1 mm diameter (Nbe/Vx).					Partially melted from drilling.						
1	318			92	02-MC-01	100	GB							8.6
					02-BU-01	100	GB		0.0	6.2	60.1	22.2	11.5	9.5
					02-MC-02	100	GB							17.0
2	317		**ICE** (2 to 2.7 m) ICE, granular, stratified layers 0.5 - 1.0 cm thick, clear to white. 100% ice.	85										
			SAND (VX) (2.7 to 3 m) SAND, fine to coarse; some silt; some gravel, fine to medium, angular to subangular; well graded, reddish brown, compact, massive, partly frozen (possibly melted from drilling). Well bonded, very small amounts of excess ice, clear crystals up to 1 mm diameter (Nbe/Vx).											
3	316													
				92	02-MC-03	100	GB							57.6
4	315		**ICE + SAND** (3 to 4.6 m) ICE + SAND, fine to coarse; some silt; brownish grey. Ice is crumbly, granular, stratified with 0.5 - 1.0 cm thick layers, white to clear with brownish grey colour, organic smell. Approximately 70% ice.											
					02-EMC-01	50	GB							100.0
5	314		**ICE** (4.6 to 6.1 m) ICE, hard to crumbly, granular, stratified layers 0.5 - 1.0 cm thick, clear to white, 100% ice.	98										
6	313													
			ICE + SAND (6.1 to 10.3 m) ICE + SAND, fine to coarse grained; some silt; medium greyish brown. Ice is crumbly to hard, granular, stratified layers 0.5 - 1.0 cm thick, clear to brownish grey, approximately 70% ice. Light yellowish brown from 8.2 to 9.1 m.											
7	312			104	02-MC-04	100	GB							69.0
8	311				02-EMC-02	50	GB							100.0
				95										
9	310													
				101	02-MC-05	100	GB							55.9

GENERAL REMARKS:

Drillhole located at south toe of proposed KM107 stockpile area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

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FIGURE A.6

Contractor	Boart Longyear	**Drillhole No**	**KM107-DH19-02**	**Page**	2 of 3
Location	KM107 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	12/Apr/2019
Coordinates	564217E, 7913497N	**Total Depth**	21.33 m	**Date Completed**	13/Apr/2019
Coordinate System	17 W NAD83	**Elevation**	319 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%) COARSE	GRAVEL	SAND	FINES SILT	FINES CLAY	MC (%)
11	308	**ICE + SAND** (6.1 to 10.3 m) ICE + SAND, fine to coarse grained; some silt; medium greyish brown. Ice is crumbly to hard, granular, stratified layers 0.5 - 1.0 cm thick, clear to brownish grey, approximately 70% ice. Light yellowish brown from 8.2 to 9.1 m.	101				02-EMC-01: Moisture content estimated in field.						
		ICE (10.3 to 12.2 m) ICE, hard, clear to white, stratified layers 0.5-1.0 cm thick, 100% ice, with small air bubbles. No soil.	99	02-EMC-03	60	GB							100.0
12	307												
		ICE + SAND (12.2 to 13.7 m) ICE + SAND, fine to coarse; some silt; poorly graded, medium grey, massive to stratified, frozen. Ice is hard to crumbly in zones, granular, stratified with more soil-rich layers, clear to grey, approximately 90% ice.	101	02-MC-06	100	GB							40.0
13	306												
		ICE (13.7 to 14.2 m) ICE, hard to crumbly, granular, white to clear, 100% ice.											
14	305	**SAND (VX)** (14.2 to 19.8 m) SAND, fine to coarse; some silt; some gravel, fine to coarse, angular to subangular; some cobbles; well graded, medium reddish brown to black, compact, massive, wet to frozen (likely melted from drilling cobbles. Well bonded with clear excess ice crystals <1cm diameter (Nbe/Vx).	102				14.2-15.2 m: Ice appears melted due to heat generated from drilling cobbles. 18.3-19.8 m: Partially melted from drilling.						
				02-MC-07	100	GB							18.1
15	304		99										
				02-MC-08	100	GB							18.0
16	303												
			98	02-MC-09	100	GB							13.0
17	302												
				02-MC-10	100	GB							11.3
18	301												
		SANDY SILT (19.8 to 20 m) Sandy, fine to coarse; SILT; some gravel, fine to coarse, subangular to subrounded; well graded, low plasticity, medium greenish grey, stiff, massive, moist, not frozen.	86										
19	300		99										

GENERAL REMARKS:

Drillhole located at south toe of proposed KM107 stockpile area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

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FIGURE A.6

Contractor	Boart Longyear	**Drillhole No**	**KM107-DH19-02**	**Page**	3 of 3
Location	KM107 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	12/Apr/2019
Coordinates	564217E, 7913497N	**Total Depth**	21.33 m	**Date Completed**	13/Apr/2019
Coordinate System	17 W NAD83	**Elevation**	319 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%)					MC (%)
									COARSE	GRAVEL	SAND	FINES		
												SILT	CLAY	
21	298		**BEDROCK** (20 to 21.33 m) Bedrock. Strong to very strong, fresh, dark bluish/greenish grey.	99										
22	297		End of Drillhole: 21.33 m Confirmed bedrock											
23	296													
24	295													
25	294													
26	293													
27	292													
28	291													
29	290													

GENERAL REMARKS:

Drillhole located at south toe of proposed KM107 stockpile area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

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FIGURE A.6

Contractor	Boart Longyear	**Drillhole No**	**KM107-DH19-03**	**Page**	1 of 3
Location	KM107 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	15/Apr/2019
Coordinates	564385E, 7913556N	**Total Depth**	22.08 m	**Date Completed**	15/Apr/2019
Coordinate System	17 W NAD83	**Elevation**	318 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%) COARSE	GRAVEL	SAND	FINES SILT	FINES CLAY	MC (%)
1	317		**SAND** (0 to 1.5 m) SAND, fine to coarse; some silt; some gravel; trace clay; fine to medium, angular; well graded, medium orangish brown, loose, massive, dry to moist to 0.3m, then frozen. After 0.3m is well bonded, no excess ice (Nbn).	92	03-MC-01	100	GB	Driller notes very hard ground, causing drill to overheat.	0.0	13.5	61.2	16.8	8.5	10.8
					03-BU-01	100	GB							9.5
2	316		**ICE + SAND** (1.5 to 4.6 m) ICE + SAND, fine to coarse; some silt; trace gravel, fine to medium, angular; well graded, medium brown, compact, stratified with 0.5 - 1.0 cm ice layers. Ice is white, soft/crumbly, with some hard layers, approximately 70% ice.	97	03-MC-02	100	GB							60.6
3	315													
4	314			99	03-MC-03	100	GB							77.9
5	313		**ICE + SAND** (4.6 to 10.9 m) As above, dark greyish brown, frozen with sand and ice intermixed. Ice is hard, shattered, sand-rich, massive, dark brown, approximately 60% ice.	97	03-MC-04	100	GB							69.0
6	312													
7	311			100	03-MC-05	100	GB							68.8
8	310			100	03-MC-06	100	GB							56.8
9	309			100										

GENERAL REMARKS:

Drillhole located at southeast toe of proposed KM107 stockpile area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

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FIGURE A.7

Contractor	Boart Longyear	**Drillhole No**	**KM107-DH19-03**	**Page**	2 of 3
Location	KM107 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	15/Apr/2019
Coordinates	564385E, 7913556N	**Total Depth**	22.08 m	**Date Completed**	15/Apr/2019
Coordinate System	17 W NAD83	**Elevation**	318 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%) COARSE	GRAVEL	SAND	FINES SILT	FINES CLAY	MC (%)
			ICE + SAND (4.6 to 10.9 m) As above, dark greyish brown, frozen with sand and ice intermixed. Ice is hard, shattered, sand-rich, massive, dark brown, approximately 60% ice.	100	03-MC-07	100	GB							75.8
11	307		**SAND (VX)** (10.9 to 15.2 m) SAND, fine to coarse; some silt; some gravel, fine to medium, angular; well graded, dark brownish grey, becoming medium brown at 13.7 m, massive, frozen. Well bonded, crumbly, granular, clear to grey, approximately 15% ice (Nbe/Vx).	100										
					03-MC-08	100	GB							80.0
12	306													
				98										
13	305				03-MC-09	100	GB							12.8
14	304			99										
					03-MC-10	100	GB							16.9
15	303													
			SAND (15.2 to 21 m) As above, medium orangish brown, compact, massive, wet, not frozen.	100										
16	302				03-MC-11	100	GB							7.6
				100										
17	301				03-MC-12	100	GB							9.5
18	300													
				100										
19	299				03-MC-13	100	GB							11.0
				84										

GENERAL REMARKS:

Drillhole located at southeast toe of proposed KM107 stockpile area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

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FIGURE A.7

Contractor	Boart Longyear	**Drillhole No**	**KM107-DH19-03**	**Page**	3 of 3
Location	KM107 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	15/Apr/2019
Coordinates	564385E, 7913556N	**Total Depth**	22.08 m	**Date Completed**	15/Apr/2019
Coordinate System	17 W NAD83	**Elevation**	318 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%)					MC (%)
									COARSE	GRAVEL	SAND	FINES		
												SILT	CLAY	
			SAND (15.2 to 21 m) As above, medium orangish brown, compact, massive, wet, not frozen.	84										
21	297		**BEDROCK** (21 to 22.08 m) Bedrock. Strong, moderately weathered, medium orangish brown, burning smell when drilled.		03-MC-14	100	GB	Recovered core is very hot with burning smell. Used 2 drill bits to complete last 1 m of drillhole.						10.7
22	296			100										
			End of Drillhole: 22.08 m Confirmed bedrock											
23	295													
24	294													
25	293													
26	292													
27	291													
28	290													
29	289													

GENERAL REMARKS:

Drillhole located at southeast toe of proposed KM107 stockpile area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

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FIGURE A.7

Contractor	Boart Longyear	**Drillhole No**	**KM107-DH19-04**	**Page**	1 of 1
Location	KM107 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	15/Apr/2019
Coordinates	564355E, 7913717N	**Total Depth**	3.66 m	**Date Completed**	16/Apr/2019
Coordinate System	17 W NAD83	**Elevation**	330 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%)					MC (%)
									COARSE	GRAVEL	SAND	FINES		
												SILT	CLAY	
			SILTY, GRAVELLY SAND (0 to 0.6 m) Silty; gravelly, fine to coarse, angular; SAND, fine to coarse; well graded, non-plastic, medium brown, loose, massive, frozen. Well bonded, partly melted from drilling, minor excess ice (Nbn).											
					04-MC-01	100	GB							46.7
1	329			100				Recovered core has burnt smell, very hard to drill.						
			WEATHERED BEDROCK (0.6 to 3 m) Weathered bedrock. Strong with weak friable zones, moderately to highly weathered, medium orangish brown with cream, dry.											
					04-MC-02	100	GB							8.8
2	328			99										
3	327		**BEDROCK** (3 to 3.66 m) Bedrock. Very strong, fresh, dark bluish/greenish grey.	98										
			End of Drillhole: 3.66 m Confirmed bedrock											
4	326													
5	325													
6	324													
7	323													
8	322													
9	321													

GENERAL REMARKS:

Drillhole located northcentral in proposed KM107 stockpile area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

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FIGURE A.8

Contractor	Boart Longyear	**Drillhole No**	**KM107-DH19-05**	**Page**	1 of 2
Location	KM107 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	07/Apr/2019
Coordinates	563874E, 7913618N	**Total Depth**	11.58 m	**Date Completed**	08/Apr/2019
Coordinate System	17 W NAD83	**Elevation**	341 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, 90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%) COARSE	GRAVEL	SAND	FINES SILT	FINES CLAY	MC (%)
			GRAVELLY SAND (0 to 3 m) Gravelly, fine to coarse; angular to subangular; SAND, fine to coarse; some silt; some cobbles; trace boulders up to 40 cm; well graded, non-plastic, light brownish orange to medium brownish grey with depth, loose to compact, massive, moist becoming saturated below 1.5 m, partly frozen. No visible ice, poorly bonded, possibly melted (Nf).											
					05-MC-01	100	GB							4.1
1	340			92										
2	339				05-BU-01	300	GB		0.0	32.6	44.4	18.2	4.8	8.9
				92	05-MC-02	100	GB							11.0
3	338		**ICE + SAND** (3 to 3.26 m) ICE + SAND, fine to coarse; poorly graded, medium greyish brown, massive, frozen. Ice is hard, clear, porous, and massive, approximately 30% ice.											
				100	05-MC-03	100	GB							14.9
4	337		**SAND (VX)** (3.26 to 6.1 m) SAND, fine to coarse; some silt; some gravel, fine to coarse, angular; some cobbles; well graded, non-plastic, medium brownish to greenish grey, massive, saturated, frozen. Well bonded, with excess ice crystals up to 0.5 cm diameter (Nbe/Vx).											
5	336				05-MC-04	100	GB							13.6
				98										
6	335													
			SAND (6.1 to 9.4 m) SAND, fine to coarse; trace silt, trace gravel; poorly graded, non-plastic, medium brownish grey with lenses of orangish brown, loose, massive, wet to saturated, partly frozen. 5-10 cm lenses of frozen material (Nbn) alternating with non-frozen.	99	05-MC-05	100	GB	6.1-7.6 m: Driller notes lenses of frozen material within unfrozen mass. 7.6-9.4 m: Possibly melted from drilling.						9.9
7	334													
8	333			100	05-MC-06	100	GB							12.5
9	332													
			BEDROCK (9.4 to 11.58 m) Bedrock. Strong to very strong, fresh, dark bluish grey, dense.		05-MC-07	100	GB							11.0
				100										

GENERAL REMARKS:

Drillhole located in proposed KM107 stockpile access road area, below haul road to the west of stockpile. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

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FIGURE A.9

Contractor	Boart Longyear	**Drillhole No**	**KM107-DH19-05**	**Page**	2 of 2
Location	KM107 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	07/Apr/2019
Coordinates	563874E, 7913618N	**Total Depth**	11.58 m	**Date Completed**	08/Apr/2019
Coordinate System	17 W NAD83	**Elevation**	341 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, 90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%)					MC (%)
									COARSE	GRAVEL	SAND	FINES		
												SILT	CLAY	
			BEDROCK (9.4 to 11.58 m) Bedrock. Strong to very strong, fresh, dark bluish grey, dense.	100										
11	330			100										
			End of Drillhole: 11.58 m Confirmed bedrock											
12	329													
13	328													
14	327													
15	326													
16	325													
17	324													
18	323													
19	322													

GENERAL REMARKS:

Drillhole located in proposed KM107 stockpile access road area, below haul road to the west of stockpile. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

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FIGURE A.9

Contractor	Boart Longyear	**Drillhole No**	**KM107-DH19-06**	**Page**	1 of 3
Location	KM107 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	11/Apr/2019
Coordinates	564308E, 7913350N	**Total Depth**	22.86 m	**Date Completed**	12/Apr/2019
Coordinate System	17 W NAD83	**Elevation**	305 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%) COARSE	GRAVEL	SAND	FINES SILT	FINES CLAY	MC (%)
			SILTY SAND (0 to 3 m) Silty; SAND, fine to coarse; some clay; some gravel, fine to coarse, subangular to angular; medium reddish brown to dark greyish brown, dense, massive, dry to moist, frozen. Well bonded, no excess ice (Nbn). Friable (Nf) from 0.9-1.2 m, low moisture content.	99	06-MC-01	100	GB							17.5
1	304				06-BU-01	100	GB		0.0	15.1	53.2	20.5	11.2	7.1
					06-MC-02	100	GB							15.0
2	303			99										
3	302		**SILTY SAND (VS)** (3 to 4.6 m) As above, dark brown, compact, frozen, organic scent. Stratified ice and soil layers approximately 1.0 cm thick, ice is white to brown, friable, approximately 40% ice (Vs).		06-MC-03	100	GB							40.0
4	301			100										
5	300		**ICE** (4.6 to 7.6 m) ICE, hard, clear to greyish brown, shattered, with <1mm laminations in some zones, bubbles throughout, organic smell. Trace sand giving brown colour, approximately 80% ice.	100				Ice has a rainbow sheen.						
6	299				06-MC-04	100	GB							79.5
7	298			97	06-MC-05	100	GB							80.0
8	297		**ICE + SAND** (7.6 to 10.7 m) ICE + SAND, fine to coarse; some silt; some gravel, fine to coarse, angular to subangular; dark brown, organic smell. Ice is hard, stratified with more sand-rich layers, dark brown to clear, shattered, approximately 30% ice to 9.1 m then 80% ice.	97	06-MC-06	100	GB							25.0
9	296													
				93	06-MC-07	100	GB							81.3

GENERAL REMARKS:

Drillhole located in proposed KM107 stockpile alternative seepage collection pond area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

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FIGURE A.10

Contractor	Boart Longyear	**Drillhole No**	**KM107-DH19-06**	**Page**	2 of 3
Location	KM107 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	11/Apr/2019
Coordinates	564308E, 7913350N	**Total Depth**	22.86 m	**Date Completed**	12/Apr/2019
Coordinate System	17 W NAD83	**Elevation**	305 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%) COARSE	GRAVEL	SAND	FINES SILT	FINES CLAY	MC (%)
11	294	**ICE + SAND** (7.6 to 10.7 m) ICE + SAND, fine to coarse; some silt; some gravel, fine to coarse, angular to subangular; dark brown, organic smell. Ice is hard, stratified with more sand-rich layers, dark brown to clear, shattered, approximately 30% ice to 9.1 m then 80% ice.	93				Driller notes ground is soft, very easy to drill.						
				06-EMC-01	60	GB							100.0
12	293	**ICE** (10.7 to 12.1 m) ICE, hard, shattered, clear to grey, trace sand, with small air bubbles. 100% clear/white ice from 11.4 - 11.6 m.	92										
		ICE + SAND (12.1 to 12.4 m) ICE + SAND, fine to coarse; some silt; dark brown. Stratified alternating layers of clear ICE + SAND, approximately 0.7 cm thick.		06-EMC-02	50	GB							100.0
13	292	**ICE** (12.4 to 13.8 m) ICE, hard, cloudy, stratified layers 0.5 cm thick, slight red tinge, trace reddish brown sand, approximately 95% ice.	95										
14	291	**ICE + SAND** (13.8 to 18.3 m) ICE + SAND, fine to coarse; some silt; trace gravel, fine to coarse, angular to subangular; dark brown to brownish grey. Hard, stratified clear ICE + SAND-rich layers, approximately 95% ice to 15.2 m then reduces to 60% ice.		06-MC-08	100	GB							20.0
			100										
15	290												
16	289		91										
				06-MC-09	100	GB							63.0
17	288												
				06-MC-10	100	GB							38.9
18	287		98										
19	286	**SAND (VX)** (18.3 to 21.1 m) SAND, fine to coarse; some silt; some gravel, fine to coarse, subangular to subrounded; well graded, dark greyish brown, compact, massive, frozen. Well bonded with some excess ice crystals ~1mm diameter, hard, clear, approximately 25% ice (Nbe/Vx).	100										
				06-MC-11	100	GB							12.2
			100										

GENERAL REMARKS:

Drillhole located in proposed KM107 stockpile alternative seepage collection pond area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

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FIGURE A.10

Contractor	Boart Longyear	**Drillhole No**	**KM107-DH19-06**	**Page**	3 of 3
Location	KM107 Stockpile	**Drill Type**	Mini Sonic 130C	**Date Started**	11/Apr/2019
Coordinates	564308E, 7913350N	**Total Depth**	22.86 m	**Date Completed**	12/Apr/2019
Coordinate System	17 W NAD83	**Elevation**	305 m	**Logged By**	JAG
Hole Size	4 IN	**Azimuth, Inclination**	0°, -90°	**Reviewed By**	ALA

DEPTH - (M)	ELEVATION - (M)	GRAPHIC LOG	MATERIAL DESCRIPTION	RUN RECOVERY (%)	SAMPLE NO	SAMPLE REC. (%)	SAMPLE TYPE	NOTES	PARTICLE SIZE DISTRIBUTION (%)					MC (%)
									COARSE	GRAVEL	SAND	FINES		
												SILT	CLAY	
			SAND (VX) (18.3 to 21.1 m) SAND, fine to coarse; some silt; some gravel, fine to coarse, subangular to subrounded; well graded, dark greyish brown, compact, massive, frozen. Well bonded with some excess ice crystals ~1mm diameter, hard, clear, approximately 25% ice (Nbe/Vx).	100	06-MC-12	100	GB							14.3
21	284							Driller notes very hard rock.						
			BEDROCK (21.1 to 22.86 m) Bedrock. Strong to very strong, fresh, dark grey with pink (Gneiss).											
22	283			98										
23	282		End of Drillhole: 22.86 m Confirmed bedrock											
24	281													
25	280													
26	279													
27	278													
28	277													
29	276													

GENERAL REMARKS:

Drillhole located in proposed KM107 stockpile alternative seepage collection pond area. Sonic drilling without water injection. No casing used. Drillhole backfilled with sand to surface.

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FIGURE A.10

APPENDIX B

Drill Site Photographs

(Pages B-1 to B-22)

PHOTO 1 - KM106-DH19-01 Looking East During Drilling

PHOTO 2 - KM106-DH19-01 Looking North During Drilling

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PHOTO 3 - KM106-DH19-01 Looking South During Drilling

PHOTO 4 - KM106-DH19-01 Looking West During Drilling

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PHOTO 5 - KM106-DH19-02 Looking East During Drilling

PHOTO 6 - KM106-DH19-02 Looking North During Drilling

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PHOTO 7 - KM106-DH19-02 Looking South During Drilling

PHOTO 8 - KM106-DH19-02 Looking West During Drilling

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PHOTO 9 - KM106-DH19-03 Looking East During Drilling

PHOTO 10 - KM106-DH19-03 Looking North During Drilling

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PHOTO 11 - KM106-DH19-03 Looking South During Drilling

PHOTO 12 - KM106-DH19-03 Looking West During Drilling

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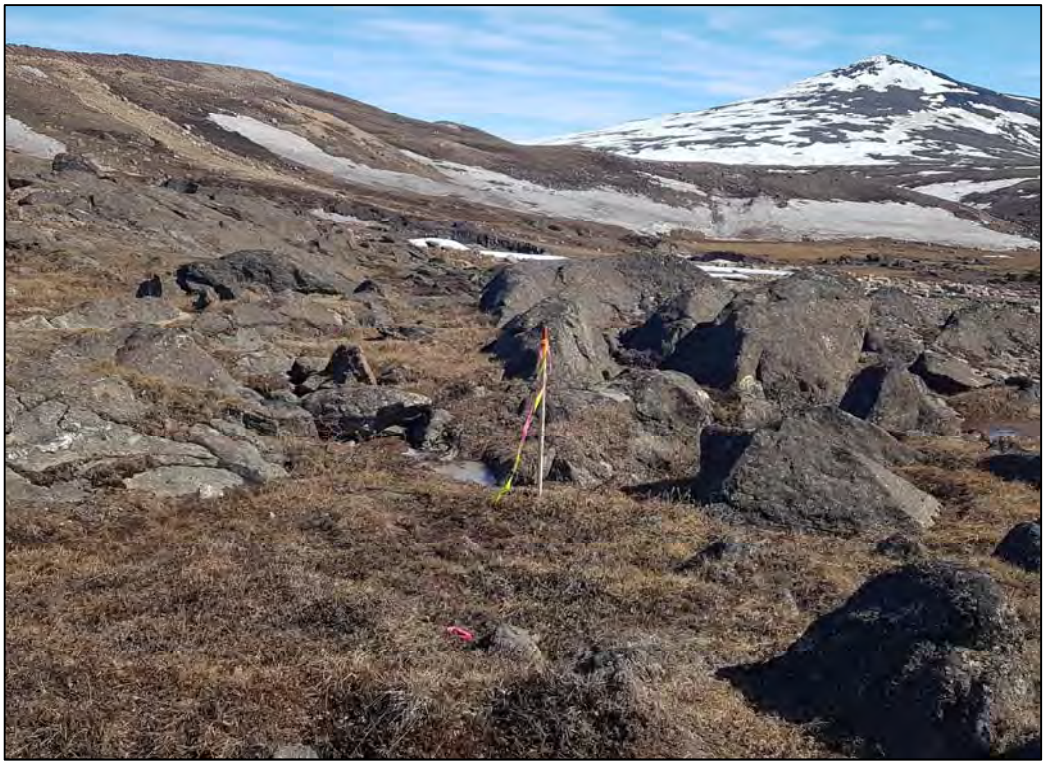

PHOTO 13 - KM106-DH19-04 Looking East Before Drilling

PHOTO 14 - KM106-DH19-04 Looking North Before Drilling

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PHOTO 15 - KM106-DH19-04 Looking South Before Drilling

PHOTO 16 - KM106-DH19-04 Looking West Before Drilling

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PHOTO 17 - KM106-DH19-05 Looking East During Drilling

PHOTO 18 - KM106-DH19-05 Looking North During Drilling

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PHOTO 19 - KM106-DH19-05 Looking South During Drilling

PHOTO 20 - KM106-DH19-05 Looking West During Drilling

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PHOTO 21 - KM107-DH19-01 Looking East During Drilling

PHOTO 22 - KM107-DH19-01 Looking North During Drilling

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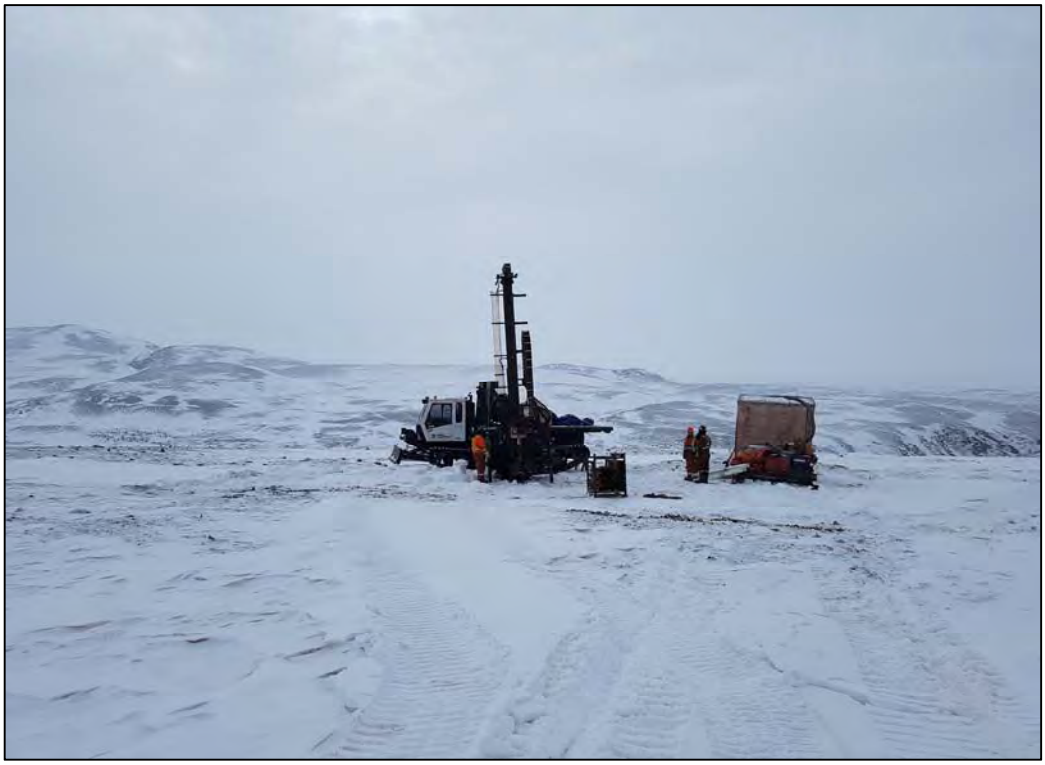

PHOTO 23 - KM107-DH19-01 Looking South During Drilling

PHOTO 24 - KM107-DH19-01 Looking West During Drilling

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PHOTO 25 - KM107-DH19-02 Looking East During Drilling

PHOTO 26 - KM107-DH19-02 Looking North During Drilling

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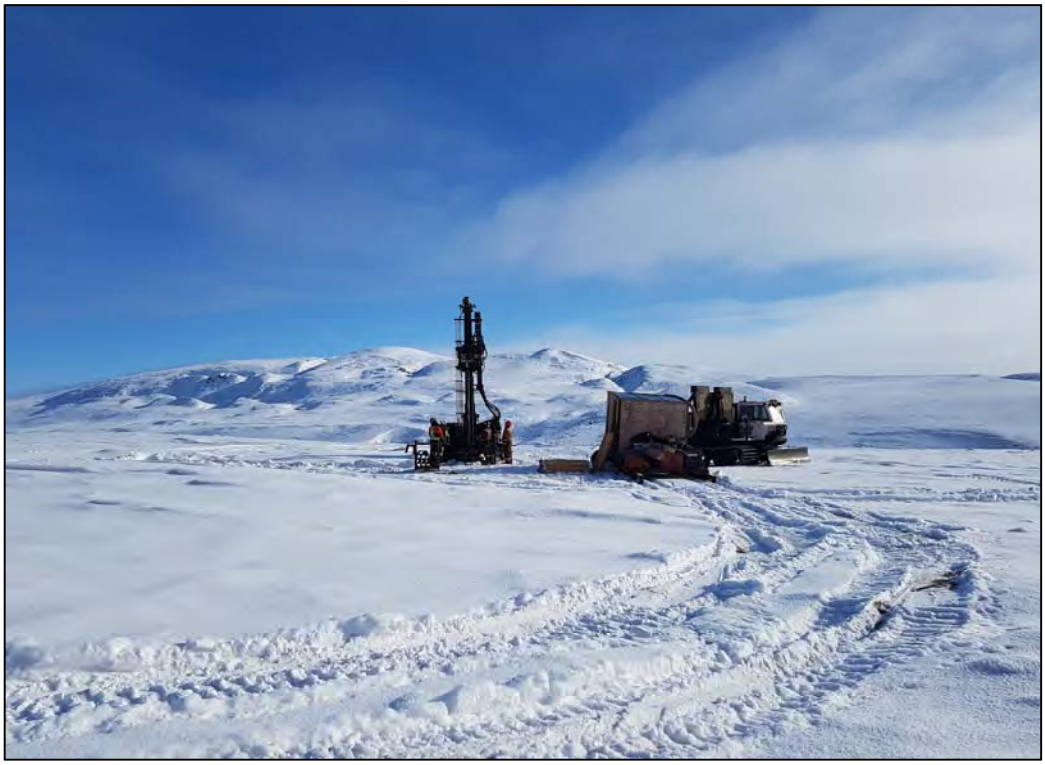

PHOTO 27 - KM107-DH19-02 Looking South During Drilling

PHOTO 28 - KM107-DH19-02 Looking West During Drilling

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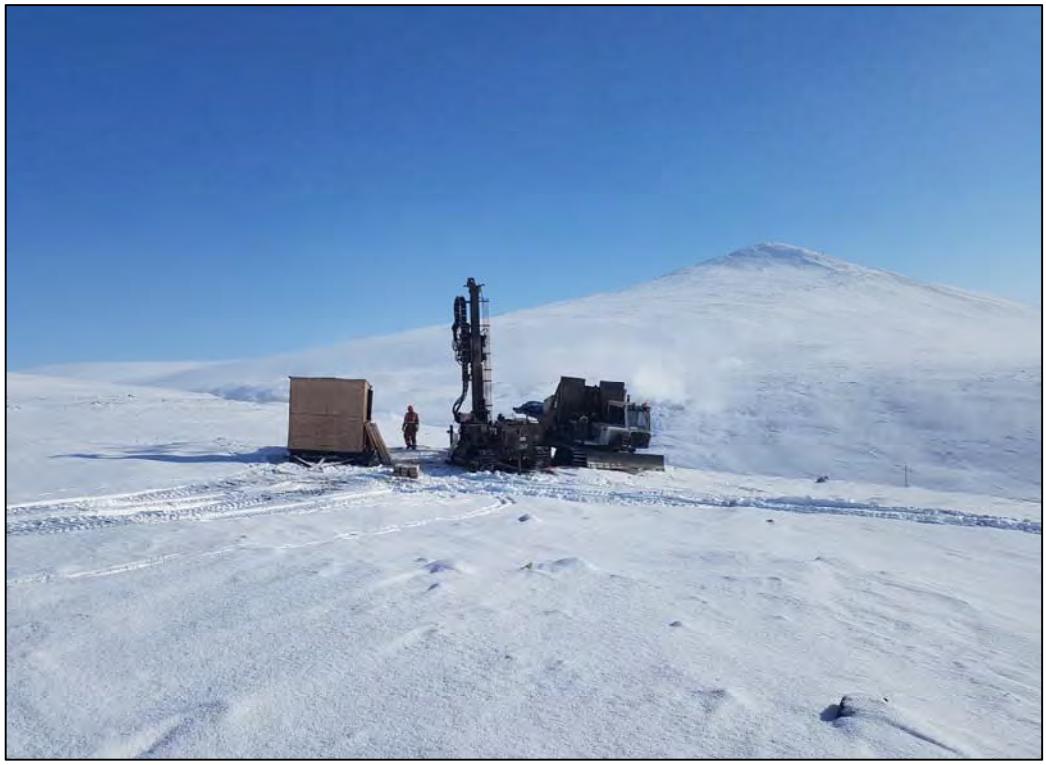

PHOTO 29 - KM107-DH19-03 Looking East During Drilling

PHOTO 30 - KM107-DH19-03 Looking North During Drilling

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PHOTO 31 - KM107-DH19-03 Looking South During Drilling

PHOTO 32 - KM107-DH19-03 Looking West During Drilling

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PHOTO 33 - KM107-DH19-04 Looking East During Drilling

PHOTO 34 - KM107-DH19-04 Looking North During Drilling

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PHOTO 35 - KM107-DH19-04 Looking South During Drilling

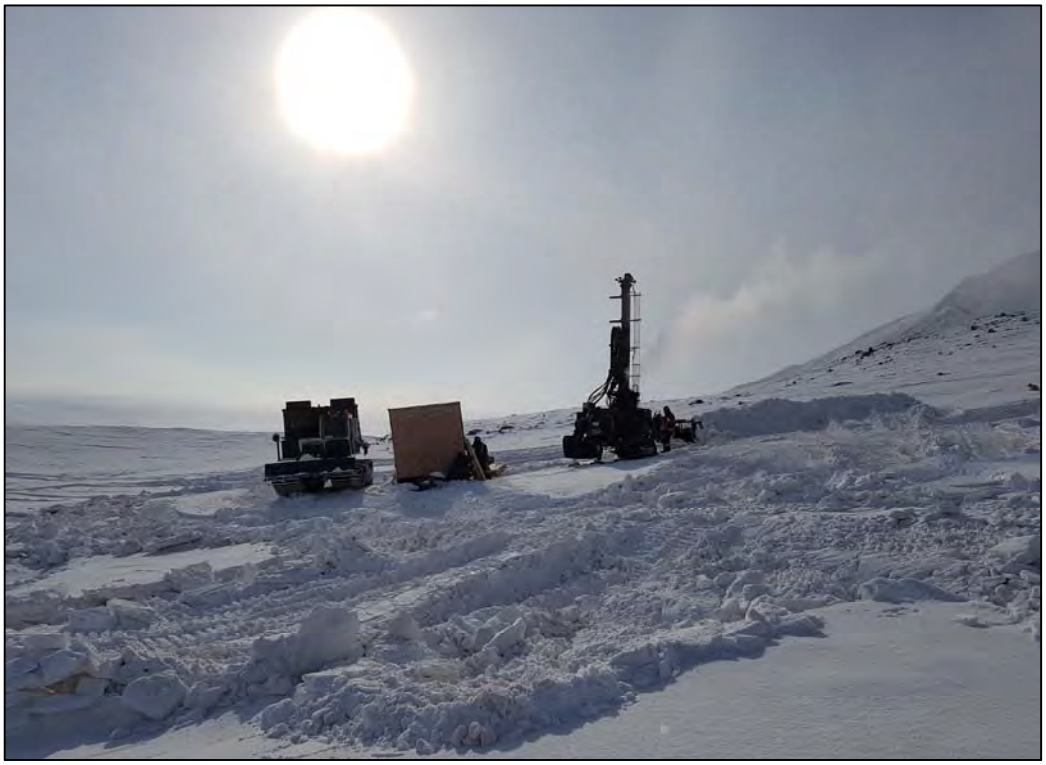

PHOTO 36 - KM107-DH19-04 Looking West During Drilling

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PHOTO 37 - KM107-DH19-05 Looking East During Drilling

PHOTO 38 - KM107-DH19-05 Looking North During Drilling

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PHOTO 39 - KM107-DH19-05 Looking South During Drilling

PHOTO 40 - KM107-DH19-05 Looking West During Drilling

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PHOTO 41 - KM107-DH19-06 Looking East During Drilling

PHOTO 42 - KM107-DH19-06 Looking North During Drilling

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PHOTO 43 - KM107-DH19-06 Looking South During Drilling

PHOTO 44 - KM107-DH19-06 Looking West During Drilling

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APPENDIX C

Core Box Photographs

(Pages C-1 to C-22)

PHOTO 1 - KM106-DH19-01 0.00 - 1.52 m (EOH)

PHOTO 2 - KM106-DH19-02 0.00 - 1.52 m (EOH)

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PHOTO 3 - KM106-DH19-03 0.00 - 1.83 m (EOH)

PHOTO 4 - KM106-DH19-05 0.00 - 2.13 m

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PHOTO 5 - KM106-DH19-05 2.13 - 4.00 m

PHOTO 6 - KM106-DH19-05 4.00 - 4.57 m (EOH)

PHOTO 7 - KM107-DH19-01 0.00 - 3.05 m

PHOTO 8 - KM107-DH19-01 3.05 - 6.10 m

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PHOTO 9 - KM107-DH19-01 6.10 - 9.14 m

PHOTO 10 - KM107-DH19-01 9.14 - 12.19 m

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PHOTO 11 - KM107-DH19-01 12.19 - 14.48 m

PHOTO 12 - KM107-DH19-01 14.48 - 18.29 m

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PHOTO 13 - KM107-DH19-01 18.29 - 21.33 m

PHOTO 14 - KM107-DH19-01 21.33 - 22.86 m (EOH)

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PHOTO 15 - KM107-DH19-02 0.00 - 3.05 m

PHOTO 16 - KM107-DH19-02 3.05 - 6.10 m

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PHOTO 17 - KM107-DH19-02 6.10 - 9.14 m

PHOTO 18 - KM107-DH19-02 9.14 - 12.19 m

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PHOTO 19 - KM107-DH19-02 12.19 - 15.24 m

PHOTO 20 - KM107-DH19-02 15.24 - 18.29 m

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PHOTO 21 - KM107-DH19-02 18.29 - 21.33 m (EOH)

PHOTO 22 - KM107-DH19-03 0.00 - 3.05 m

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PHOTO 23 - KM107-DH19-03 3.05 - 6.10 m

PHOTO 24 - KM107-DH19-03 6.10 - 9.14 m

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PHOTO 25 - KM107-DH19-03 9.14 - 12.19 m

PHOTO 26 - KM107-DH19-03 12.19 - 15.24 m

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PHOTO 27 - KM107-DH19-03 15.24 - 18.29 m

PHOTO 28 - KM107-DH19-03 18.29 - 21.33 m

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PHOTO 29 - KM107-DH19-03 21.33 - 22.08 (EOH)

PHOTO 30 - KM107-DH19-04 0.00 - 3.66 m (EOH)

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PHOTO 31 - KM107-DH19-05 0.00 - 1.68 m

PHOTO 32 - KM107-DH19-05 1.68 - 3.05 m

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PHOTO 33 - KM107-DH19-05 3.05 - 6.10 m

PHOTO 34 - KM107-DH19-05 6.10 - 9.14 m

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PHOTO 35 - KM107-DH19-05 9.14 - 10.67 m

PHOTO 36 - KM107-DH19-05 10.67 - 11.58 m (EOH)

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PHOTO 37 - KM107-DH19-06 0.00 - 3.05 m

PHOTO 38 - KM107-DH19-06 3.05 - 6.10 m

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PHOTO 39 - KM107-DH19-06 6.10 - 9.14 m

PHOTO 40 - KM107-DH19-06 9.14 - 12.19 m

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PHOTO 41 - KM107-DH19-06 12.19 - 15.24 m

PHOTO 42 - KM107-DH19-06 15.24 - 18.29 m

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PHOTO 43 - KM107-DH19-06 18.29 - 21.33 m

PHOTO 44 - KM107-DH19-06 21.33 - 22.86 m (EOH)

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APPENDIX D

Laboratory Data

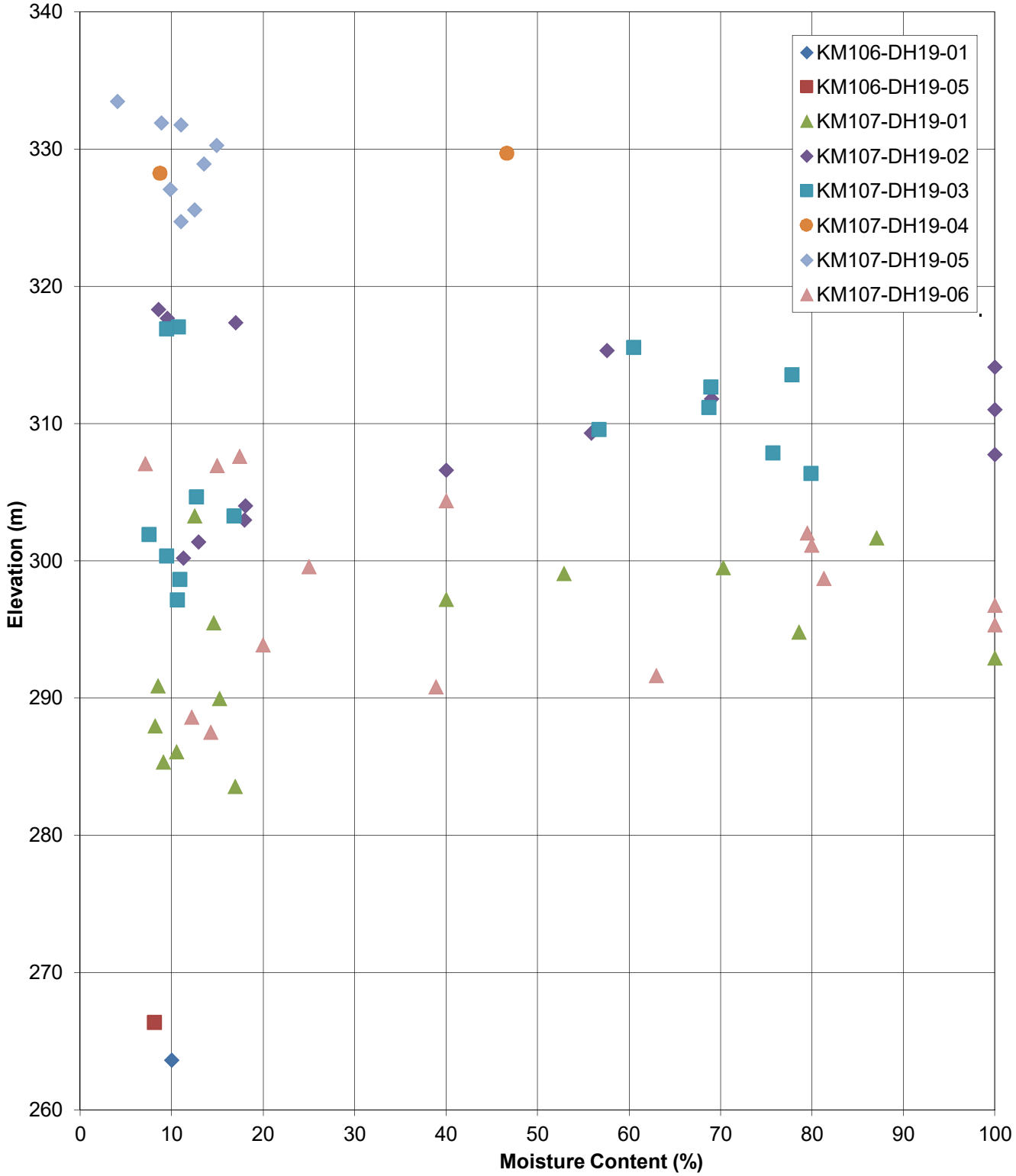
Appendix D1
Laboratory Data Summary Plots

Appendix D2
Laboratory Data Reports

APPENDIX D1

Laboratory Data Summary Plots

(Pages D1-1 to D1-3)



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KM106 AND KM107 STOCKPILE MOISTURE CONTENT

Knight Piésold CONSULTING

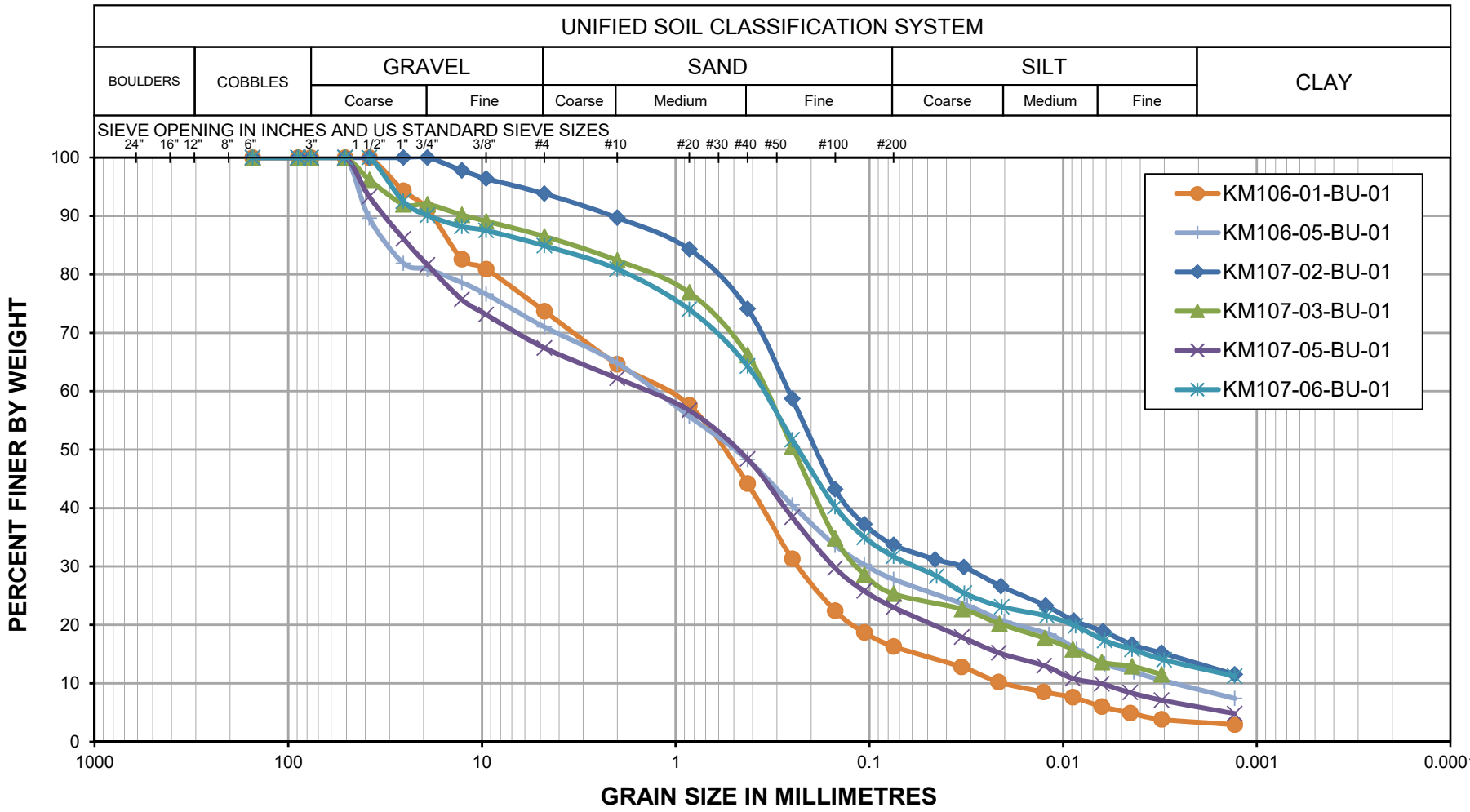
P/A NO. NB102-181/57

REF. NO. NB19-00431

FIGURE D1.1

REV 0

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	31MAY'19	ISSUED WITH LETTER	JAG	ALA



BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM106 AND KM107 STOCKPILE PARTICLE SIZE DISTRIBUTION

Knight Piésold CONSULTING

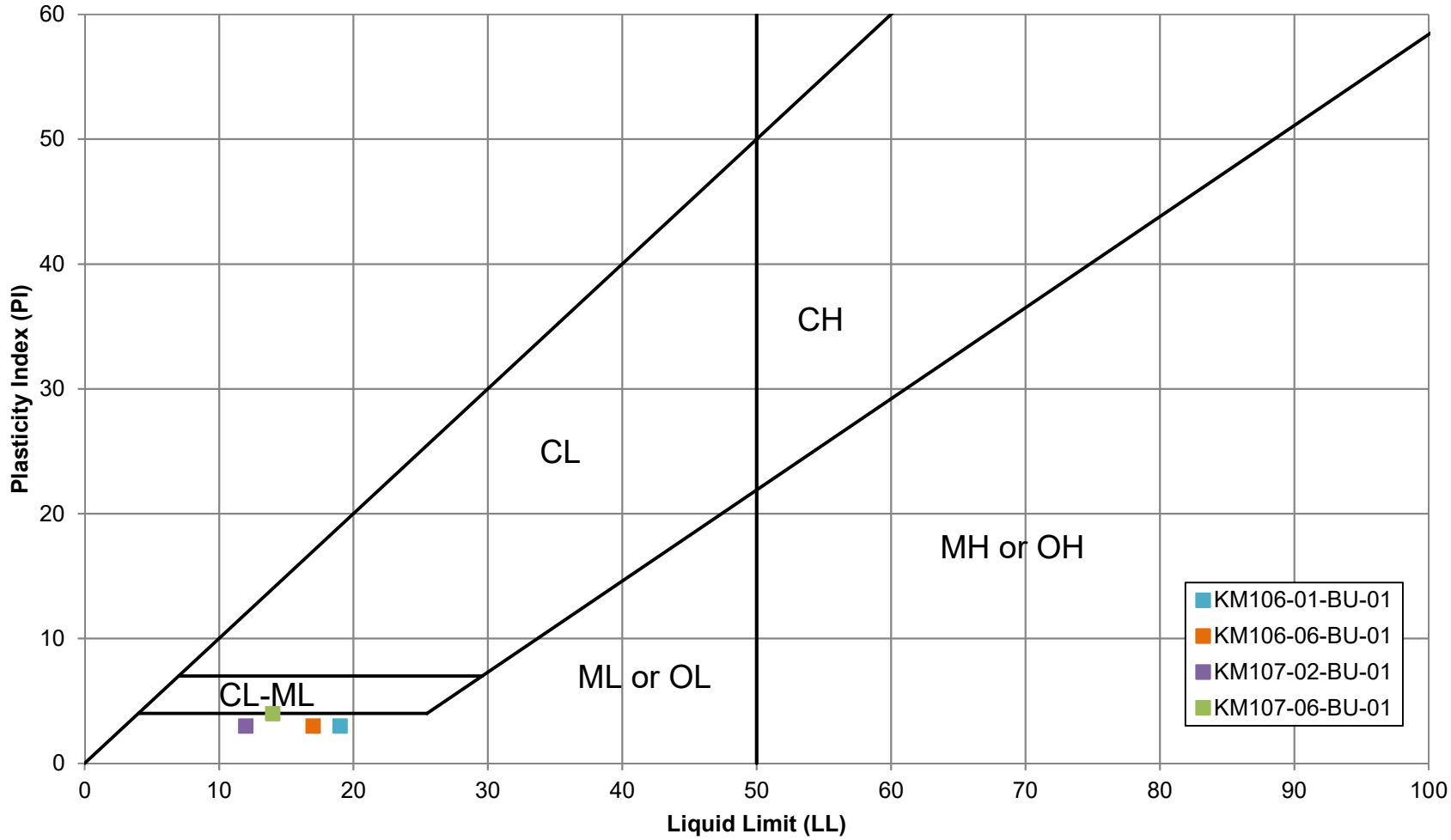
P/A NO. NB102-181/57

REF. NO. NB19-00431

FIGURE D1.2

REV 0

REV	DATE	DESCRIPTION	PREP'D	REV'D
0	31MAY'19	ISSUED WITH LETTER	JAG	ALA



NOTES:
1. KM107-03-BU-01 AND KM107-05-BU-01 TESTED AS NON-PLASTIC (NP).

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	31MAY'19	ISSUED WITH LETTER	JAG	ALA

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM106 AND KM107 STOCKPILE PLASTICITY CHART

Knight Piésold CONSULTING

P/A NO. NB102-181/57

REF NO. NB19-00431

FIGURE D1.3

REV 0

APPENDIX D2

Laboratory Data Reports

(Pages D2-1 to D2-24)

Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

ASTM D854

Project No.:	19122781-2000	**Borehole:**	KM106-DH19-01
Project:	KM106 Stockpile 2019 Geotechnical Site Investiga	**Sample Number:**	01-BU-01
Location:	Mary River	**Depth (m):**	0.3 - 0.5
Client:	Knight Piesold Ltd.	**Lab Sch. No:**	B19-151

Visual Description:

% Passing 4.75 mm	73.66
Excluded Material Description	

Specific Gravity of Fine Fraction Method B - Oven Dried Samples

		Trial 1	Trial 2
Flask Number		5	6
Air Removal Method	M_p	Vacuum	Vacuum
Mass of Flask (g)		174.62	173.28
Mass of Flask + Dry Soil (g)		275.11	273.73
Mass of Flask + Soil + Water (g)	$M_{rws,t}$	736.28	734.51
Test Temperature (°C)	T_t	22.30	22.40
Mass of Flask + Water (g)	$M_{rw,t}$	672.66	671.07
Tare Number		11D	12D
Mass of Tare + Dry Soil (g)		285.97	283.60
Mass of Tare (g)		185.49	183.17
Mass of Oven Dry Soil (g)	M_S	100.48	100.43
Temperature Coefficient	K	1.00	1.00
Specific Gravity at Test Temperature	G_t	2.73	2.72
Specific Gravity at 20ºC	$G_{20ºC}$	2.72	2.71

AVERAGE SPECIFIC GRAVITY OF TRIALS	2.72

The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

DC	May 29, 2019	SJ	May 30, 2019
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd.
300, 3811 North Fraser Way, Burnaby, British Columbia, Canada V5J 5J2
Tel: 604-412-6899 Fax: 604-412-6816 www.golder.com

Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

ASTM D854

Project No.:	19122781-2000	**Borehole:**	KM106-DH19-05
Project:	KM106 Stockpile 2019 Geotechnical Site Investiga	**Sample Number:**	05-BU-01
Location:	Mary River	**Depth (m):**	1.6 - 1.8
Client:	Knight Piesold Ltd.	**Lab Sch. No:**	B19-151

Visual Description:

% Passing 4.75 mm	70.97
Excluded Material Description	

Specific Gravity of Fine Fraction Method B - Oven Dried Samples

		Trial 1	Trial 2
Flask Number		3	4
Air Removal Method	M_p	Vacuum	Vacuum
Mass of Flask (g)		173.63	172.34
Mass of Flask + Dry Soil (g)		273.85	272.70
Mass of Flask + Soil + Water (g)	$M_{rws,t}$	734.96	734.06
Test Temperature (°C)	T_t	22.20	22.50
Mass of Flask + Water (g)	$M_{rw,t}$	671.74	670.50
Tare Number		1D	2D
Mass of Tare + Dry Soil (g)		281.87	285.33
Mass of Tare (g)		181.58	184.95
Mass of Oven Dry Soil (g)	M_S	100.29	100.38
Temperature Coefficient	K	1.00	1.00
Specific Gravity at Test Temperature	G_t	2.71	2.73
Specific Gravity at 20ºC	$G_{20ºC}$	2.70	2.72

AVERAGE SPECIFIC GRAVITY OF TRIALS	2.71

The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

DC	May 29, 2019	SJ	May 30, 2019
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd.
300, 3811 North Fraser Way, Burnaby, British Columbia, Canada V5J 5J2
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Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

ASTM D854

Project No.:	19122781-1000	**Borehole:**	KM107-DH19-02
Project:	KM107 Stockpile 2019 Geotechnical Site Investiga	**Sample Number:**	02-BU-01
Location:	Mary River	**Depth (m):**	1.2 - 1.5
Client:	Knight Piesold Ltd.	**Lab Sch. No:**	B19-112

Visual Description:

% Passing 4.75 mm	93.76
Excluded Material Description	

Specific Gravity of Fine Fraction Method B - Oven Dried Samples

		Trial 1	Trial 2
Flask Number		C	D
Air Removal Method	M_p	Vacuum	Vacuum
Mass of Flask (g)		90.20	90.43
Mass of Flask + Dry Soil (g)		160.23	161.02
Mass of Flask + Soil + Water (g)	$M_{rws,t}$	383.24	383.78
Test Temperature (°C)	T_t	24.50	23.70
Mass of Flask + Water (g)	$M_{rw,t}$	339.30	339.54
Tare Number		1D	2D
Mass of Tare + Dry Soil (g)		251.58	255.44
Mass of Tare (g)		181.55	184.90
Mass of Oven Dry Soil (g)	M_S	70.03	70.54
Temperature Coefficient	K	1.00	1.00
Specific Gravity at Test Temperature	G_t	2.68	2.68
Specific Gravity at 20ºC	$G_{20ºC}$	2.68	2.68

AVERAGE SPECIFIC GRAVITY OF TRIALS	2.68

The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

DC	May 8, 2019	LH	May 13, 2019
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd.
300, 3811 North Fraser Way, Burnaby, British Columbia, Canada V5J 5J2
Tel: 604-412-6899 Fax: 604-412-6816 www.golder.com

Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

ASTM D854

Project No.:	19122781-1000	**Borehole:**	KM107-DH19-03
Project:	KM107 Stockpile 2019 Geotechnical Site Investiga	**Sample Number:**	03-BU-01
Location:	Mary River	**Depth (m):**	1.0 - 1.3
Client:	Knight Piesold Ltd.	**Lab Sch. No:**	B19-112

Visual Description:

% Passing 4.75 mm	86.48
Excluded Material Description	

Specific Gravity of Fine Fraction Method B - Oven Dried Samples

		Trial 1	Trial 2
Flask Number		G	H
Air Removal Method	M_p	Vacuum	Vacuum
Mass of Flask (g)		88.91	89.31
Mass of Flask + Dry Soil (g)		159.27	159.82
Mass of Flask + Soil + Water (g)	$M_{rws,t}$	381.87	382.30
Test Temperature (°C)	T_t	24.40	24.80
Mass of Flask + Water (g)	$M_{rw,t}$	337.58	337.93
Tare Number		5D	6D
Mass of Tare + Dry Soil (g)		253.55	251.05
Mass of Tare (g)		183.19	180.46
Mass of Oven Dry Soil (g)	M_S	70.36	70.59
Temperature Coefficient	K	1.00	1.00
Specific Gravity at Test Temperature	G_t	2.70	2.69
Specific Gravity at 20ºC	$G_{20ºC}$	2.70	2.69

AVERAGE SPECIFIC GRAVITY OF TRIALS	2.69

The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

DC	May 8, 2019	LH	May 13, 2019
TESTED BY	DATE	CHECKED BY	DATE

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Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

ASTM D854

Project No.:	19122781-1000	**Borehole:**	KM107-DH19-05
Project:	KM107 Stockpile 2019 Geotechnical Site Investiga	**Sample Number:**	05-BU-01
Location:	Mary River	**Depth (m):**	1.9 - 2.3
Client:	Knight Piesold Ltd.	**Lab Sch. No:**	B19-112

Visual Description:

% Passing 4.75 mm	67.37
Excluded Material Description	

Specific Gravity of Fine Fraction Method B - Oven Dried Samples

		Trial 1	Trial 2
Flask Number		K	L
Air Removal Method	M_p	Vacuum	Vacuum
Mass of Flask (g)		88.07	90.13
Mass of Flask + Dry Soil (g)		198.17	160.28
Mass of Flask + Soil + Water (g)	$M_{rws,t}$	380.95	383.02
Test Temperature (°C)	T_t	24.20	23.60
Mass of Flask + Water (g)	$M_{rw,t}$	336.98	338.84
Tare Number		3D	4D
Mass of Tare + Dry Soil (g)		249.89	251.28
Mass of Tare (g)		179.83	181.12
Mass of Oven Dry Soil (g)	M_S	70.06	70.16
Temperature Coefficient	K	1.00	1.00
Specific Gravity at Test Temperature	G_t	2.68	2.70
Specific Gravity at 20ºC	$G_{20ºC}$	2.68	2.70

AVERAGE SPECIFIC GRAVITY OF TRIALS	2.69

The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

DC	May 8, 2019	LH	May 13, 2019
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd.
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Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

ASTM D854

Project No.:	19122781-1000	**Borehole:**	KM107-DH19-06
Project:	KM107 Stockpile 2019 Geotechnical Site Investiga	**Sample Number:**	06-BU-01
Location:	Mary River	**Depth (m):**	0.8 - 1.1
Client:	Knight Piesold Ltd.	**Lab Sch. No:**	B19-112

Visual Description:

% Passing 4.75 mm	84.86
Excluded Material Description	

Specific Gravity of Fine Fraction Method B - Oven Dried Samples

		Trial 1	Trial 2
Flask Number		7	8
Air Removal Method	M_p	Vacuum	Vacuum
Mass of Flask (g)		169.28	171.06
Mass of Flask + Dry Soil (g)		269.45	271.62
Mass of Flask + Soil + Water (g)	$M_{rws,t}$	730.43	732.20
Test Temperature (°C)	T_t	21.10	21.10
Mass of Flask + Water (g)	$M_{rw,t}$	667.48	669.08
Tare Number		7D	8D
Mass of Tare + Dry Soil (g)		281.93	285.17
Mass of Tare (g)		181.62	184.47
Mass of Oven Dry Soil (g)	M_S	100.31	100.70
Temperature Coefficient	K	1.00	1.00
Specific Gravity at Test Temperature	G_t	2.69	2.68
Specific Gravity at 20ºC	$G_{20ºC}$	2.68	2.68

AVERAGE SPECIFIC GRAVITY OF TRIALS	2.68

The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

DC	May 9, 2019	LH	May 13, 2019
TESTED BY	DATE	CHECKED BY	DATE

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GOLDER

WATER CONTENT DETERMINATION

ASTM D 2216

Client: Knight Piesold Ltd.

Lab Schedule No.: B19-151

Project: KM106 Sockpile 2019 Geotechnical Site Investigation

Location: Mary River

Project No.: 19122781 **Phase:** 2000

Sample Location	Sample No.	Specimen No.	Depth Interval		Water Content (%)
			Depth (m)	Bottom (m)	
KM106-DH19-01	**01-BU-01**		0.30	0.50	**10.0**
KM106-DH19-05	**05-BU-01**		1.60	1.80	**8.2**

SJ — Checked

5/30/2019 — Date

Golder Associates Ltd.
300 - 3811 North Fraser Way Burnaby, BC, V5J 5J2 CANADA
Tel: +1 (604) 412 6899 Fax: +1 (604) 412 6816 www.golder.com

GOLDER

WATER CONTENT DETERMINATION

ASTM D 2216

Client: Knight Piesold Ltd.

Lab Schedule No.: B19-112

Project: KM107 Stockpile 2019 Geotechnical Site Investigation

Location: Mary River

Project No.: 19122781 **Phase:** 1000

Sample Location	Sample No.	Specimen No.	Depth Interval		Water Content (%)
			Depth (m)	Bottom (m)	
KM107-DH19-02	**02-BU-01**		1.20	1.50	**9.5**
KM107-DH19-03	**03-BU-01**		1.00	1.30	**9.5**
KM107-DH19-05	**05-BU-01**		1.90	2.30	**8.9**
KM107-DH19-06	**06-BU-01**		0.80	1.10	**7.1**

LH — Checked

5/13/2019 — Date

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#300 - 3811 North Fraser Way Burnaby, British Columbia, Canada V5J 5J2
Tel: +1 (604) 412 6899 Fax: +1 (604) 412 6816 www.golder.com

ALS Canada Ltd.
2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **BAFFINLAND IRON MINES CORPORATION**
2275 UPPER MIDDLE ROAD EAST
SUITE 300
OAKVILLE ON L6H 0C3

Finalized Date: 18-APR-2019
Account: BIMCIO

CERTIFICATE BF19091683

Project: Moisture Testing

P.O. No.: 4500060218

This report is for 58 Drill Chip samples submitted to our lab in Baffinland, NU, Canada on 17-APR-2019.

The following have access to data associated with this certificate:

TREVOR BRISCO	SIMON FLEURY	ELEANOR GRANT
JORDON MARSH	FRANK PILECKI	DALE PITTMAN
HAYLEY POTHIER	JACOB PRINCE	MATTHEW TRACEY
LOUELL UY	WARRICK WILLIAMS	

SAMPLE PREPARATION

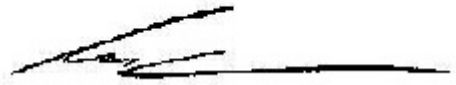
ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
WEI-22	Dry Weight

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION
OA-GRA05BF	Moisture in Iron ore samples

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature: 

Colin Ramshaw, Vancouver Laboratory Manager

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2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
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2275 UPPER MIDDLE ROAD EAST
SUITE 300
OAKVILLE ON L6H 0C3

Finalized Date: 18-APR-2019
Account: BIMCIO

Project: Moisture Testing

CERTIFICATE OF ANALYSIS BF19091683

Sample Description	Method / Analyte / Units / LOD	WEI-21 Recvd Wt. kg 0.02	WEI-22 Dry Wt. kg 0.02	OA-GRA05BF Moisture % 0.01
16/Apr/19-01-MC-01-R804101		0.64	0.56	12.50
16/Apr/19-01-MC-02-R804102		0.31	0.04	87.1
16/Apr/19-01-MC-03-R804103		1.11	0.33	70.3
16/Apr/19-01-MC-04-R804104		0.41	0.07	82.9
16/Apr/19-01-MC-05-R804105		0.25	0.15	40.0
16/Apr/19-01-MC-06-R804106		0.48	0.41	14.60
16/Apr/19-01-MC-07-R804107		0.28	0.06	78.6
16/Apr/19-01-MC-08-R804108		0.63	0.57	9.52
16/Apr/19-01-MC-09-R804109		0.59	0.50	15.25
16/Apr/19-01-MC-10-R804110		0.61	0.56	8.20
16/Apr/19-01-MC-11-R804111		0.95	0.85	10.55
16/Apr/19-01-MC-12-R804112		0.77	0.70	9.09
16/Apr/19-01-MC-13-R804113		0.59	0.49	16.95
16/Apr/19-02-MC-01-R804114		0.70	0.64	8.57
16/Apr/19-02-MC-02-R804115		0.53	0.44	17.00
16/Apr/19-02-MC-03-R804116		0.33	0.14	57.6
16/Apr/19-02-MC-04-R804117		0.29	0.09	69.0
16/Apr/19-02-MC-05-R804118		0.34	0.15	55.9
16/Apr/19-02-MC-06-R804119		0.05	0.03	40.0
16/Apr/19-02-MC-07-R804120		0.72	0.59	18.05
16/Apr/19-02-MC-08-R804121		0.39	0.32	17.95
16/Apr/19-02-MC-09-R804122		0.54	0.47	12.95
16/Apr/19-02-MC-10-R804123		0.53	0.47	11.30
16/Apr/19-03-MC-01-R804124		0.74	0.66	10.80
16/Apr/19-03-MC-02-R804125		0.33	0.13	60.6
16/Apr/19-03-MC-03-R804126		1.04	0.23	77.9
16/Apr/19-03-MC-04-R804127		0.29	0.09	69.0
16/Apr/19-03-MC-05-R804128		0.32	0.10	68.8
16/Apr/19-03-MC-06-R804129		0.37	0.16	56.8
16/Apr/19-03-MC-07-R804130		0.33	0.08	75.8
16/Apr/19-03-MC-08-R804131		0.30	0.06	80.0
16/Apr/19-03-MC-09-R804132		0.78	0.68	12.80
16/Apr/19-03-MC-10-R804133		0.65	0.54	16.90
16/Apr/19-03-MC-11-R804134		0.66	0.61	7.58
16/Apr/19-03-MC-12-R804135		0.63	0.57	9.52
16/Apr/19-03-MC-13-R804136		0.64	0.57	10.95
16/Apr/19-03-MC-14-R804137		0.84	0.75	10.70
16/Apr/19-04-MC-01-R804138		0.30	0.16	46.7
16/Apr/19-04-MC-02-R804139		0.57	0.52	8.77
16/Apr/19-05-MC-01-R804140		0.74	0.71	4.05

***** See Appendix Page for comments regarding this certificate *****

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2275 UPPER MIDDLE ROAD EAST
SUITE 300
OAKVILLE ON L6H 0C3

Finalized Date: 18-APR-2019
Account: BIMCIO

Project: Moisture Testing

CERTIFICATE OF ANALYSIS BF19091683

Sample Description	Method Analyte Units LOD	WEI-21 Recvd Wt. kg 0.02	WEI-22 Dry Wt. kg 0.02	OA-GRA05BF Moisture % 0.01
16/Apr/19-05-MC-02-R804141		0.82	0.73	11.00
16/Apr/19-05-MC-03-R804142		1.68	1.43	14.90
16/Apr/19-05-MC-04-R804143		1.18	1.02	13.55
16/Apr/19-05-MC-05-R804144		1.42	1.28	9.86
16/Apr/19-05-MC-06-R804145		1.44	1.26	12.50
16/Apr/19-05-MC-07-R804146		1.00	0.89	11.00
16/Apr/19-06-MC-01-R804147		0.63	0.52	17.45
16/Apr/19-06-MC-02-R804148		0.67	0.57	14.95
16/Apr/19-06-MC-03-R804149		0.30	0.18	40.0
16/Apr/19-06-MC-04-R804150		0.73	0.15	79.5
16/Apr/19-06-MC-05-R804151		0.45	0.09	80.0
16/Apr/19-06-MC-06-R804152		0.20	0.15	25.0
16/Apr/19-06-MC-07-R804153		0.16	0.03	81.3
16/Apr/19-06-MC-08-R804154		0.15	0.12	20.0
16/Apr/19-06-MC-09-R804155		0.27	0.10	63.0
16/Apr/19-06-MC-10-R804156		0.18	0.11	38.9
16/Apr/19-06-MC-11-R804157		0.41	0.36	12.20
16/Apr/19-06-MC-12-R804158		0.56	0.48	14.30

***** See Appendix Page for comments regarding this certificate *****

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To: **BAFFINLAND IRON MINES CORPORATION**
2275 UPPER MIDDLE ROAD EAST
SUITE 300
OAKVILLE ON L6H 0C3

Finalized Date: 18-APR-2019
Account: BIMCIO

Project: Moisture Testing

CERTIFICATE OF ANALYSIS BF19091683

CERTIFICATE COMMENTS

LABORATORY ADDRESSES

Applies to Method: Processed at ALS Baffinland, Mary River, Baffin Island, Nunavut, Canada

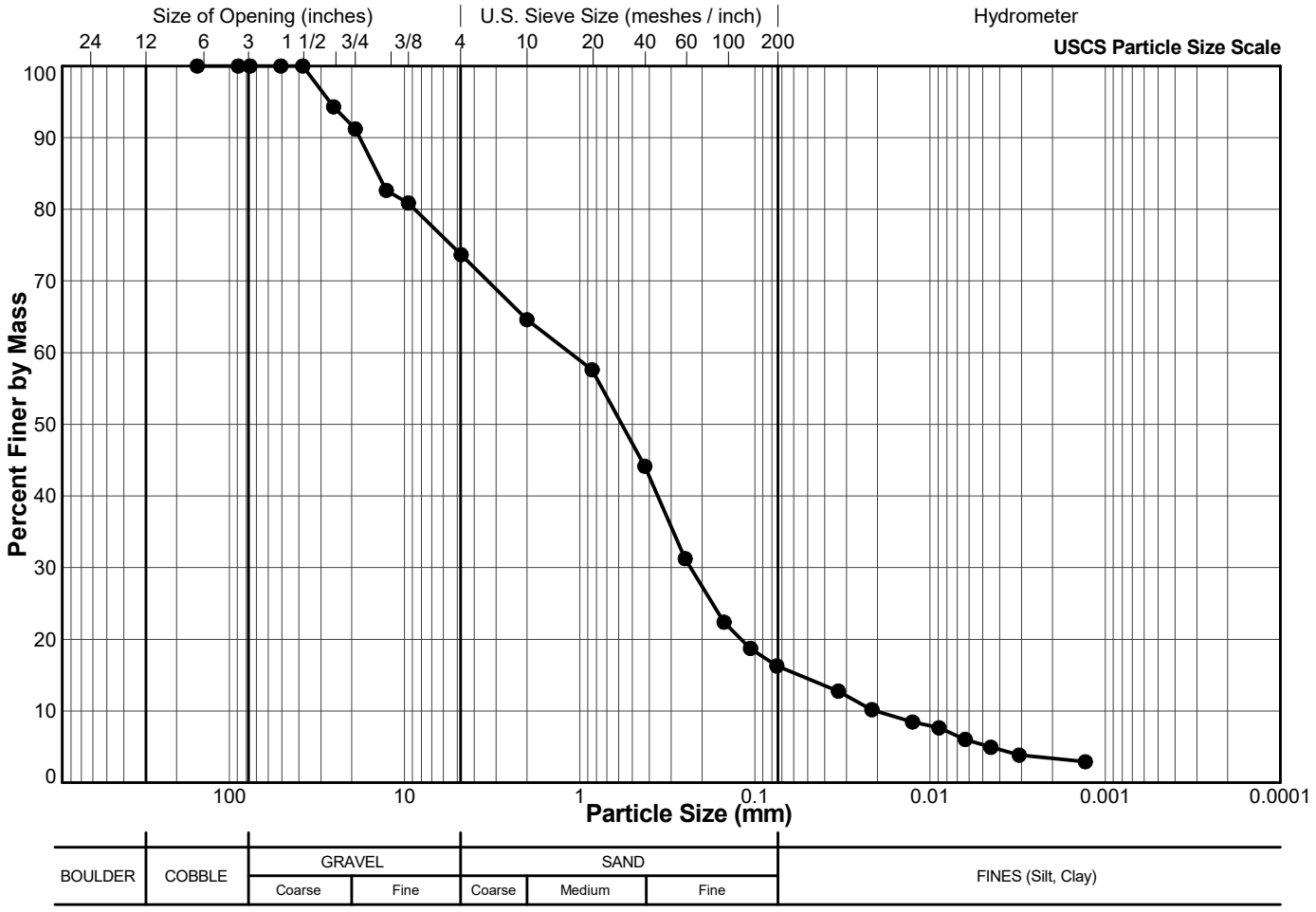
OA-GRA05BF	WEI-21	WEI-22

SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Knight Piesold Ltd.
Project: KM106 Sockpile 2019 Geotechnical Site Investigation
Location: Mary River
Project No.: 19122781 **Phase:** 2000

Sample Location: KM106-DH19-01
Sample No.: 01-BU-01
Depth Interval (m): 0.30 to 0.50
Lab Schedule No.: B19-151



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		94.3
3/4"	19.1		91.2
1/2"	12.7		82.6
3/8"	9.5		80.9
#4 US MESH	4.75		73.7
#10 US MESH	2		64.6
#20 US MESH	0.85		57.6
#40 US MESH	0.425		44.2
#60 US MESH	0.25		31.3
#100 US MESH	0.15		22.4
#140 US MESH	0.106		18.7
#200 US MESH	0.075		16.3
		0.0334	12.8
		0.0215	10.2
		0.0126	8.5
		0.0089	7.6
		0.0063	6.0
		0.0045	4.9
		0.0031	3.8
		0.0013	2.9

FF/DC	5/27/2019	SJ	5/30/2019
Tech	Date	Checked	Date

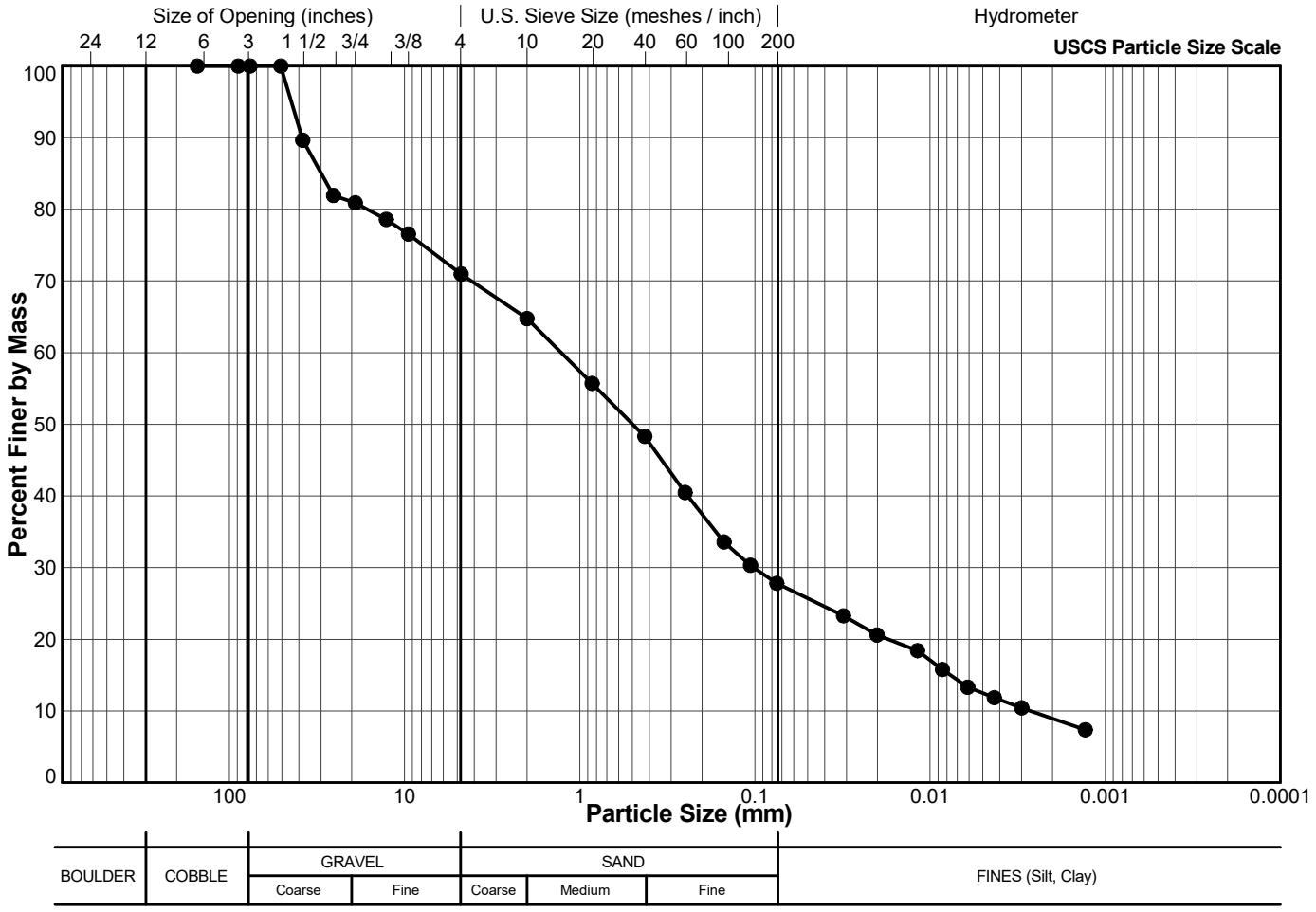
National IM Server:GINT_GAL_NATIONALIM Unique Project ID:2237 Output Form:_LAB_PARTICLE SIZE W/GRAD AND SA TYPE_SJohn_30/5/19

SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Knight Piesold Ltd.
Project: KM106 Sockpile 2019 Geotechnical Site Investigation
Location: Mary River
Project No.: 19122781 **Phase:** 2000

Sample Location: KM106-DH19-05
Sample No.: 05-BU-01
Depth Interval (m): 1.60 to 1.80
Lab Schedule No.: B19-151



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		89.6
1"	25.4		81.9
3/4"	19.1		80.9
1/2"	12.7		78.6
3/8"	9.5		76.6
#4 US MESH	4.75		71.0
#10 US MESH	2		64.8
#20 US MESH	0.85		55.7
#40 US MESH	0.425		48.3
#60 US MESH	0.25		40.5
#100 US MESH	0.15		33.6
#140 US MESH	0.106		30.3
#200 US MESH	0.075		27.8
		0.0312	23.3
		0.0201	20.6
		0.0118	18.4
		0.0085	15.8
		0.0061	13.3
		0.0043	11.9
		0.0030	10.4
		0.0013	7.4

FF/DC	5/27/2019	SJ	5/30/2019
Tech	Date	Checked	Date

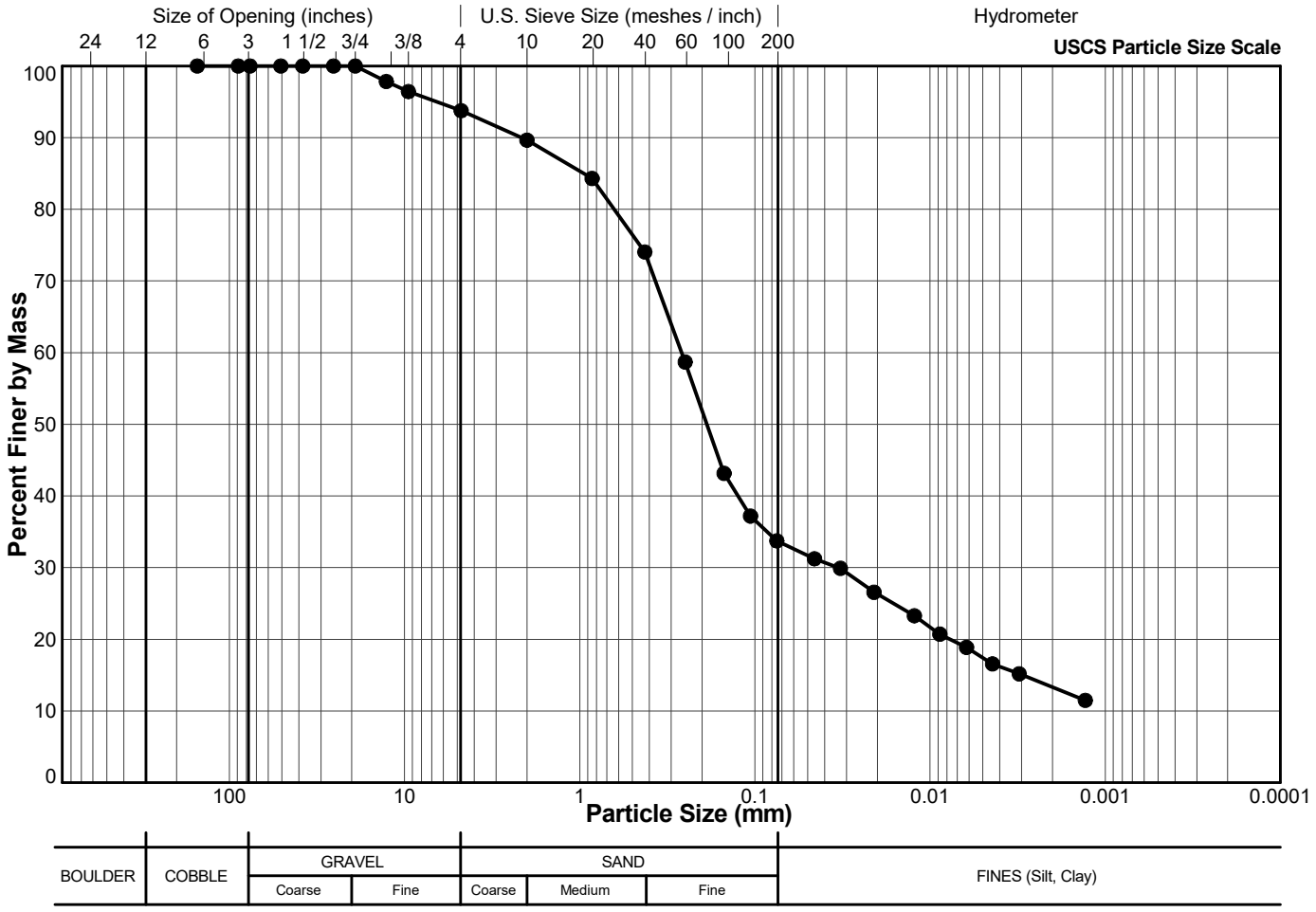
National IM Server:GINT_GAL_NATIONALIM Unique Project ID:2237 Output Form:_LAB_PARTICLE SIZE W/GRAD AND SA TYPE_SJohn_30/5/19

SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Knight Piesold Ltd.
Project: KM107 Stockpile 2019 Geotechnical Site Investigation
Location: Mary River
Project No.: 19122781 **Phase:** 1000

Sample Location: KM107-DH19-02
Sample No.: 02-BU-01
Depth Interval (m): 1.20 to 1.50
Lab Schedule No.: B19-112



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		100.0
3/4"	19.1		100.0
1/2"	12.7		97.8
3/8"	9.5		96.4
#4 US MESH	4.75		93.8
#10 US MESH	2		89.7
#20 US MESH	0.85		84.3
#40 US MESH	0.425		74.1
#60 US MESH	0.25		58.7
#100 US MESH	0.15		43.2
#140 US MESH	0.106		37.2
#200 US MESH	0.075		33.7
		0.0457	31.2
		0.0325	29.9
		0.0209	26.6
		0.0123	23.3
		0.0088	20.7
		0.0062	18.9
		0.0044	16.6
		0.0031	15.2
		0.0013	11.5

DC/GM	5/9/2019	LH	5/13/2019
Tech	Date	Checked	Date

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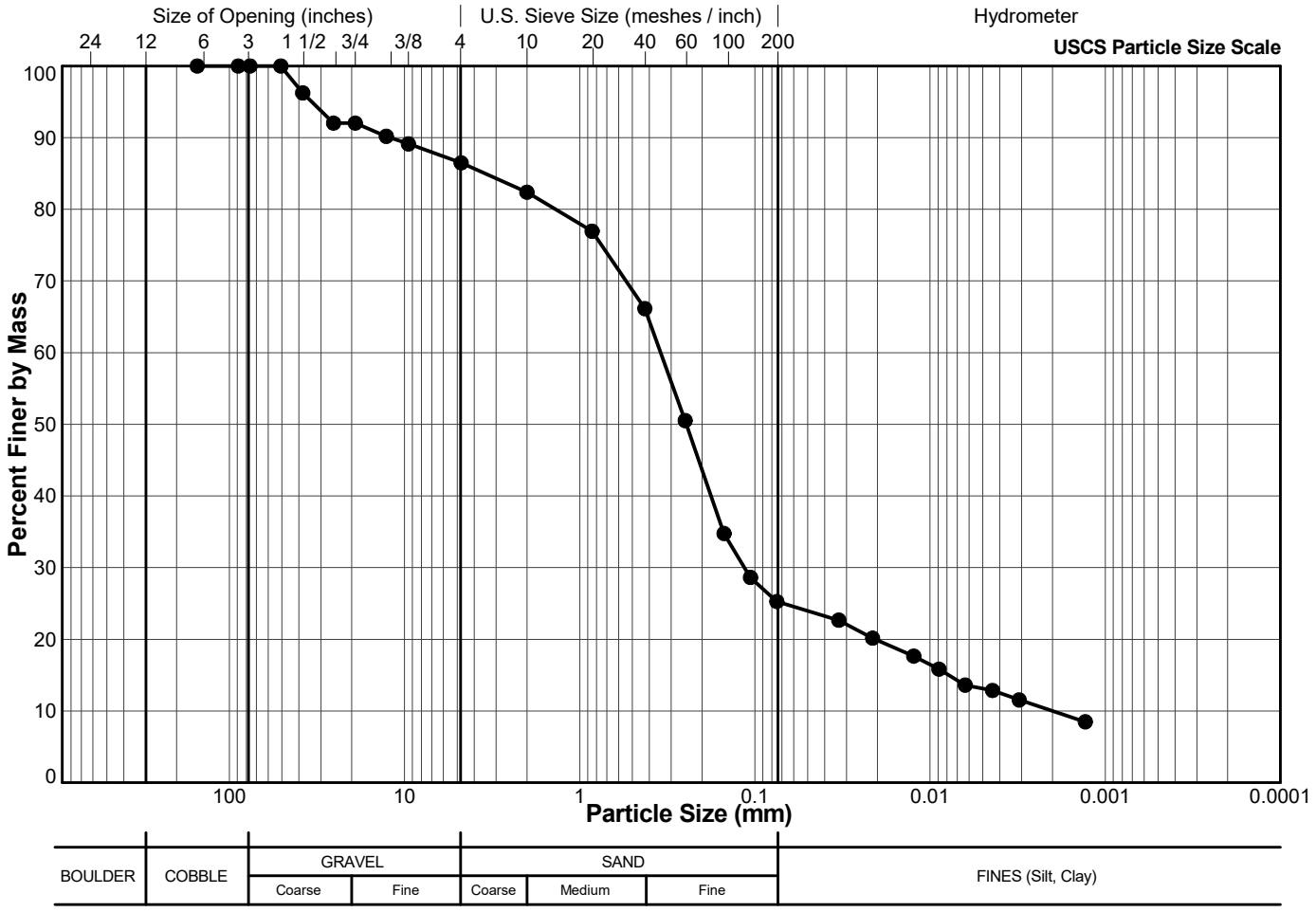
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Knight Piesold Ltd.
Project: KM107 Stockpile 2019 Geotechnical Site Investigation
Location: Mary River
Project No.: 19122781 **Phase:** 1000

Sample Location: KM107-DH19-03
Sample No.: 03-BU-01
Depth Interval (m): 1.00 to 1.30
Lab Schedule No.: B19-112



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		96.2
1"	25.4		92.0
3/4"	19.1		92.0
1/2"	12.7		90.2
3/8"	9.5		89.1
#4 US MESH	4.75		86.5
#10 US MESH	2		82.4
#20 US MESH	0.85		76.9
#40 US MESH	0.425		66.2
#60 US MESH	0.25		50.5
#100 US MESH	0.15		34.8
#140 US MESH	0.106		28.6
#200 US MESH	0.075		25.3
		0.0332	22.7
		0.0213	20.2
		0.0124	17.7
		0.0089	15.8
		0.0063	13.6
		0.0044	12.9
		0.0031	11.5
		0.0013	8.5

DC/GM	5/9/2019	LH	5/13/2019
Tech	Date	Checked	Date

National IM Server:GINT_GAL_NATIONALIM Unique Project ID:2218 Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) 2018 LHu 14/5/19

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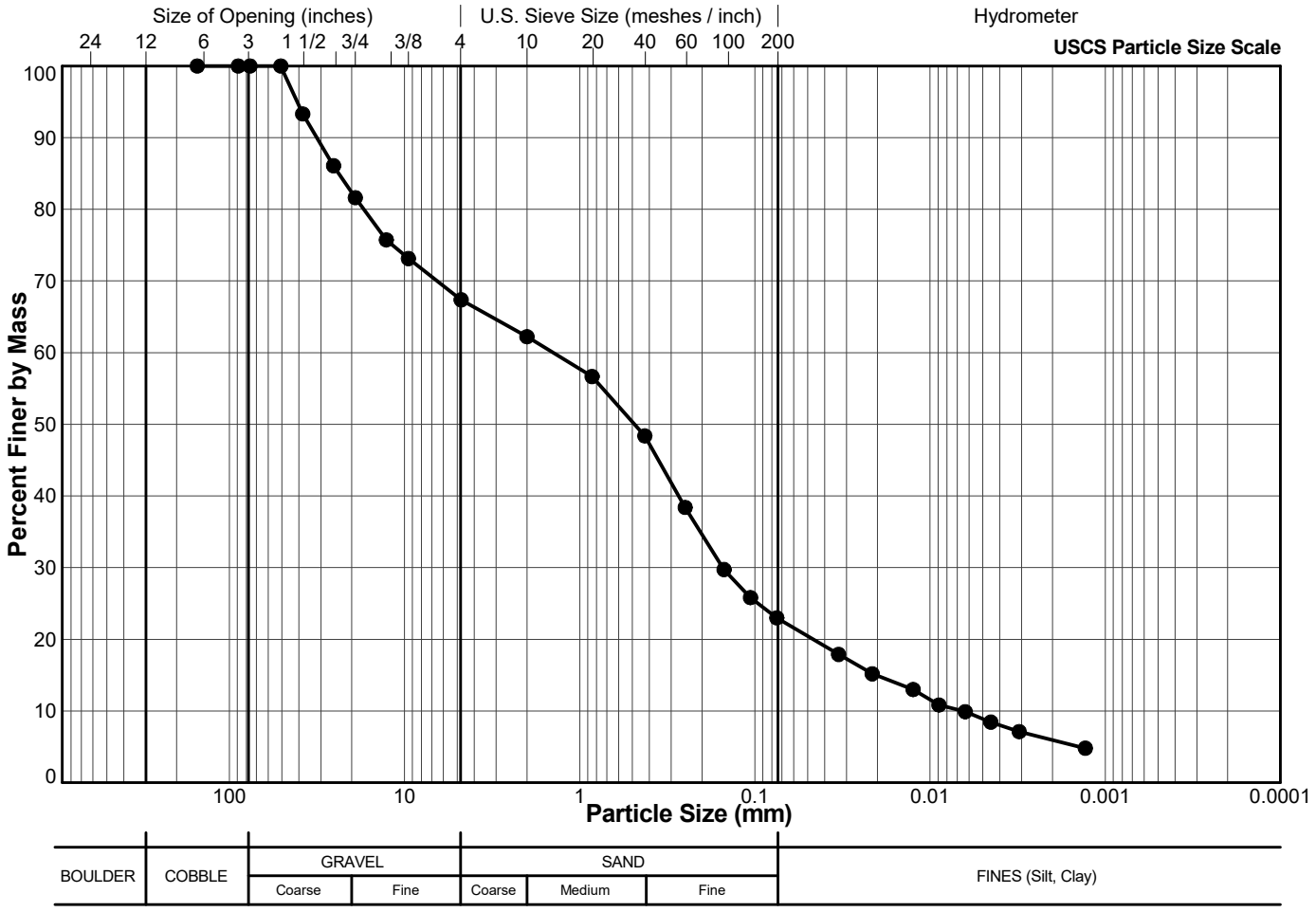
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Knight Piesold Ltd.
Project: KM107 Stockpile 2019 Geotechnical Site Investigation
Location: Mary River
Project No.: 19122781 **Phase:** 1000

Sample Location: KM107-DH19-05
Sample No.: 05-BU-01
Depth Interval (m): 1.90 to 2.30
Lab Schedule No.: B19-112



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		93.3
1"	25.4		86.1
3/4"	19.1		81.6
1/2"	12.7		75.7
3/8"	9.5		73.1
#4 US MESH	4.75		67.4
#10 US MESH	2		62.2
#20 US MESH	0.85		56.7
#40 US MESH	0.425		48.4
#60 US MESH	0.25		38.4
#100 US MESH	0.15		29.7
#140 US MESH	0.106		25.8
#200 US MESH	0.075		23.0
		0.0333	17.9
		0.0214	15.2
		0.0125	13.0
		0.0089	10.8
		0.0063	9.9
		0.0045	8.4
		0.0031	7.1
		0.0013	4.8

DC/GM	5/9/2019	LH	5/13/2019
Tech	Date	Checked	Date

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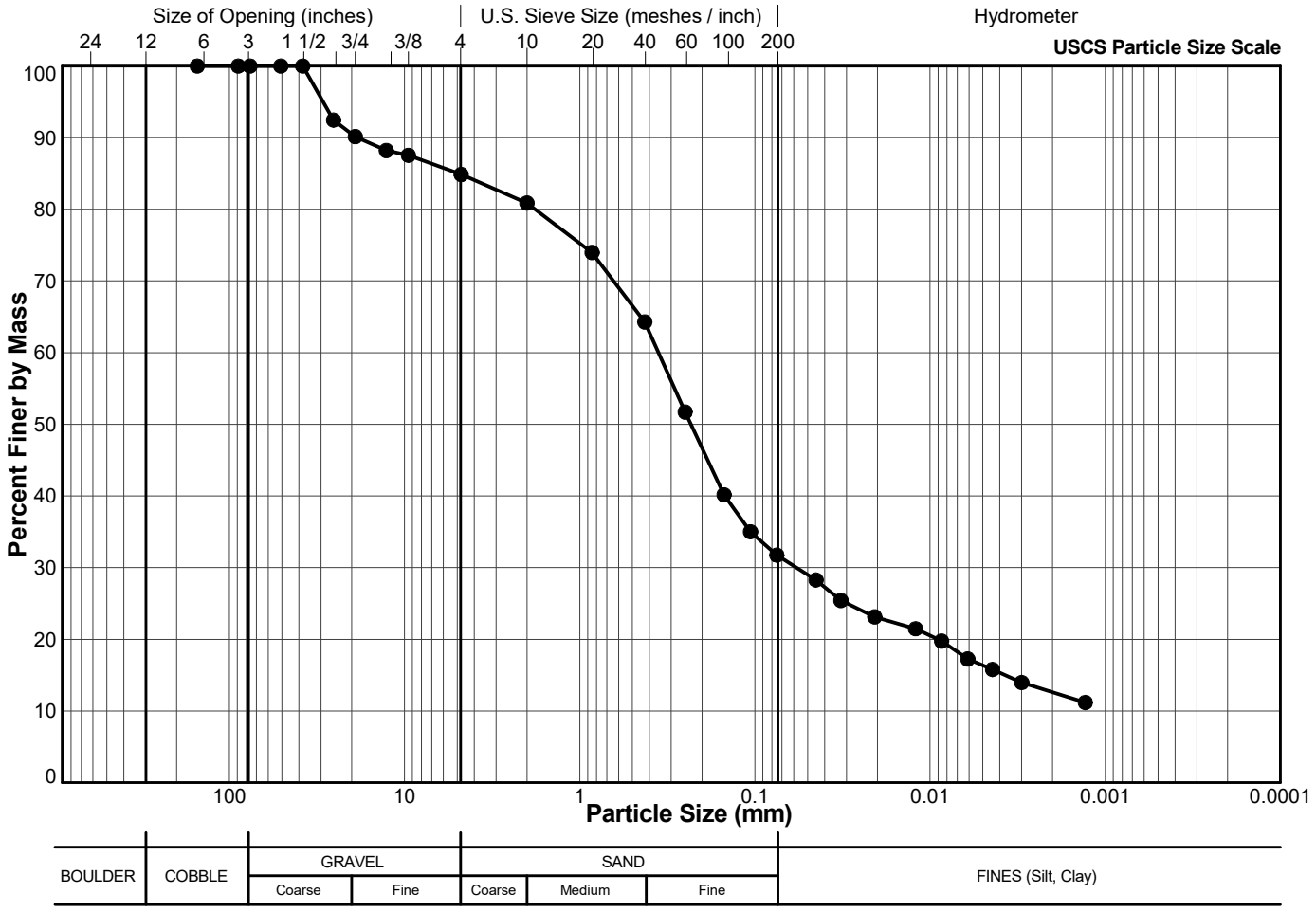
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Knight Piesold Ltd.
Project: KM107 Stockpile 2019 Geotechnical Site Investigation
Location: Mary River
Project No.: 19122781 **Phase:** 1000

Sample Location: KM107-DH19-06
Sample No.: 06-BU-01
Depth Interval (m): 0.80 to 1.10
Lab Schedule No.: B19-112



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		92.5
3/4"	19.1		90.1
1/2"	12.7		88.2
3/8"	9.5		87.5
#4 US MESH	4.75		84.9
#10 US MESH	2		80.9
#20 US MESH	0.85		74.0
#40 US MESH	0.425		64.3
#60 US MESH	0.25		51.7
#100 US MESH	0.15		40.2
#140 US MESH	0.106		35.0
#200 US MESH	0.075		31.7
		0.0448	28.3
		0.0323	25.4
		0.0207	23.1
		0.0121	21.5
		0.0086	19.8
		0.0061	17.3
		0.0044	15.8
		0.0030	14.0
		0.0013	11.2

DC/GM	5/9/2019	LH	5/13/2019
Tech	Date	Checked	Date

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

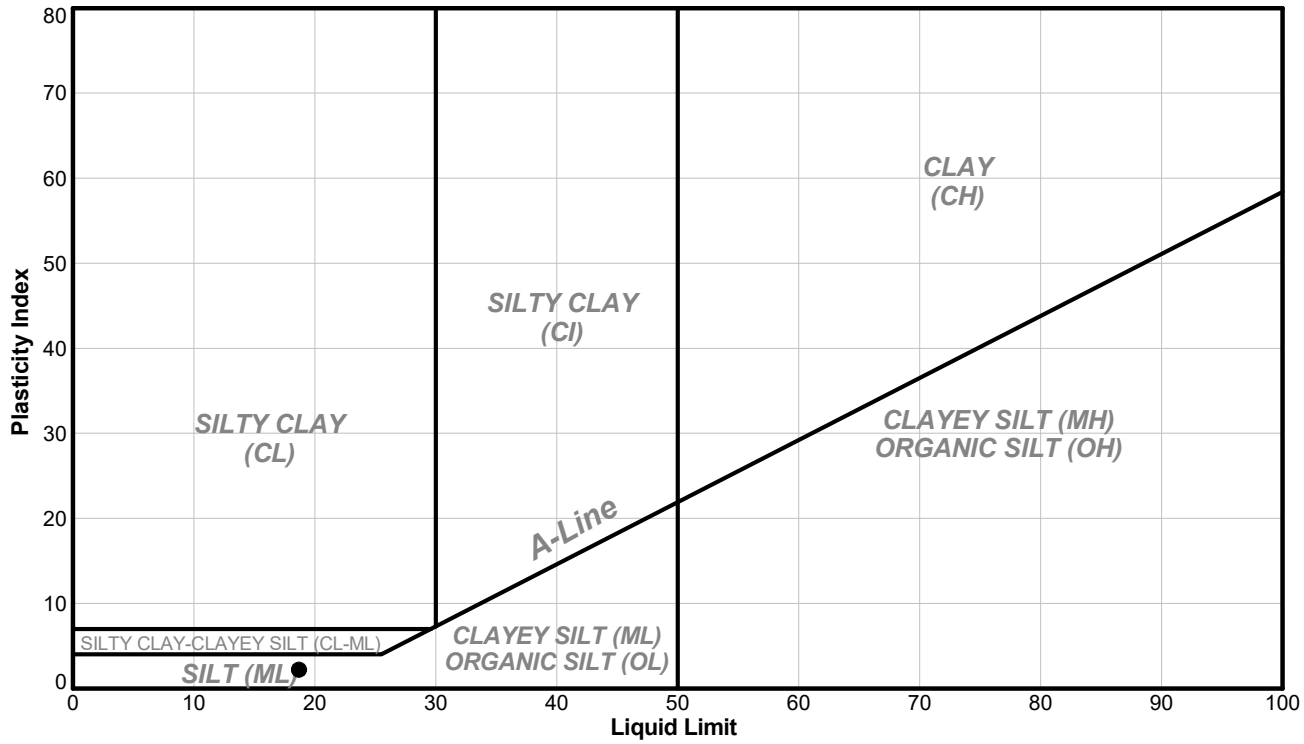
ASTM D 4318

Client:	Knight Piesold Ltd.	**ID:**	**KM106-DH19-01**
Project:	KM106 Sockpile 2019 Geotechnical Site Investigation	**Sample No.:**	**01-BU-01**
Location:	Mary River	**Depth Interval (m):**	0.30 to 0.50
Project No.:	19122781 **Phase:** 2000	**Lab Schedule No.:**	B19-151

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Air Dried**

PLASTICITY CHART



Sym.	Sample Location	Sample / Specimen Number	Depth (m)	Bottom (m)	Percent Passing #40 Sieve (%)	Liquid Limit	Plastic Limit	Plasticity Index	Natural Water Content (%)	Liquidity Index
●	KM106-DH19-01	01-BU-01	0.30	0.50	44	19	16	3.0	10.0	-2.0

NP - NON-PLASTIC RESULT ND - NOT DETERMINED

Note: The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

FF	5/29/2019	SJ	5/30/2019
Tech	Date	Checked	Date

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

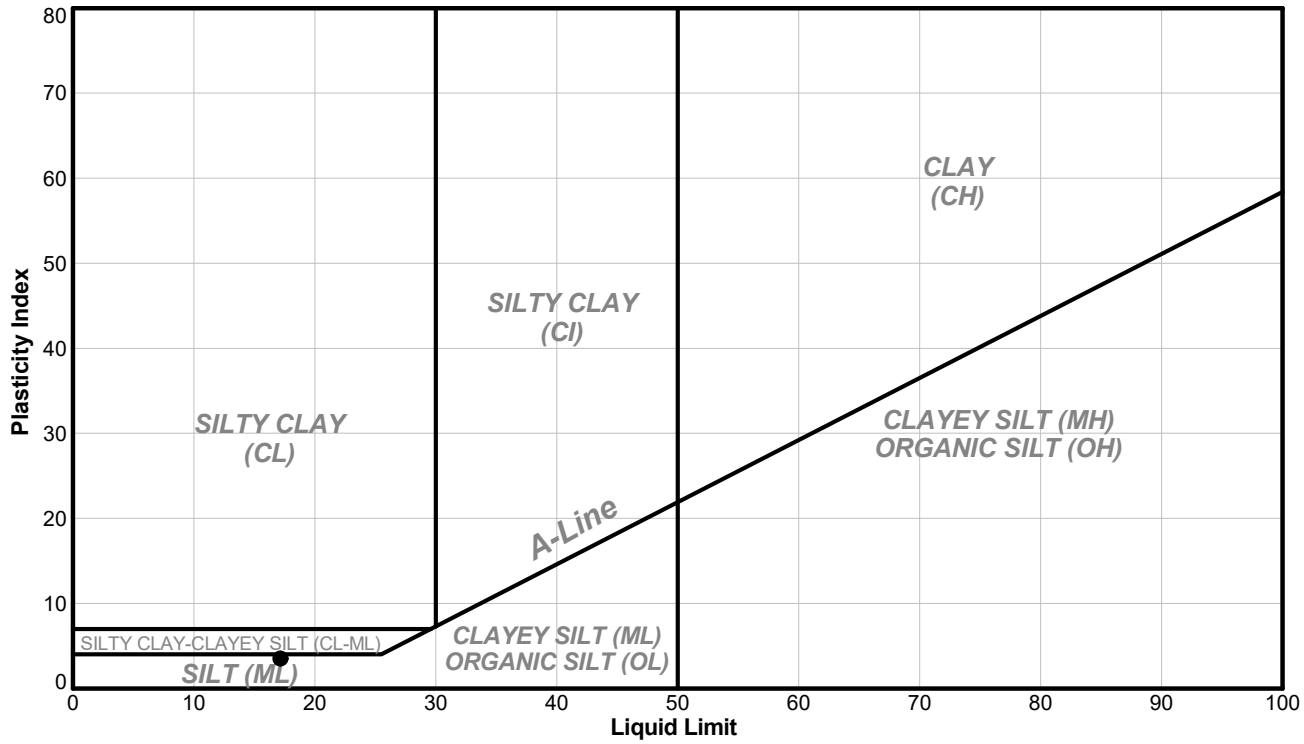
ASTM D 4318

Client:	Knight Piesold Ltd.	**ID:**	**KM106-DH19-05**
Project:	KM106 Sockpile 2019 Geotechnical Site Investigation	**Sample No.:**	**05-BU-01**
Location:	Mary River	**Depth Interval (m):**	1.60 to 1.80
Project No.:	19122781 **Phase:** 2000	**Lab Schedule No.:**	B19-151

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Air Dried**

PLASTICITY CHART



Sym.	Sample Location	Sample / Specimen Number	Depth (m)	Bottom (m)	Percent Passing #40 Sieve (%)	Liquid Limit	Plastic Limit	Plasticity Index	Natural Water Content (%)	Liquidity Index
●	KM106-DH19-05	05-BU-01	1.60	1.80	48	17	14	3.0	8.2	-1.9

NP - NON-PLASTIC RESULT ND - NOT DETERMINED

Note: The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

FF	5/29/2019	SJ	5/30/2019
Tech	Date	Checked	Date

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

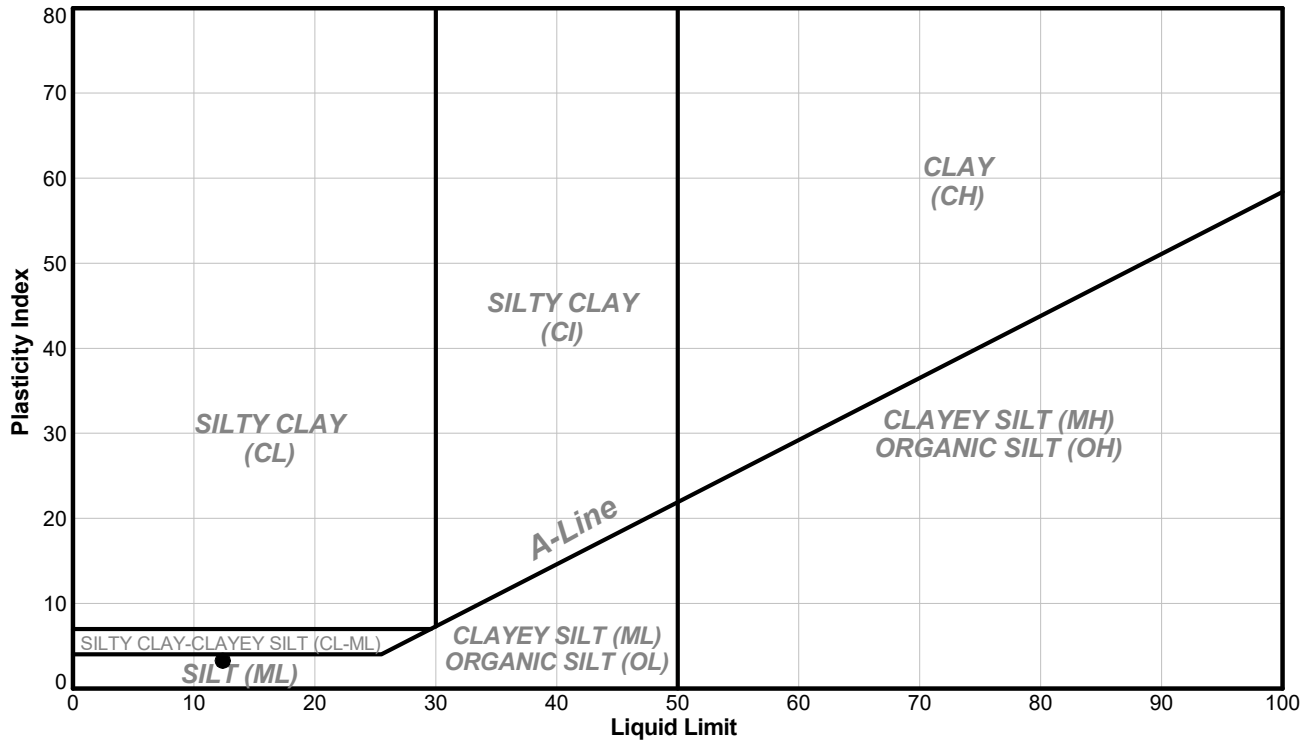
ASTM D 4318

Client:	Knight Piesold Ltd.	**ID:**	**KM107-DH19-02**
Project:	KM107 Stockpile 2019 Geotechnical Site Investigation	**Sample No.:**	**02-BU-01**
Location:	Mary River	**Depth Interval (m):**	1.20 to 1.50
Project No.:	19122781 **Phase:** 1000	**Lab Schedule No.:**	B19-112

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Air Dried**

PLASTICITY CHART



Sym.	Sample Location	Sample / Specimen Number	Depth (m)	Bottom (m)	Percent Passing #40 Sieve (%)	Liquid Limit	Plastic Limit	Plasticity Index	Natural Water Content (%)	Liquidity Index
●	KM107-DH19-02	02-BU-01	1.20	1.50	74	12	9	3.0	9.5	0.2

NP - NON-PLASTIC RESULT ND - NOT DETERMINED

Note: The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

BJ	5/9/2019	LH	5/13/2019
Tech	Date	Checked	Date

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

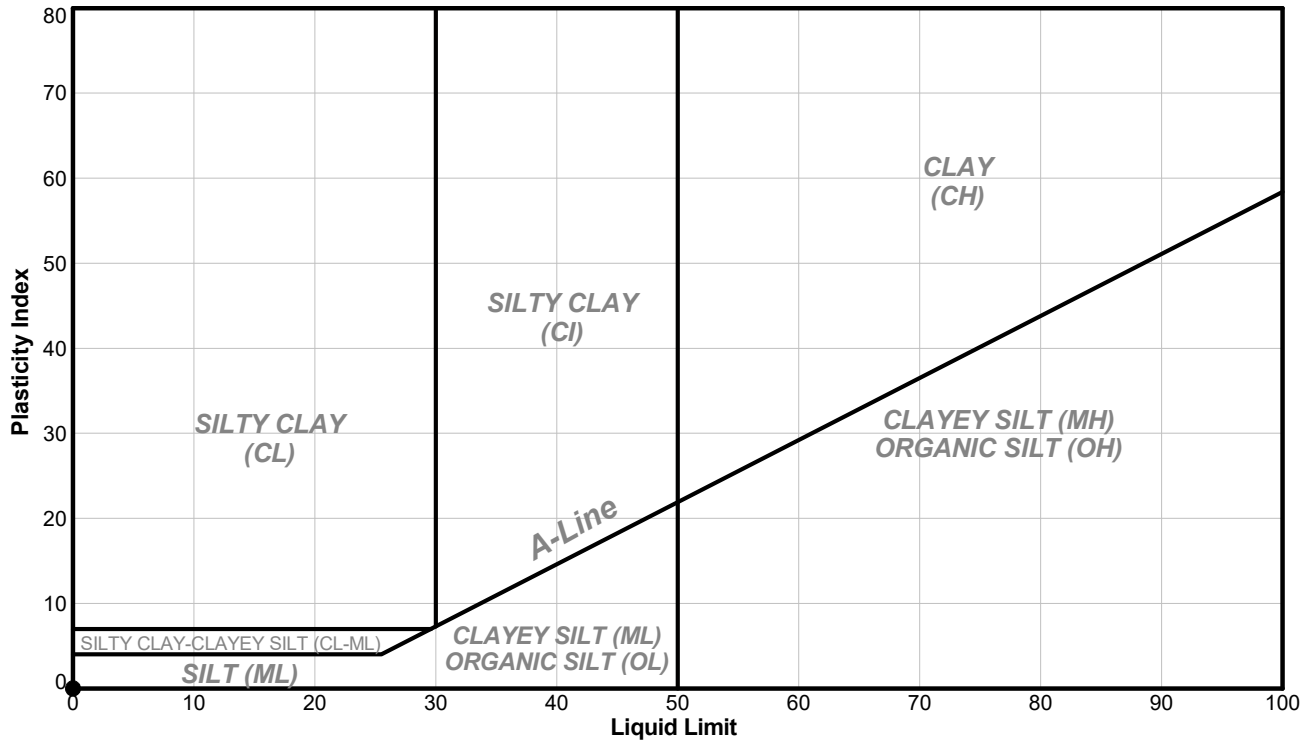
ASTM D 4318

Client:	Knight Piesold Ltd.	**ID:**	**KM107-DH19-03**
Project:	KM107 Stockpile 2019 Geotechnical Site Investigation	**Sample No.:**	**03-BU-01**
Location:	Mary River	**Depth Interval (m):**	1.00 to 1.30
Project No.:	19122781 **Phase:** 1000	**Lab Schedule No.:**	B19-112

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Air Dried**

PLASTICITY CHART



Sym.	Sample Location	Sample / Specimen Number	Depth (m)	Bottom (m)	Percent Passing #40 Sieve (%)	Liquid Limit	Plastic Limit	Plasticity Index	Natural Water Content (%)	Liquidity Index
●	KM107-DH19-03	03-BU-01	1.00	1.30	66	NP	NP	NP	9.5	NP

NP - NON-PLASTIC RESULT ND - NOT DETERMINED

Note: The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

BJ	5/10/2019	LH	5/13/2019
Tech	Date	Checked	Date

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

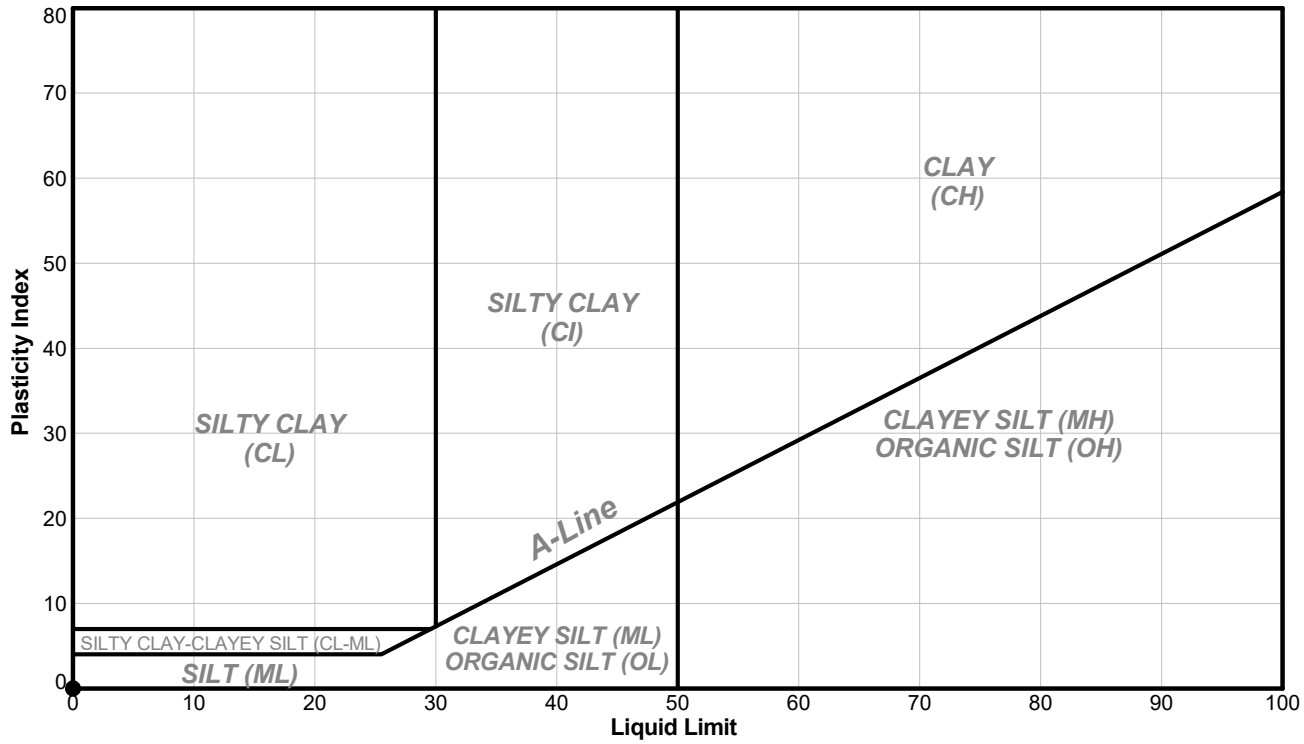
ASTM D 4318

Client:	Knight Piesold Ltd.	**ID:**	**KM107-DH19-05**
Project:	KM107 Stockpile 2019 Geotechnical Site Investigation	**Sample No.:**	**05-BU-01**
Location:	Mary River	**Depth Interval (m):**	1.90 to 2.30
Project No.:	19122781 **Phase:** 1000	**Lab Schedule No.:**	B19-112

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Air Dried**

PLASTICITY CHART



Sym.	Sample Location	Sample / Specimen Number	Depth (m)	Bottom (m)	Percent Passing #40 Sieve (%)	Liquid Limit	Plastic Limit	Plasticity Index	Natural Water Content (%)	Liquidity Index
●	KM107-DH19-05	05-BU-01	1.90	2.30	48	NP	NP	NP	8.9	NP

NP - NON-PLASTIC RESULT ND - NOT DETERMINED

Note: The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

BJ	5/10/2019	LH	5/13/2019
Tech	Date	Checked	Date

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

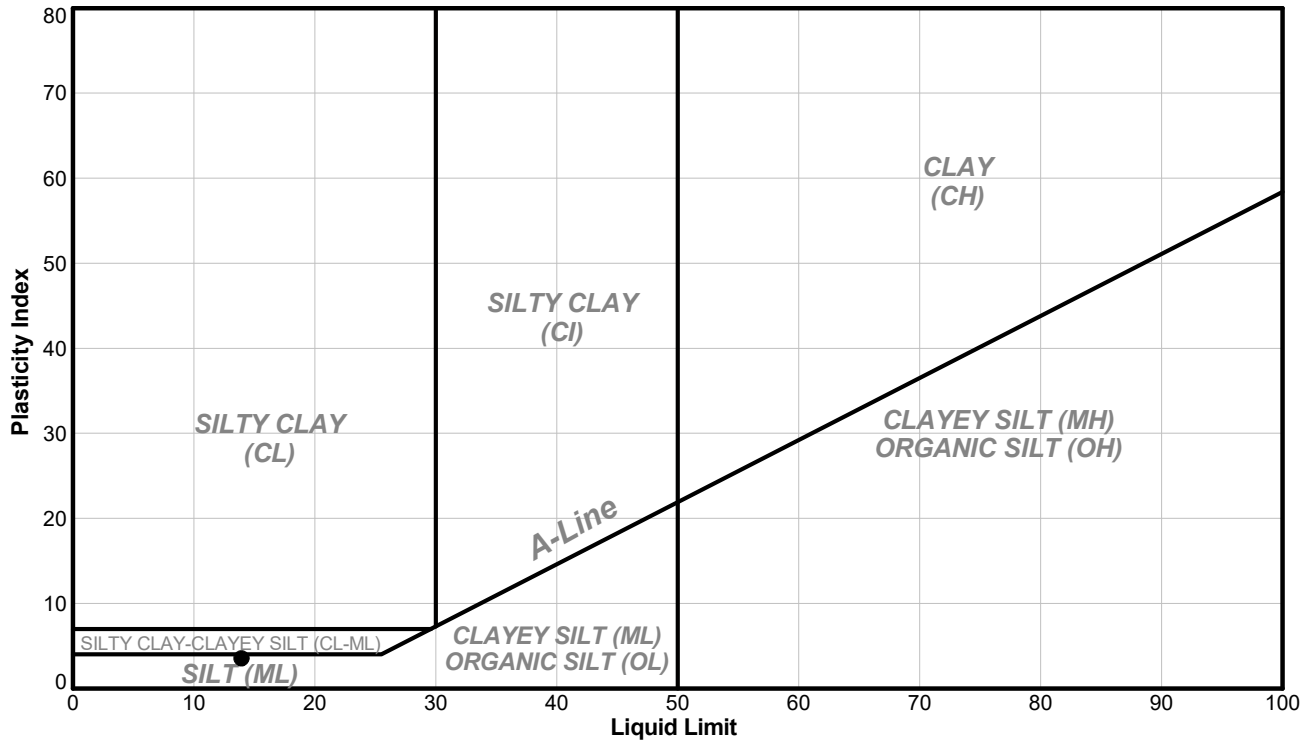
ASTM D 4318

Client:	Knight Piesold Ltd.	**ID:**	**KM107-DH19-06**
Project:	KM107 Stockpile 2019 Geotechnical Site Investigation	**Sample No.:**	**06-BU-01**
Location:	Mary River	**Depth Interval (m):**	0.80 to 1.10
Project No.:	19122781 **Phase:** 1000	**Lab Schedule No.:**	B19-112

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Air Dried**

PLASTICITY CHART



Sym.	Sample Location	Sample / Specimen Number	Depth (m)	Bottom (m)	Percent Passing #40 Sieve (%)	Liquid Limit	Plastic Limit	Plasticity Index	Natural Water Content (%)	Liquidity Index
●	KM107-DH19-06	06-BU-01	0.80	1.10	64	14	10	4.0	7.1	-0.7

NP - NON-PLASTIC RESULT ND - NOT DETERMINED

Note: The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

BJ	5/9/2019	LH	5/13/2019
Tech	Date	Checked	Date

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