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**NB102-181/63-1**

# MARY RIVER PROJECT
# MINE SITE WATER MANAGEMENT PLAN

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Knight Piésold
CONSULTING

# EXECUTIVE SUMMARY

Baffinland Iron Mines Corporation (Baffinland) retained Knight Piésold Ltd. (KP) to prepare this Water Management Plan (WMP) for the Mine Site at the Mary River Project.

Baffinland has experienced erosion and sedimentation issues along the Mine Haul Road (MHR) and within the Mine Site which have resulted in impacts to Camp Lake, Sheardown Lake and their tributaries. Runoff from these areas has exceeded Type A Water Licence 2AM-MRY1325 discharge limits for total suspended solids (TSS) during the current Early Revenue Phase of the Project. The management of water and the control of erosion and sediment are influenced by the extreme regional temperatures, near surface soil types and permafrost ground conditions.

The primary objective of this WMP is to identify measures that will assist Baffinland in achieving compliance with respect to discharge of sediment-laden water into local watercourses. This WMP aims to:

- Identify key issues and concerns related to the management of surface water at the mine site
- Identify the applicable design criteria to be applied to future water management infrastructure
- Identify the conceptual water management infrastructure required over the selected planning horizon (2021-2025), accounting for new Phase 2 Proposal infrastructure (pending approval)
- Be consistent with the requirements of the Type A Water Licence and Project Certificate

Three categories of water management measures have been identified for the site:

- **Operational Improvements -** Minor improvements to operational practices that reduce the potential for erosion and sedimentation. Examples of operational improvements identified during this study include modifying grader practices and reducing dust emissions at the source.
- **Remedial Measures -** Repairs, improvements, or other modifications to existing infrastructure. Examples include placing riprap in ditches, stabilizing select cut slopes with riprap, and regrading the crusher pad.
- **New Water Management Structures -** Additional water management measures that need to be designed and constructed. Examples include sedimentation ponds and larger engineered check dams and diversion ditches/berms.

For this planning exercise, the mine site was divided into three water management areas:

- Area 1 - Mary River Catchment
- Area 2 - Sheardown Lake Catchment
- Area 3 - Camp Lake Catchment

Water management measures proposed within Area 1 - Mary River Catchment include:

- Operational improvements:
  - Improve MHR grader practices to eliminate deposition of excess gravel in berms/windrows that can be easily eroded and transported to the inside ditch

- Remedial measures:
    - Address sources of seepage daylighting on the MHR by directing the drainage causing the seepage to the MHR ditch or installing a culvert to convey the drainage beneath the MHR
    - Stabilize exposed and over-steepened slopes along the MHR
    - Once the above changes have been made on the MHR, determine if further mitigation is required within the explosive magazine area, ranging from do-nothing, stabilize exposed slopes, improvements to existing sediment control measures to the construction of a new sedimentation pond
- New water management structures:
    - Re-slope the MHR so drainage is to an upgraded inside ditch equipped with energy dissipation structures (rock check dams, gabions, etc.)
    - Construct one or more sedimentation ponds to collect runoff from the upgraded MHR ditch

Water management measures proposed within Area 2 - Sheardown Lake Catchment include:

- Operational improvements:
    - Dust minimization and suppression
- Remedial measures:
    - Regrade the mine infrastructure areas to direct runoff to water management measures
    - Divert runoff from the Crusher Facility around the existing Surface Water Management Pond to report to the future SDLT-1 Sedimentation Pond
- New water management structures:
    - Install rock berms along the downstream edges of disturbed areas, including snow stockpiles
    - Install rock check dams in non-fish habitat water courses
    - Construct a new sedimentation pond (SDLT-1 Sedimentation Pond)

Water management measures proposed for the Camp Lake Catchment (Area 3) include:

- Operational improvements:
    - Implement dust source control on the airstrip and apron
- Remedial measures:
    - Regrade the airstrip apron, roads and other disturbed areas
    - Stabilize regraded and other disturbed surfaces to minimize erosion
    - Replace or extend existing culverts under roads
    - Armour culvert inlets and outlets and road banks
- New water management structures:
    - Install rock berms along the downstream edges of disturbed areas, including snow stockpiles
    - Construct a sump in Quarry QMR2 to act as a small sedimentation pond
    - Increase the capacity of the existing rock check dams, constructing new sediment traps and raising the roadbed in the Water Jetty area
    - Construct a new sedimentation pond behind the Weatherhaven Camp (Weatherhaven Camp Sedimentation Pond)

Operational improvements and remedial measures can be implemented by Baffinland through 2021. New structures/facilities will be installed over a longer period as geotechnical site investigations are required to confirm the conditions for detailed design. Should challenging ground conditions (i.e., massive ice lenses or other geotechnical issues) be identified, some aspects of the WMP may need to be revisited. The proposed WMP would be implemented between the summer of 2021 and fall 2023.

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# Abbreviations

| | |
|---|---|
| Baffinland | Baffinland Iron Mines Corporation |
| BCMOE | British Columbia Ministry of Environment |
| CDA | Canadian Dam Association |
| CIRNAC | Crown-Indigenous Relations and Northern Affairs Canada |
| EDI | Environmental Dynamics Inc. |
| Golder | Golder Associates Ltd. |
| Hatch Ltd. | Hatch |
| IDF | Inflow Design Flood |
| IFC | Issued for Construction |
| KP | Knight Piésold Ltd. |
| MDMER | Metal and Diamond Mining Effluent Regulations |
| MHR | Mine Haul Road |
| MSC | Mine Site Complex |
| NIRB | Nunavut Impact Review Board |
| NWB | Nunavut Water Board |
| NWT | Northwest Territories |
| ROM | Run-of-Mine |
| RWDI | RWDI AIR Inc. |
| SDLT-1 | Sheardown Lake Tributary 1 |
| the Project | Mary River Project |
| TSS | Total Suspended Solids |
| WMP | Water Management Plan |
| WRF | Waste Rock Facility |

# 1.0 INTRODUCTION

Baffinland Iron Mines Corporation (Baffinland) owns and operates the Mary River Project (the Project), an open pit iron ore mine located on northern Baffin Island (Figure 1.1).

Baffinland retained Knight Piésold Ltd. (KP) to prepare this Water Management Plan (WMP) for the Mine Site. This WMP presents conceptual plans that will be validated or modified following completion of geotechnical site investigations and detailed engineering.

## 1.1 BACKGROUND

The management of water and the control of erosion and sediment are influenced by extreme regional temperatures, near surface soil types and permafrost ground conditions (Section 3.1).

Baffinland has experienced erosion and sedimentation issues along the Mine Haul Road (MHR) and within the Mine Site generally impacting Camp Lake, Sheardown Lake and their tributaries (Figure 1.2). Runoff from these areas has exceeded Type A Water Licence 2AM-MRY1325 discharge limits for total suspended solids (TSS) during the current Early Revenue Phase of the Project.

Baffinland continues to improve its understanding of operational factors and the unique site conditions that influence erosion and sedimentation events as well as the selection of appropriate sediment and erosion control measures through the ongoing construction and operation of the Project. There are several site factors that contribute to the erosion and sedimentation issues being experienced by Baffinland at the Mine Site as well as elsewhere on the Project:

- A short and pronounced freshet period, much of which occurs when the ground is frozen or partially frozen
- Ice-rich and thaw sensitive soils that are prone to erosion including mass wasting
- Steep topography at some locations such as the MHR
- Lack of an existing vegetative cover to stabilize undisturbed areas
- A cold climate and short growing season that prevents the use of revegetation for short-term stabilization of disturbed surfaces

This WMP will assist Baffinland in addressing the erosion and sedimentation issues in the near term, with several measures remaining in place for the long term. This includes addressing runoff interacting with the MHR, and runoff from the Mine Site area flowing to Camp and Sheardown Lakes.

## 1.2 STUDY AREAS

For this planning exercise, the mine site was divided into three water management areas:

- Area 1 - Mary River Catchment
- Area 2 - Sheardown Lake Catchment
- Area 3 - Camp Lake Catchment

These areas are shown on the mine site layout on Figure 1.2.

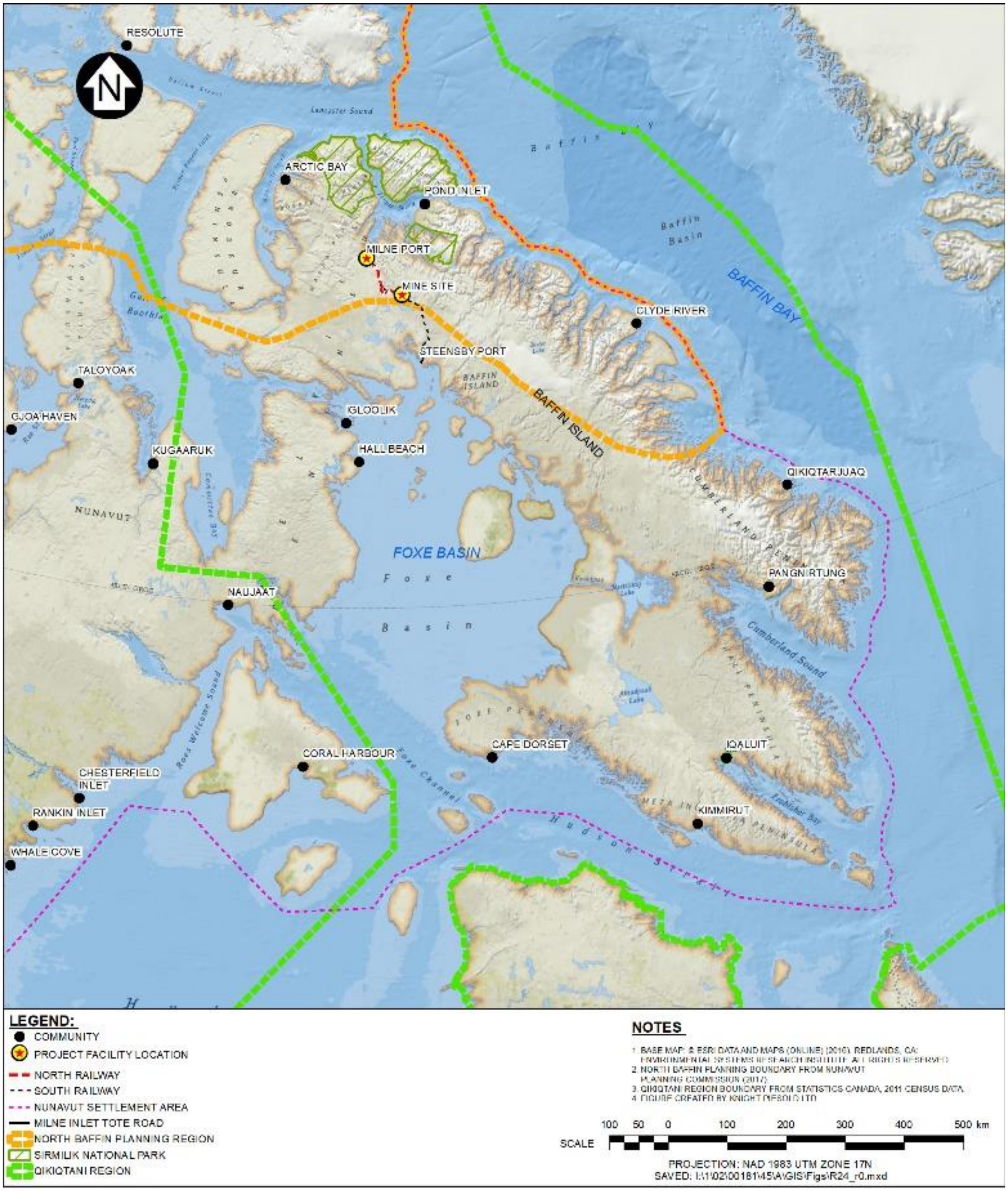
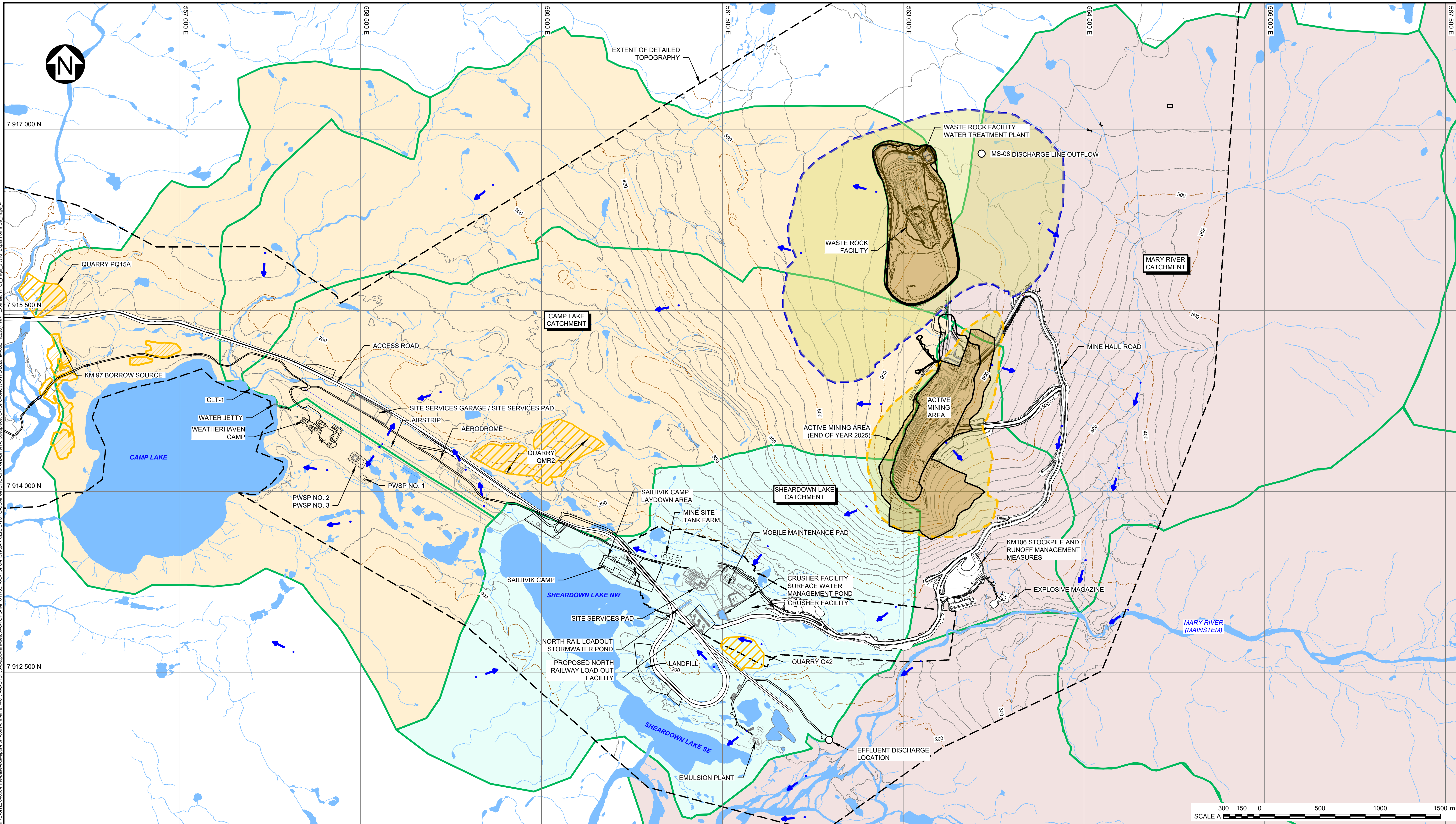



**Figure 1.1 Project Location Map**




**LEGEND:**

- EXISTING BORROW AREA
- WATER
- ULTIMATE DEPOSIT NO. 1 PIT LIMITS
- ULTIMATE WASTE ROCK STOCKPILE LIMITS
- CONTOUR
- CAMP LAKE CATCHMENT
- SHEARDOWN LAKE CATCHMENT
- MARY RIVER CATCHMENT
- DRAINAGE DIRECTION
- EFFLUENT DISCHARGE LOCATION

**NOTES:**

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. DETAILED WATER FROM EAGLE MAPPING (2019). CONTOUR PROVIDED BY BAFFINLAND (2005) INTERVAL IS 20 m.
3. CURRENT MINE AREA FROM THE WASTE DUMP TO THE CRUSHER PAD, AND DITCHES ALONG THE HAUL ROAD PROVIDED BY BIM (MARCH 12, 2018).
4. MINE HAUL ROAD AS-BUILT PROVIDED BY BAFFINLAND IRON MINES CORPORATION (MAY 2021).
5. 2021 WASTE ROCK FACILITY AND 2025 ACTIVE MINING AREA PROVIDED BY BAFFINLAND IRON MINES CORP. (OCT 9, 2020).
6. ALL OTHER SITE INFRASTRUCTURE PROVIDED BY HATCH (AUGUST 2, 2016). AND SIMPLIFIED BY KP STAFF (JAN, 2018).

| REV | DATE | DESCRIPTION | DESIGNED | DRAWN | REVIEWED |
|---|---|---|---|---|---|
| 1 | 24JUN'21 | ISSUED WITH REPORT | DMMD | AS | RAC |
| 0 | 09APR'21 | ISSUED WITH REPORT | DMMD | AS | KEH |

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

**MINE SITE LAYOUT WITH PHASE 2 INFRASTRUCTURE**

Knight Piésold CONSULTING

P/A NO. NB102-181/63 | REF NO. 1

**FIGURE 1.2** | REV 1

## 1.3 PAST NON-COMPLIANCE EVENTS

Fourteen (14) sediment releases into local waterbodies have been reported to the Nunavut/NWT Spill Line since 2016 as summarized in Table 1.1.

**Table 1.1 Reported Sediment Spills at the Mine Site (2016-2020)**

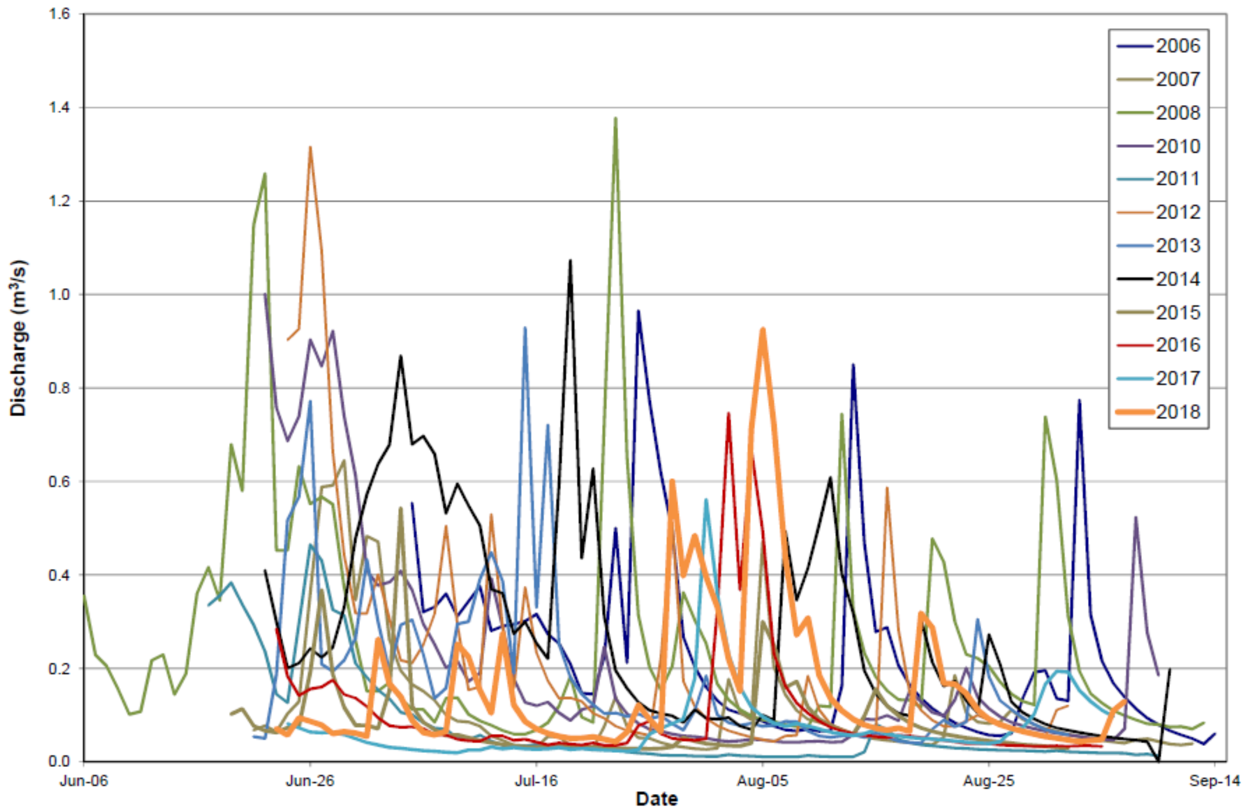
| Year | Date | Spill No. | Location |
|---|---|---|---|
| 2016 | May 7 | 15-158 | Sheardown Lake and tributary |
| | May 17 | 16-176 | Camp Lake and tributary |
| | May 20 | 16-181 | Sheardown Lake and tributary |
| | May 29 | 16-198 | Camp Lake and tributary |
| 2017 | May 11 | 17-161 | Sheardown Lake and tributary |
| | May 13 | 17-162 | Camp Lake and tributary |
| | July 12 | 17-253 | MHR to Mary River tributary |
| 2018 | May 16 | 18-180 | Camp Lake |
| | May 17 | 18-182 | Sheardown Lake<br>Camp Lake and tributaries |
| | June 8 | 18-214 | MHR (km 107-108) to Mary River tributary |
| 2019 | May 7 | 19-198 | Tributaries of both Camp Lake and Sheardown Lakes |
| | May 30 | 19-226 | Mine Haul Road to Mary River and Tributary F |
| 2020 | May 16 | 20-141 | Camp Lake tributaries and Sheardown Lake tributaries |
| | June 14 | 20-179 | MHR to Mary River and Tributary F<br>Mary River downstream project infrastructure |

**Note(s):**

1. Only sediment spills that occurred within the mine site are included.

Of the 14 sediment spills reported to date at the Mine Site (Table 1.1), 11 have occurred during the month of May when the snowpack is melting but lakes are ice-covered, larger streams are filled with ice, and the ground is frozen. Two of the 14 spills occurred in June when much of the land is generally snow-free but frozen, and one (1) spill occurred during open water conditions in July. For reference, freshet typically starts in mid-June and continues into mid-July (Figure 1.3), and hence most sediment spills have occurred during snowpack melt when the ground is frozen, and lakes are ice-covered.

A waters inspection conducted in September 2019 identified (among other issues) that erosion was not being adequately prevented at the culvert outlets on the downhill side of the MHR, in contravention of Part D, Item 5 of the Type A Water Licence (CIRNAC, 2019). The inspection report directed Baffinland to develop a plan to stop this erosion from occurring. The plan was to be submitted to the Nunavut Water Board (NWB) for review to ensure its adequacy prior to December 15, 2019. Baffinland submitted a report as requested on December 16, 2019 (Baffinland, 2019a) which included an outline of proposed water management improvements to the MHR in 2020 (Baffinland, 2019b). The latter document committed to the development of a long-term water management plan for the Mine Site. This WMP is the first step in completing the long-term plan.




**Note(s):**

1. Source: environmental applications group, 2019.

**Figure 1.3 Measured Streamflow Hydrograph for Station H05 Camp Lake Tributary 1 Hydrograph, 2006-2018**

## 1.4 PLAN LIMITS AND OBJECTIVES

The battery limits for the WMP include:

- The Mine Site component of the Project
- The next five years of mining (2021 to 2025)
- That the Phase 2 Proposal, currently in the environmental review process, may be constructed and operational within this timeframe

The Active Mining Area and Waste Rock Facility (WRF), along with their associated water management features are excluded from the WMP.

Undisturbed areas around mine infrastructure that report runoff to disturbed areas (e.g., tundra areas upslope of the MHR) are included in the WMP. Undisturbed areas that experience windblown dust deposition that do not report runoff to disturbed areas are not included in this WMP.

Figure 1.2 shows the Mine Site area including the five-year open pit and WRF along with Phase 2 Proposal infrastructure. While Phase 2 infrastructure is accounted for in this plan, the facilities proposed are not contingent on the Phase 2 Proposal proceeding.

The primary objective of this WMP is to identify measures that will assist Baffinland in achieving compliance for the discharge of sediment-laden water into local watercourses. This WMP aims to:

- Identify key issues and concerns related to the management of surface water at the Mine Site
- Identify the applicable design criteria to be applied to future water management infrastructure, if different from the current civil design criteria (Hatch, 2018a)
- Identify the conceptual water management infrastructure required over the selected planning horizon, accounting for new infrastructure that could be constructed as part of the Phase 2 Proposal (pending approval)
- Be consistent with the requirements of the Type A Water Licence (NWB, 2015), Metal and Diamond Mining Effluent Regulations (MDMER; Minister of Justice, 2020) and Project Certificate (Nunavut Impact Review Board (NIRB), 2020)

## 1.5 SCOPE OF WORK

KP's scope of work for this assignment included the following tasks:

- **Desktop Review -** A desktop review of the relevant documentation describing historical surface water runoff issues (related to surface water quantity and/or quality) and any mitigation measures which were implemented, including applicable point source mitigation measures. Documentation reviewed included spill reports, regulator communications, regular monitoring reports, design reports, as-built reports, etc.
- **Site Visit -** KP's senior engineer Deena Duff, P.Eng. conducted a site visit over the period of September 3-11, 2020, to refamiliarize KP staff with the current mine site arrangement, observe surface water runoff flows in the mine site catchments, visit locations prone to erosion and potential sources of sediment laden runoff, and visit any currently operating erosion and sedimentation mitigation measures. Interviews with key Baffinland personnel were conducted as part of the site visit to help gain a better understanding of the current surface water management practices and erosion and sediment issues that have occurred.
- **Water Management Options Development and Selection -** Potential water management options were identified and developed to a conceptual level. In some instances, options were evaluated, and a preferred option was selected. KP hosted a workshop with key Baffinland staff from the appropriate departments to review the identified options and obtain operational input.
- **Water Management Plan -** This WMP was produced and presents the design criteria to be applied to water management infrastructure, a summary of the proposed water management strategies, and conceptual arrangements of each of the water management options identified in the selection process.

# 2.0 DESIGN BASIS

This section provides an overview of the relevant design guidelines and regulations for various water management infrastructure components, including:

- Sedimentation ponds, including water removal systems
- Conveyance/diversion ditches/berms

Water management infrastructure will be sized in consideration of the following:

- **General -** An appropriate meteorological design event (i.e., snowmelt, rainfall, etc.) (discussed below).
- **Sedimentation Ponds -** The holding (retention) time required to achieve the necessary settling of solids and the management of an appropriate meteorological design event, i.e., snowmelt, rainfall, etc. (discussed below).
- **Conveyance/Diversion Ditches/Berms, Sedimentation Pond Spillways, and Rock Check Dams -** The configuration and lining requirements (if applicable) of each will be determined based on peak runoff flows and peak flow depths reporting to each.

More specifically, sedimentation ponds will be sized in consideration of the following.

**Holding Time**

The sedimentation ponds will not be designed as flow-through ponds, which is the conventional configuration of sedimentation ponds at mine sites. Rather, because of the operational challenges associated with operating ponds in a very cold environment where there is the potential for blockage of decants and short-circuiting of flows due to ice formation, the ponds will be designed as temporary holding ponds. Therefore, mechanical means such as pumping or siphoning will be required to discharge water after some sediment settling occurs.

The holding (retention) time will be the time required to achieve the necessary settling of solids to meet the TSS discharge limits of the Type A Water Licence (NWB, 2015) and Metal and Diamond Mines Effluent Regulations (MDMER; Minister of Justice, 2020) (maximum average concentration of 15 mg/L and maximum grab sample concentration of 30 mg/L).

The settling characteristics of TSS generated from erosion of ground surfaces will be different than that of TSS generated from ore dust that has accumulated in the snowpack. Sampling programs are proposed for the spring and summer of 2021 to collect the requisite information.

Following the British Columbia Ministry of Environment guidance document (BCMOE, 2015), and assuming settlement of fine silt sized particles at 0°C, the estimated settling time (i.e., holding time) required in the pond is upwards of 72 hours. Soil testing is currently being conducted to determine sediment particle size distribution and actual settling time. Until the results are available and the actual settling requirements can be confirmed, it is currently recommended that careful removal of water from the pond start no sooner than 72 hours following the start of the snowmelt and rainfall event.

The use of flocculants may be required to assist with the settling of solids and thereby reduce the required holding time. Geotubes may also be beneficial to supplement the settling capacity of the ponds.

### Meteorological Design Event

The ponds will be designed to manage an appropriate meteorological design event (i.e., snowmelt and rainfall). Two analyses were previously completed to generate return period runoff values for the Project, one based on measured flow records for a creek near the Mine Site (Golder, 2018) and the other based on regional rainfall, snow depth, and snow water equivalent measurements (Hatch, 2018b). KP reviewed both analyses and recommends that the return period runoff values developed by Golder be used as the basis for sizing ponds in the Mary River Mine Site area, as summarized in Table 2.1. The runoff estimates are deemed to be appropriate for sizing the ponds without being increased by the 1.2 factor recommended by Golder. An assessment of the measured/synthesized data values used by Golder indicates that estimated runoff values used to supplement the measured data result in highly skewed runoff frequency distributions that produce relatively high runoff estimates, particularly for longer return periods such as 100 years. As such, the computed values are appropriately conservative for design purposes and do not require an uplift.

**Table 2.1 Estimated Runoff (mm) by Return Period and Event Duration**

| Return Period (Years) | Flood Event Duration (days) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 15 | 20 | 30 | 45 | 60 | 75 | 90 | 105 |
| 2 | 21 | 38 | 52 | 66 | 79 | 92 | 105 | 117 | 129 | 140 | 186 | 217 | 264 | 309 | 327 | 348 | 359 | 362 |
| 5 | 26 | 47 | 63 | 82 | 98 | 114 | 129 | 143 | 157 | 169 | 229 | 265 | 326 | 369 | 397 | 425 | 438 | 440 |
| 10 | 32 | 57 | 74 | 96 | 114 | 131 | 146 | 161 | 175 | 188 | 258 | 298 | 358 | 398 | 430 | 463 | 476 | 478 |
| 25 | 41 | 73 | 94 | 119 | 140 | 157 | 171 | 185 | 199 | 211 | 294 | 342 | 392 | 425 | 464 | 501 | 514 | 515 |
| 50 | 50 | 90 | 116 | 141 | 163 | 180 | 192 | 204 | 216 | 228 | 321 | 376 | 414 | 442 | 484 | 524 | 538 | 538 |
| 100 | 61 | 113 | 146 | 168 | 190 | 206 | 215 | 223 | 234 | 244 | 349 | 410 | 433 | 457 | 502 | 544 | 558 | 558 |

**Note(s):**

1. Source: Golder, 2018.

With respect to the appropriate design runoff event, KP recommends that the ponds are sized to retain the runoff volume resulting from the 1 in 50-year, 3-day snowmelt plus rainfall event (116 mm total equivalent precipitation depth). The 3-day duration is based on the expected settling time after which pumping can begin.

The recommended design event for the conveyance/diversion ditches/berms is the 1 in 25-year, 24-hour rainfall event, while the design event for the sedimentation pond emergency spillways will depend on Canadian Dam Association (CDA) requirements (2013) and will be equal to at least the 1 in 200-year, 24-hour rainfall event. Details are provided in Appendix A.

### Pond Operation

Sedimentation ponds will be maintained empty to the greatest extent possible: water will be drawn down to the dead storage level once water quality discharge limits have been achieved. Thus, adequate pumping capacity will be required, and pumping should begin once the collected runoff is suitable for discharge. This is important both to re-establish the capacity of the ponds to store the design runoff event, and to minimize the transfer of heat from water contained in the pond into the frozen foundations.

# 3.0 KEY WATER MANAGEMENT STRATEGIES

## 3.1 REGIONAL LANDSCAPE, CLIMATE AND HYDROLOGY

The regional landscape, climate and hydrology have influenced project design and appropriate mitigation measures.

The Project lies within the zone of continuous permafrost, with an active layer thickness of up to 2 m and a permafrost depth that may be as much as 610 m deep, based on extrapolation from temperature gradients measured in a 400 m deep thermistor-instrumented drillhole located on site (Baffinland, 2012; Volume 3). The presence of permafrost greatly increases ground stability at depth but at surface it can affect the rates of soil erosion through the formation of ice wedges and patterned ground, pingos and palsas, massive ground ice, thermokarst, and mass wasting (i.e., solifluction).

Regional data near the Project indicates a mean annual temperature of approximately -15°C. The frigid temperatures result in low precipitation values for northern Baffin Island due to the combined effect of the low moisture carrying capacity of cold air and the scarcity of liquid water throughout much of the year. According to Natural Resources Canada, the mean annual total precipitation ranges from 200 to 400 mm in the Project area, classifying it as semi-arid (Baffinland, 2012; Appendix 5A).

The extreme temperatures of the region, combined with permafrost ground conditions, result in a short period of runoff that typically occurs from June to September, extending into October in watersheds with significant lake surface areas. All rivers and creeks, with perhaps the exception of the very largest systems are frozen solid to the bottom during the winter months. The peak runoff period is quite short, and the volume of the annual hydrograph is low, relative to the rest of Canada, due to the region's very low average annual precipitation (RWDI AIR Inc., 2010; KP, 2012; KP, 2016). However, the proportion of annual precipitation that is realized as runoff is very high, due to low temperatures (low evaporation) and the permafrost ground conditions (low infiltration) and minimal vegetative cover (limited uptake by plants). Groundwater infiltration, storage and flow in the region is limited due to the permafrost and is generally restricted to occur in the upper one to two metres (i.e., the summer active layer).

Peak instantaneous flows are significant due to frozen ground conditions and the lack of vegetation. This in turn produces very rapid basin runoff response. In larger watersheds, peak instantaneous flows are typically produced by snowmelt during freshet, but in smaller watersheds (less than a few hundred square kilometres) rainfall, or rain on snow may produce the largest peak flows and may occur at any time during the non-freeze period. Flood water levels in the smaller watersheds typically rise and fall very quickly with runoff response (KP, 2012). The largest annual runoff events typically occur during the freshet period in July, though occasionally these occur due to intense rainfall in August or September (KP, 2016).

## 3.2 WATER MANAGEMENT STRATEGIES

A greater level of understanding of the unique site conditions that influence the selection of appropriate sediment and erosion control measures has been achieved through the ongoing construction and operation of the Project. Due to the impeded vegetation growth rate, sediment and erosion control techniques that involve vegetative covers (i.e., hydroseeding and the use of erosion control blankets) have been dismissed as potential mitigation options. Furthermore, straw bales will not be brought to site due to the possibility of introducing foreign species.

Strategies incorporated into this WMP include:

- Maximizing the diversion of non-contact runoff that must be handled by water management measures
- Minimizing conveyance of sediment laden water to surrounding waterbodies
- Planning for and designing water management infrastructure accounting for future mining operations as well as closure
- Minimizing pumping

## 3.3 CATEGORIES OF WATER MANAGEMENT MEASURES

Three categories of water management measures were identified in this study:

- **Operational Improvements -** Minor improvements to operational practices that reduce the potential for erosion and sedimentation. Examples of operational improvements identified during this study include modifying grader practices and reducing dust emissions at the source.
- **Remedial Measures -** Repairs, improvements or other modifications to existing infrastructure. Examples include placing riprap in ditches, stabilizing select cut slopes with riprap, and regrading the crusher pad.
- **New Water Management Structures -** Additional water management measures that need to be designed and constructed. Examples include sedimentation ponds and larger engineered check dams and diversion ditches/berms.

To address the issues identified during the desktop review and site visit, proposed measures/actions were developed for each area. These proposed measures/actions are described in Sections 4, 5 and 6.

## 3.4 WATER MANAGEMENT MEASURES

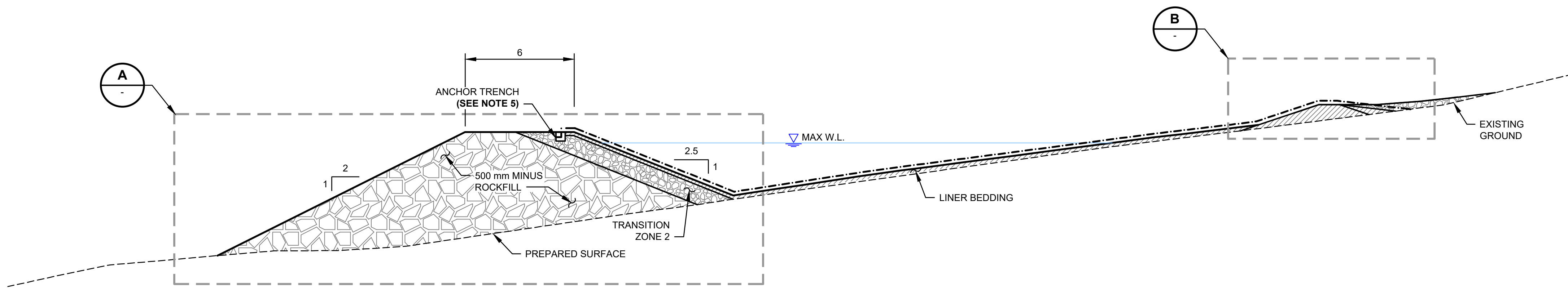
The following sections provide some additional typical details regarding several of the proposed water management measures. Typical sections and details for each are provided on Figures 3.1 and 3.2, and in Appendix A.

### 3.4.1 SEDIMENTATION PONDS

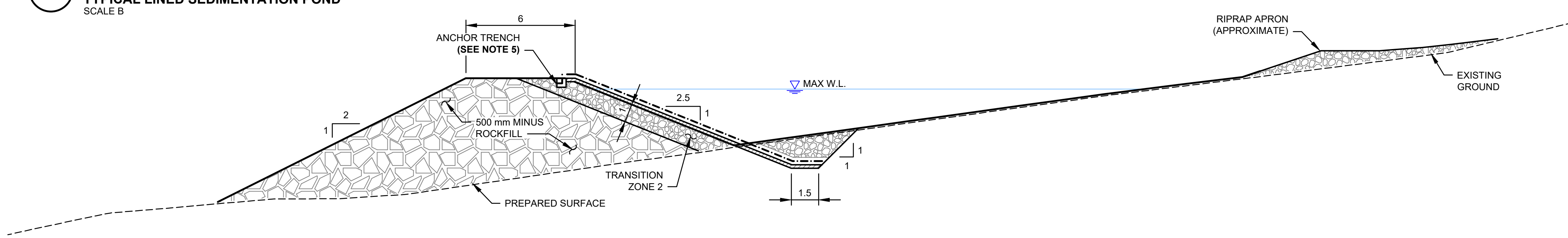
Runoff will report to sedimentation ponds directly from adjacent catchment areas or will be routed to the ponds from catchment areas further upstream by ditches/berms. Sedimentation ponds will be formed by constructing rockfill embankments across low points in the topography to form a basin for the runoff to collect in. Any surface vegetation present within the embankment footprint will be removed prior to fill placement. Excavation of the existing ground will be minimized so as not to disturb the underlying permafrost.

Sedimentation ponds may be completely lined or may have liner on the upstream embankment slopes. If required, the pond liner will likely consist of a linear low density textured geomembrane or approved equivalent.

Each pond will be equipped with a pump and pipeline system to drain the pond and release the water to the environment, provided it meets water quality objectives, or divert the water for treatment. Each pond will also be equipped with an emergency spillway to be constructed in the pond embankment or in the existing ground at the embankment abutment.




1 SECTION
TYPICAL LINED SEDIMENTATION POND
SCALE B




2 SECTION
TYPICAL UNLINED SEDIMENTATION POND
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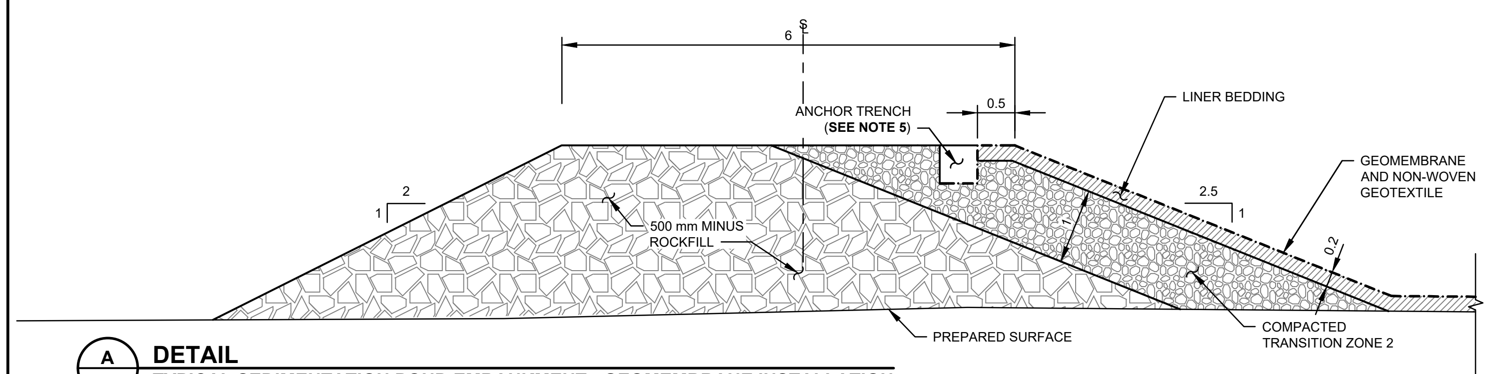
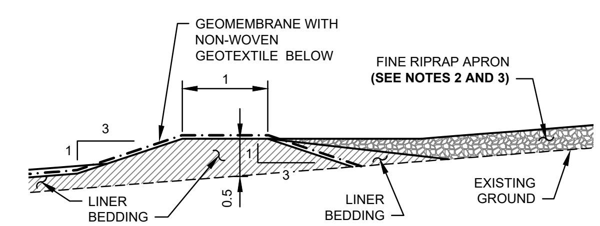
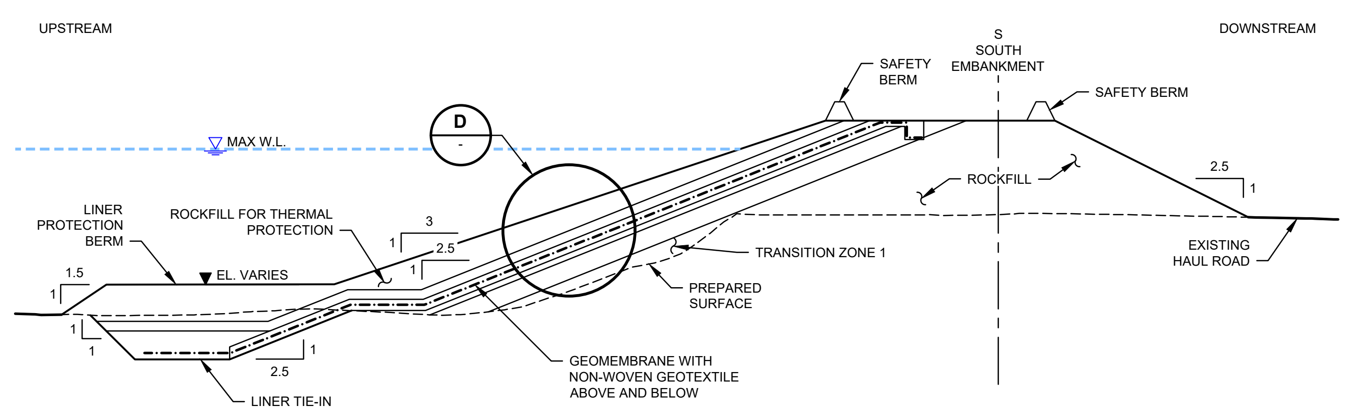


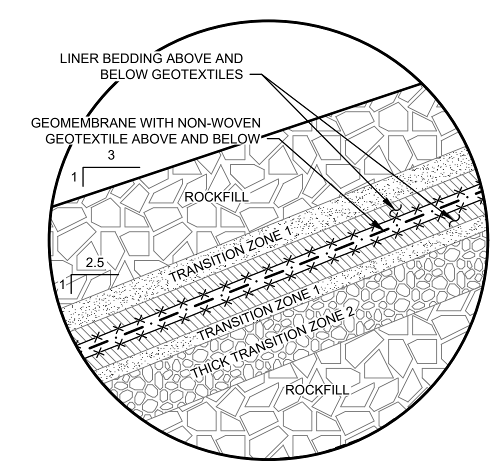

A DETAIL
TYPICAL SEDIMENTATION POND EMBANKMENT - GEOMEMBRANE INSTALLATION
SCALE B




B DETAIL
GEOMEMBRANE ANCHORING DETAIL AT POND INLET
SCALE C




3 SECTION
TYPICAL SEDIMENTATION POND EMBANKMENT - TYPICAL DESIGN SECTION
SCALE C



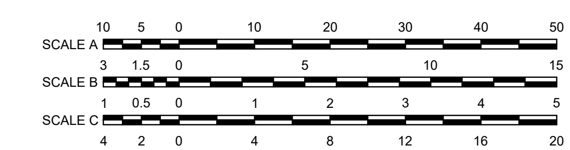

D DETAIL
TYPICAL LINED EMBANKMENT SLOPE
NTS

## LEGEND:

- 500 mm MINUS ROCKFILL
- COARSE RIPRAP
- FINE RIPRAP
- TRANSITION ZONE 2
- LINER BEDDING
- GEOMEMBRANE WITH NON-WOVEN GEOTEXTILE BELOW
- NON-WOVEN GEOTEXTILE
- EXISTING GROUND
- PREPARED SURFACE
- SEDIMENTATION POND / SPILLWAY CHANNEL PROJECTED TO SECTION
- ESTIMATED POND EXTENTS

## NOTES:

1. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. RIPRAP TO BE CLEAN, DURABLE AND ANGULAR. RIPRAP TO BE TIGHTLY PLACED.
3. LIMITS OF RIPRAP APRON TO DEPEND ON ACTUAL SITE CONDITIONS.
4. COLLECTION/DIVERSION BERMS TO BE GRADED AT 1% (MINIMUM) IN DIRECTION OF FLOW.
5. ANCHOR TRENCH TO BE EXCAVATED TO THE APPROXIMATE LIMITS SHOWN (0.5 m x 0.5 m IN SECTION) UNLESS NOTED OTHERWISE. FOLLOWING GEOSYNTHETICS INSTALLATION, TRENCH TO BE BACKFILLED WITH COMPACTED INTERMEDIATE BEDDING MATERIAL.
6. DITCHES TO BE LINED WITH RIPRAP OVERLYING NON-WOVEN GEOTEXTILE ONLY IF REQUIRED FOR EROSION PROTECTION AGAINST HIGHER VELOCITIES.
7. MATERIAL EXCAVATED FROM DITCHES MAY BE PLACED ADJACENT TO THE DITCH TO PREVENT RUNOFF FROM OTHER AREAS FLOWING INTO THE DITCH.
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. 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.
10. LOCATIONS AND DETAILS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT ACTUAL SITE CONDITIONS.
11. NON-WOVEN GEOTEXTILE TO BE LP7 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.
12. GEOMEMBRANE TO BE LINEAR LOW DENSITY TEXTURED GEOMEMBRANE OR APPROVED EQUIVALENT. TO BE INSTALLED AS PER MANUFACTURER'S SPECIFICATIONS. A PROTECTIVE COVER LAYER MAY NEED TO BE PROVIDED. DETAILS TO BE CONFIRMED.




BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

**PROPOSED WATER MANAGEMENT MEASURES TYPICAL SECTIONS AND DETAILS SHEET 1 OF 2**

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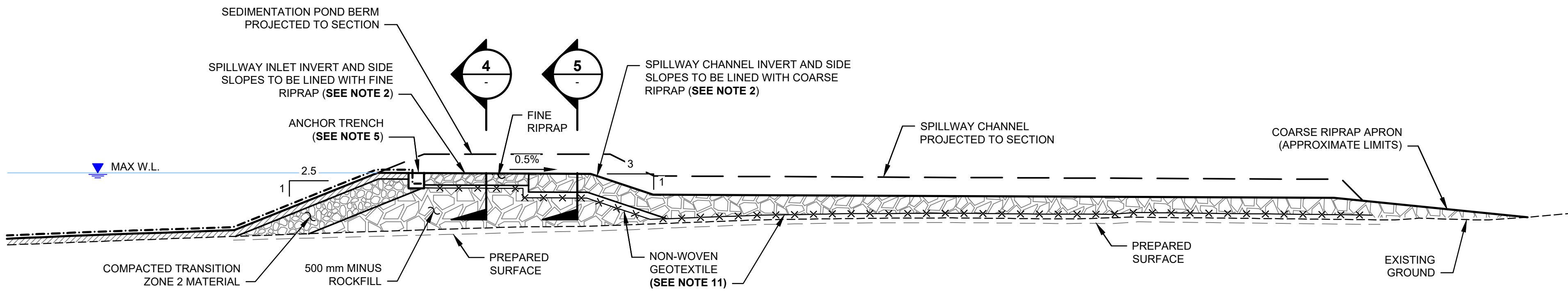
| NB102-181/63 | 1 |

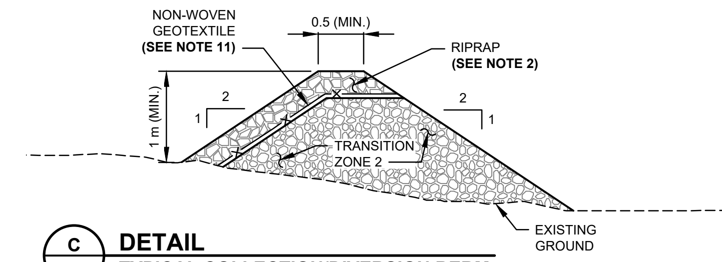
**FIGURE 3.1** REV 1

| REV | DATE | DESCRIPTION | DESIGNED | DRAWN | REVIEWED |
|---|---|---|---|---|---|
| 1 | 24JUN'21 | ISSUED WITH REPORT | DMMD | AS | KEH |
| 0 | 09APR'21 | ISSUED WITH REPORT | DMMD | AS | KEH |

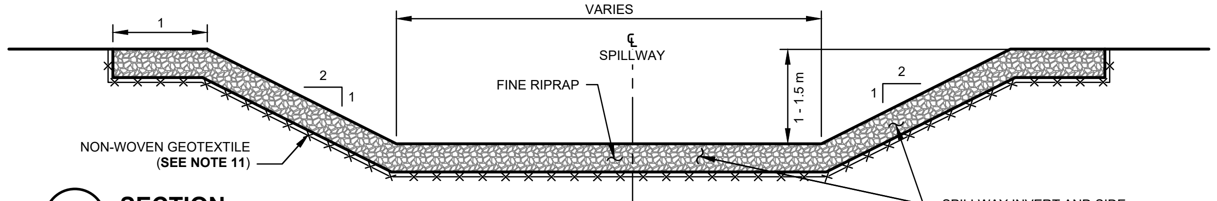
SAVED: I:\102\00181\63\A\Acad\FIGS\B15 R1, 6/25/2021 10:44:56 AM , SRICHARD PRINTED: 6/25/2021 10:46:41 AM, FIG 3.1, SRICHARD ACAD VERSION: 24.0S (LMS TECH)
XREF FILE(S): X-C-TOPO-MINE SITE; X-C-TOPO-INFRA-DES; X-C-TOPO-INFRA-OTHRS IMAGE FILE(S):



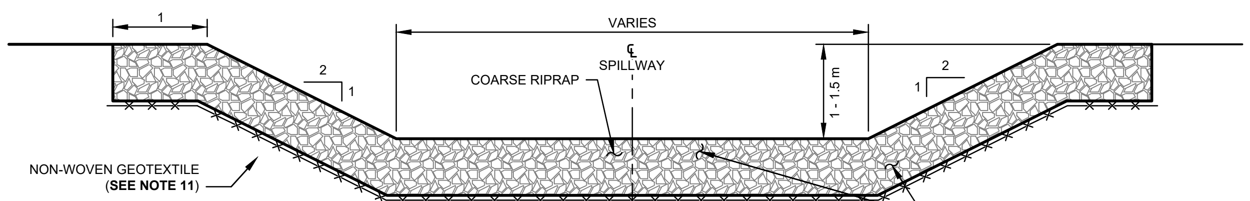

## 3 SECTION
**SEDIMENTATION POND - TYPICAL EMERGENCY SPILLWAY**
SCALE A



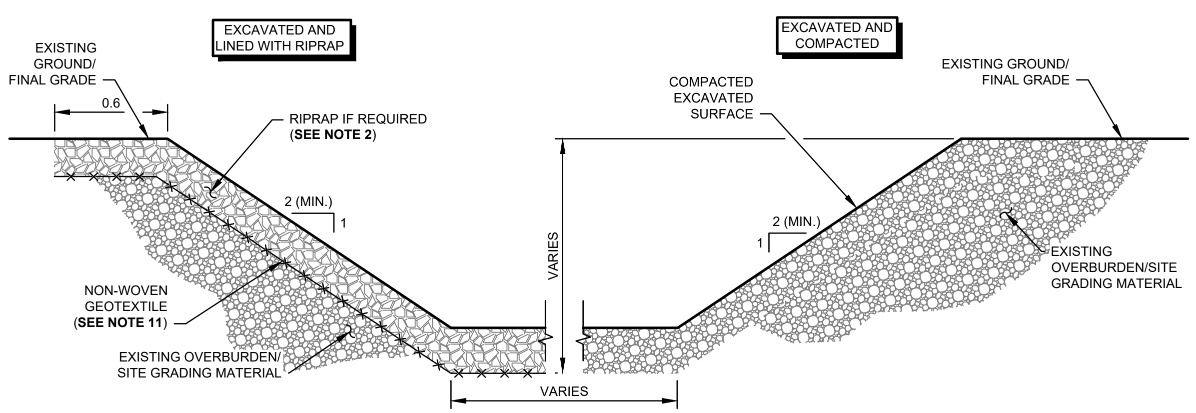

## C DETAIL
**TYPICAL COLLECTION/DIVERSION BERM**
NTS



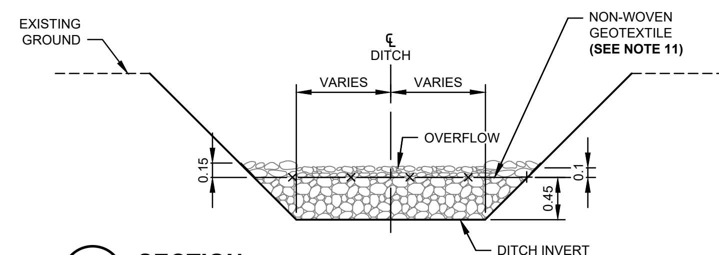

## 4 SECTION
**TYPICAL EMERGENCY SPILLWAY INLET**
SCALE C



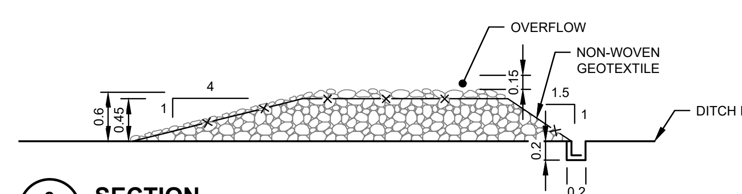

## 5 SECTION
**TYPICAL EMERGENCY SPILLWAY CHANNEL**
SCALE C



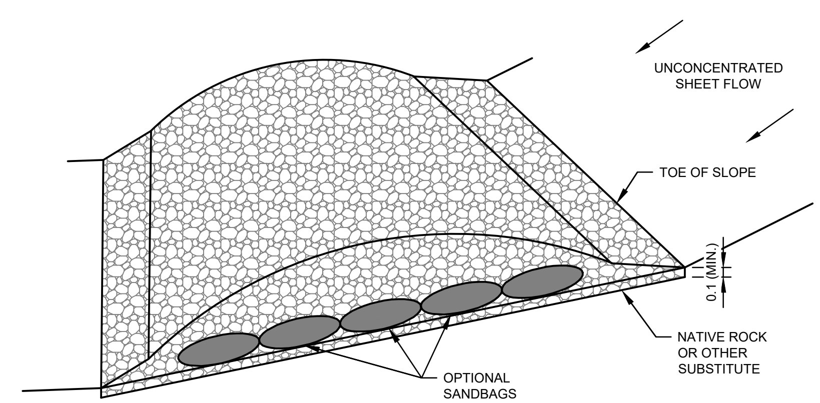

## 6 SECTION
**TYPICAL TRAPEZOIDAL DITCH (WITH AND WITHOUT EROSION PROTECTION)**
NTS




## 7 SECTION
**ROCK CHECK DAM - TYPICAL SECTION**
SCALE D




## 8 SECTION
**ROCK CHECK DAM - TYPICAL PROFILE**
SCALE D




## D DETAIL
**ROCK DAM - TYPICAL DETAIL**
SCALE D

**LEGEND:**

- 500 mm MINUS ROCKFILL
- COARSE RIPRAP
- FINE RIPRAP
- TRANSITION ZONE 2
- LINER BEDDING
- GEOMEMBRANE WITH NON-WOVEN GEOTEXTILE BELOW
- NON-WOVEN GEOTEXTILE
- EXISTING GROUND
- PREPARED SURFACE
- SEDIMENTATION POND / SPILLWAY CHANNEL PROJECTED TO SECTION

**NOTES:**

1. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
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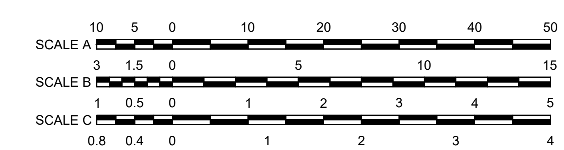
3. LIMITS OF RIPRAP APRON TO DEPEND ON ACTUAL SITE CONDITIONS.
4. CONVEYANCE/DIVERSION BERMS TO BE GRADED AT 1% (MINIMUM) IN DIRECTION OF FLOW.
5. ANCHOR TRENCH TO BE EXCAVATED TO THE APPROXIMATE LIMITS SHOWN (0.5 m x 0.5 m IN SECTION) UNLESS NOTED OTHERWISE. FOLLOWING GEOSYNTHETICS INSTALLATION, TRENCH TO BE BACKFILLED WITH COMPACTED INTERMEDIATE BEDDING MATERIAL.
6. CONVEYANCE/DIVERSION DITCHES TO BE GRADED AT 1% (MINIMUM) IN DIRECTION OF FLOW. SIDE SLOPES TO BE 2H:1V OR FLATTER, BASED ON ACTUAL SITE CONDITIONS. DITCHES TO BE LINED WITH RIPRAP OVERLYING NON-WOVEN GEOTEXTILE ONLY IF REQUIRED FOR EROSION PROTECTION AGAINST HIGHER VELOCITIES.
7. MATERIAL EXCAVATED FROM DITCHES MAY BE PLACED ADJACENT TO THE DITCH TO PREVENT RUNOFF FROM OTHER AREAS FLOWING INTO THE DITCH.
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. 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.
10. LOCATIONS AND DETAILS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT ACTUAL SITE CONDITIONS.
11. NON-WOVEN GEOTEXTILE TO BE LP7 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.
12. GEOMEMBRANE TO BE LINEAR LOW DENSITY TEXTURED GEOMEMBRANE OR APPROVED EQUIVALENT. TO BE INSTALLED AS PER MANUFACTURER'S SPECIFICATIONS.




BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

**PROPOSED WATER MANAGEMENT MEASURES**
**TYPICAL SECTIONS AND DETAILS**
**SHEET 2 OF 2**

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| P/A NO. | REF NO. |
|---|---|
| NB102-181/63 | 1 |

**FIGURE 3.2** REV 1

| REV | DATE | DESCRIPTION | DESIGNED | DRAWN | REVIEWED |
|---|---|---|---|---|---|
| 1 | 24JUN'21 | ISSUED WITH REPORT | DMMD | AS | KEH |
| 0 | 09APR'21 | ISSUED WITH REPORT | DMMD | AS | KEH |

SAVED: I:\1\02\00181\63\A\Acad\FIGS\B15 R1, 6/25/2021 9:03:28 AM , SRICHARD PRINTED: 6/25/2021 9:05:55 AM, FIG 3.2, SRICHARD ACAD VERSION: 24.0S (LMS TECH)

### 3.4.2 CONVEYANCE/DIVERSION DITCHES AND BERMS

Conveyance ditches/berms will be used to route runoff to the sedimentation ponds, while diversion ditches/berms will be used to divert runoff from undisturbed areas around mine infrastructure areas and to the environment as that runoff does not need to report to the sedimentation ponds.

Conveyance/diversion berms will be constructed by placing and compacting rockfill directly on the existing ground, or on the ground once surface vegetation has been removed, with minimal disturbance to the existing ground surface. Conveyance/diversion ditches will be excavated into the existing ground and lined with riprap overlying non-woven geotextile as required.

### 3.4.3 SEDIMENT TRAPS

The impoundment of sediment laden flow in sediment traps permits the settling of suspended sediment particles. This technique is normally applied to concentrated flow within the permanent or temporary drainage system of a site.

Traps may be formed through excavation, above ground embankments, or a combination of the two, and are commonly constructed of earth and/or stone. Ideally, the sediment trap should be located near the sediment source. Only the area exposed to erosion should drain into the trap. Roadside ditches and old drainage channels could also be used as sediment entrapment areas.

### 3.4.4 ROCK CHECK DAMS

Rock check dams will be installed in ditches or non-fish habitat watercourses to reduce runoff flow velocities and to help settle out some of the TSS in the runoff.

The rock check dams will be flow-through structures, constructed out of clean rock, placed in an interlocking manner to form a low height berm across the ditch/watercourse. The top of the rock check dam will be lower than the top of the ditch side slope/watercourse bank and will include an overflow point. Non-woven geotextile will be installed just below the top of the rockfill to trap sediment. Rock check dams may also be constructed using rockfilled gabion baskets.

### 3.4.5 ROCK BERMS

Rock berms will be placed along the downstream sides of disturbed areas where runoff can not easily be conveyed to a sedimentation pond. The berms will trap sediment by slowing down or temporarily ponding the runoff from these areas, or by filtering the sediment as the runoff passes through permeable berms. These berms will be constructed of rockfill placed in an interlocking manner, with an optional layer of sandbags placed at the core to further help to trap sediment. They may be used in combination with a silt fence to minimize under-draining of the fence and increase sheet flow runoff filtering.

### 3.4.6 SACRIFICIAL GRAVEL COVERS

Sacrificial gravel covers will be placed on ground surfaces where the surface material is fine-grained and highly erodible but there is not sufficient room for rock berms or other water management measures. Sacrificial gravel covers can also be used in areas that experience high rates of dust deposition, to retain the fine-grained materials. The ground surface will be gently graded to minimize pooling of water and to promote drainage to a nearby water course/water body. The sacrificial gravel cover would then be placed above the erodible ground surface to minimize wind and water erosion of the finer material below.

# 4.0 AREA 1 - MARY RIVER

## 4.1 APPLICABLE COMPONENTS

Area 1 consists of the following key components (Figure 4.1):

- Active Mining Area (hillside cut)
- Waste Rock Facility (WRF)
- Mine Haul Road (MHR)
- Explosive Magazine Area
- Run-of-Mine (ROM) stockpile at KM106 and sedimentation pond

Each of these components are described below. As noted in Section 1.4, the Active Mining Area and the WRF are excluded from this Plan.

### 4.1.1 MINE HAUL ROAD

The MHR is situated within catchments that report to Sheardown Lake, the Mary River mainstem, and Mary River Tributary F. The road was constructed in 2013/14 according to a design provided by Hatch (2013). Drainage upgrades were implemented in 2016 (Golder, 2016a, b and c), and further upgrades of the road were completed in 2019. Additional upgrades were completed to expand the road base to accommodate larger CAT 793 mine trucks, construct a switchback road, and to incorporate additional erosion and sediment control measures (McElhanney Consulting Services Ltd., 2019). The erosion protection features associated with the MHR include safety berms, culverts with armoured outlets to reduce erosion, and rock check dams. Further upgrades including additional spur roads are planned in coming years.

### 4.1.2 KM106 STOCKPILE

The KM106 stockpile was designed by KP (2019) and constructed in 2020 with construction supervised and documented by Baffinland. The stockpile is equipped with a sedimentation pond designed in accordance with the civil design criteria (Hatch, 2018a) and sized to capture runoff from the stockpile only.

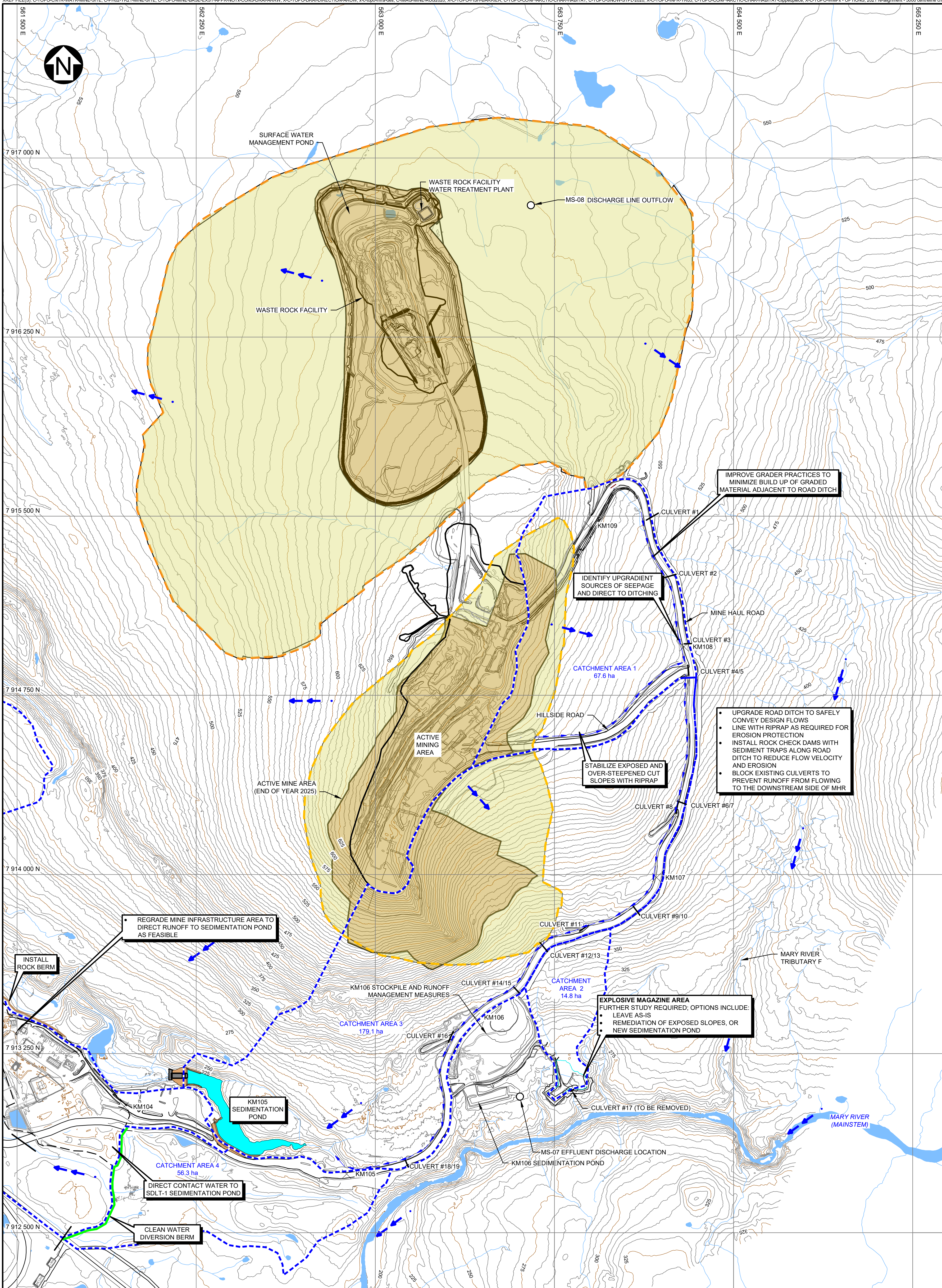
### 4.1.3 CHANGES RESULTING FROM THE PHASE 2 PROPOSAL

The Phase 2 Proposal will increase the production rate and therefore accelerate development of the Active Mining Area and the WRF. The Phase 2 Proposal does not change how Deposit No. 1 is mined, result in modifications to any of the infrastructure components described above or require additional infrastructure.

## 4.2 KEY ISSUES

The Project development areas within the Mary River Catchment are located at high elevation and/or in areas of steep topography. This is particularly the case for the MHR, which has cut slopes and steep terrain.

A sediment spill was reported once in each of the last four years (Table 1.1). Of these spills, one occurred in May, two in June and one in July. While snowmelt is delayed at this higher elevation, the timing of spills (mostly in June or July when the ground has partially thawed) suggests dust in the melting snowpack is likely not a major contributor of sediment, and instead erosion along the MHR, and truck tire and road maintenance generated dust and sediment on the road are likely the primary contributors for this area.




**LEGEND:**

- CURRENT
- ULTIMATE
- WATER
- ESTIMATED MAXIMUM POND (EXTREME PRECIPITATION CONDITIONS)
- SEDIMENTATION POND EMBANKMENT (APPROXIMATE)
- EFFLUENT DISCHARGE LOCATION
- ULTIMATE DEPOSIT NO. 1 PIT LIMITS
- ULTIMATE WASTE ROCK STOCKPILE LIMITS
- CULVERT (APPROXIMATE)
- DRAINAGE DIRECTION
- WATER MANAGEMENT PLAN CATCHMENT (APPROXIMATE)

**NOTES:**

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. DETAILED WATER FROM EAGLE MAPPING (2005). CONTOUR PROVIDED BY BAFFINLAND (2019) INTERVAL IS 5 m.
3. CURRENT MINE AREA FROM THE WASTE DUMP TO THE CRUSHER PAD, AND DITCHES ALONG THE HAUL ROAD PROVIDED BY BIM (MARCH 12, 2018).
4. MINE HAUL ROAD AS-BUILT PROVIDED BY BAFFINLAND IRON MINES CORPORATION (MAY 2021).
5. ALL OTHER SITE INFRASTRUCTURE PROVIDED BY HATCH (AUGUST 2, 2016) AND SIMPLIFIED BY KP STAFF (JANUARY 2018).
6. LOCATIONS AND DETAILS OF PROPOSED WATER MANAGEMENT MEASURES TO BE CONFIRMED BASED ON ACTUAL SITE CONDITIONS.

SCALE A: 150 75 0 250 500 750 m

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

**MARY RIVER CATCHMENT
PROPOSED WATER MANAGEMENT MEASURES**

Knight Piésold CONSULTING

| P/A NO. | REF NO. |
|---|---|
| NB102-181/63 | 1 |
| FIGURE 4.1 | REV 1 |

| REV | DATE | DESCRIPTION | DESIGNED | DRAWN | REVIEWED |
|---|---|---|---|---|---|
| 1 | 24JUN'21 | ISSUED WITH REPORT | DMMD | AS | RAC |
| 0 | 09APR'21 | ISSUED WITH REPORT | DMMD | AS | RAC |

Key water management issues related to this area include:

- Material deposited by the grader along the edge of the MHR, upslope of the ditches, prevents runoff from the road surface from entering ditches along their entire length (Photo 1, Appendix B).
- Exposed and over-steepened cut slopes along the MHR and Hillside Road are not stable and are therefore being eroded during larger rain events (Photo 2, Appendix B).
- The MHR is not sloped towards the inside ditches (hill side) along its entire length, and thus runoff occurs to the far side of the road surface at some locations. The outer safety berm prevents this water from leaving the road surface. Cut outs have been constructed in the safety berm as a temporary measure to allow the runoff to leave the road surface and drain to the environment.
- Seepage daylighting on the MHR can cause ice conditions and contribute to sediment loading (Photo 3, Appendix B).
- Some culverts along the MHR have sediment buildup in and/or immediately upstream of the culverts. In addition, some culverts have been damaged during snow removal from upstream or downstream of the culverts in preparation for freshet.
- Erosion of the natural slopes downstream of the MHR and its culverts, is also occurring (Photos 4 and 5, Appendix B).
- Ditches, check dams and sumps at various locations along the MHR are undersized, according to feedback from site personnel.
- The check dams at the explosive magazine area are undersized for freshet and heavy rain events, according to feedback from site personnel (Photos 8 and 9, Appendix B).
- Sediment buildup behind these structures needs to be removed more often (if these facilities continue to be used).
- When surface water flows over the ground are concentrated (as opposed to sheet flow), additional sediment is often picked up from the natural ground, thereby further increasing TSS levels downstream.

## 4.3 CONCEPTUAL WATER MANAGEMENT MEASURES

Proposed water management measures in the Mary River catchment include operational improvements, remedial measures, and new water management measures, as summarized in Table 4.1 and shown on Figure 4.1.

As part of the initial implementation phase, new water management measures include redesigning the inside ditch of the MHR to direct all flows from the road and the surrounding area to a new sedimentation pond at KM105. The MHR will be re-sloped where required to the inside ditch, and existing culverts that convey flows under the road will be plugged or removed.

One or more ponds will be constructed to receive sediment laden runoff from the MHR ditch and adjacent upslope areas. This will include the staged construction of the KM105 Sedimentation Pond and subsequent expansions (an additional pond and/or diversions). The KM105 Pond will include a south embankment that encroaches on the current MHR, necessitating a localized realignment of the haul road. A second embankment will also be required at the northwest extent of the proposed KM105 Pond area (Figure 4.1).

Following adequate settling time of solids, the collected runoff will be discharged downstream of the northwest embankment, eventually reporting to the Sheardown Lake Tributary 1.

**Table 4.1 Proposed Water Management Measures - Mary River Catchment**

| Project Component | Consideration | Category | Proposed Measure/Action |
|---|---|---|---|
| Mine Haul Road | Material deposited by the grader along the edge of the MHR, adjacent to the inside ditches, prevents runoff from the road surface from entering the ditches along their entire length. | Operational improvement | Improve MHR grader practices to eliminate deposition of excess gravel in berms/windrows that can be easily eroded and transported to the inside ditch. |
| | Seepage daylighting on the MHR can cause icy conditions and contribute to sediment loading. | Remedial measure | Address upgradient source(s) of seepage daylighting on the MHR by directing the drainage causing the seepage to the MHR ditch or installing a culvert to convey the drainage beneath the MHR. |
| | Exposed and over-steepened cut slopes along the MHR and Hillside Road are not stable and are therefore being eroded during larger rain events. | | Stabilize exposed and over-steepened cut slopes with riprap and non-woven geotextile as required. |
| | Current water management structures (ditches, culverts, check dams and sediment ponds) are insufficient in managing runoff along the road. The road is not sloped towards the inside ditches (hill side) in some areas and notches are cut into the safety berm (at certain times of the year) leading to uncontrolled release of runoff from the road surface to the environment. Erosion of the natural slopes downstream of the MHR and its culverts is occurring. MHR runoff must be managed as per MDMER (i.e., disturbed area adjacent to mining activity). | New water management measures | Plug or remove culverts that pass flows from the inside ditch to the downstream side of the MHR.<br>Re-slope the MHR so drainage is to an upgraded inside ditch equipped with energy dissipation structures (rock check dams, gabions, etc.).<br>The upgraded ditch will convey water to one or more new sedimentation ponds. |
| Explosive Magazine Area | Check dams and sedimentation ponds are undersized for freshet and heavy rain events. | Remedial measure and/or new water management structure | The removal/plugging of culverts and re-sloping of the MHR will reduce flows on the downstream side of the MHR, including the explosives magazine area. Once these changes have been realized, further study can determine if further mitigation is required within the explosive magazine area. If additional mitigation is required, this may include measures to stabilize exposed slopes, improvements to existing rock check dams and sediment traps, or the construction of a new sedimentation pond. |

The available storage in the KM105 Pond provides approximately 60% of the required design storage capacity based on the current mining footprint (72 mm equivalent runoff depth, compared to the design event depth of 116 mm). The KM105 Pond design storage capacity approaches the 1 in 10-year, 3-day event (74 mm), and thus use of this pond in the short term (i.e., 1 to 3 years) is considered appropriate. In addition, the proposed KM105 Pond design incorporates an emergency spillway sized to convey the Inflow Design Flood (IDF) event.

Expansion beyond the initial KM105 Pond is proposed to achieve the meteorological event design criteria in Section 2. Construction of a larger pond at the same location is not feasible due to the combination of topographic constraints and anticipated poor ground conditions. A larger pond further downstream in the catchment at KM104 was determined not to be feasible due to potential geotechnical risks (downstream infrastructure).

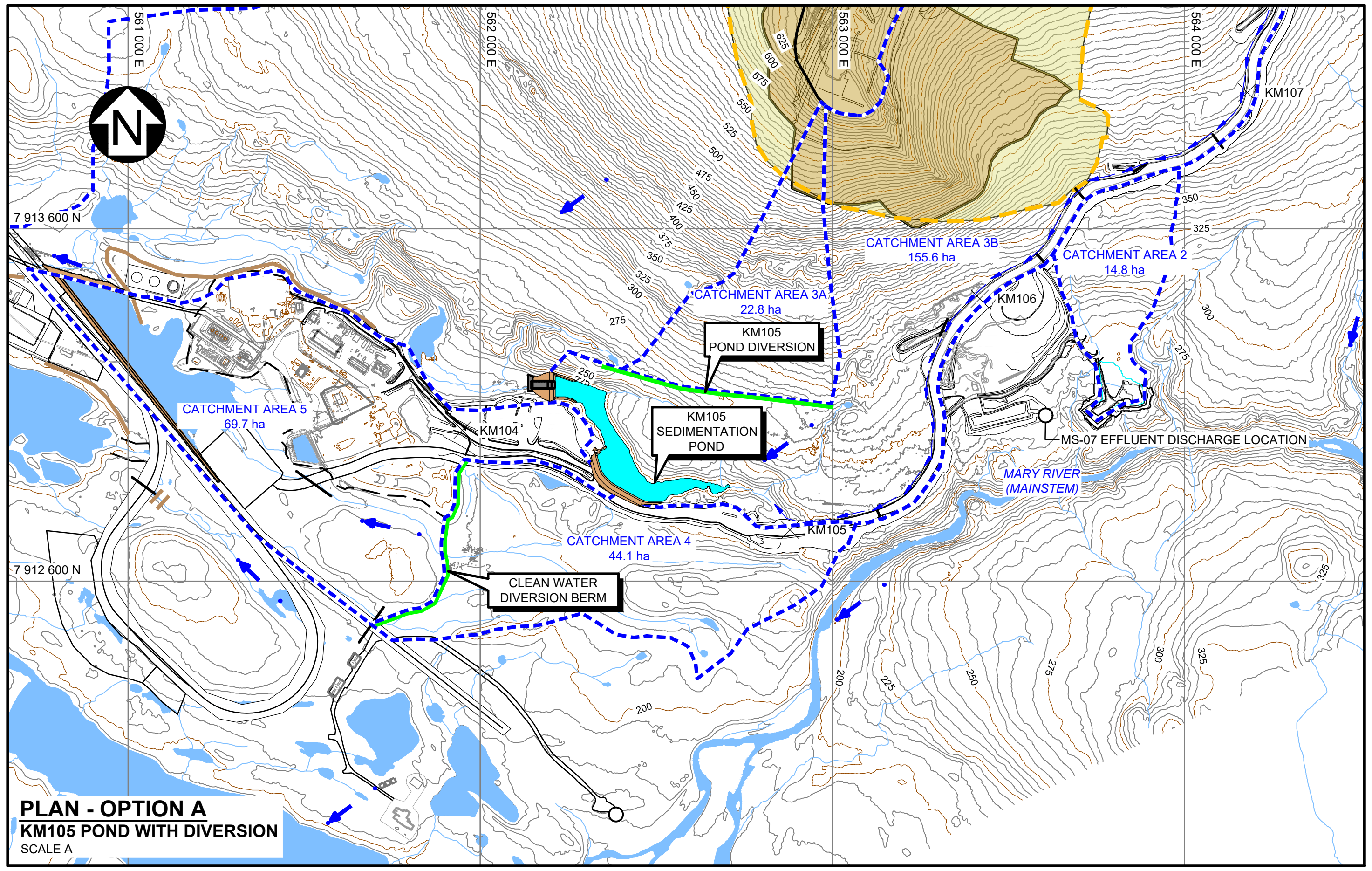
Three expansion options have been identified for the staged expansion of the initial KM105 Pond so that the design storage requirement is met:

- Option A: a potential diversion to divert non-contact water around the KM105 Pond
- Option B: KM105 Pond and a smaller KM104 Pond
- Option C: KM105 Pond and a smaller KM104 Pond (Option B) plus a full diversion

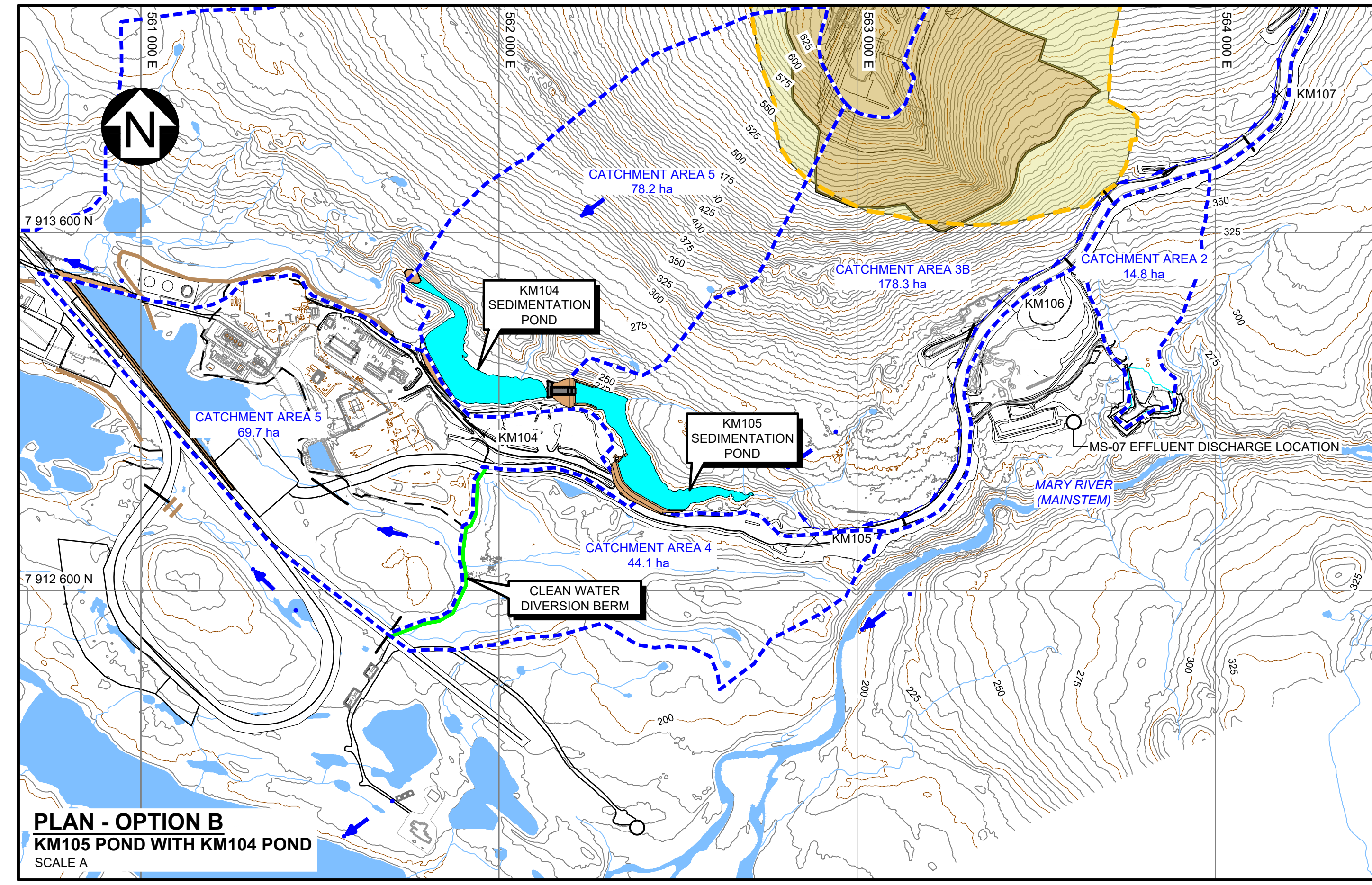
These options are presented on Figure 4.2 and in Table 4.2, along with the capacities and effective design flood event associated with each option as the pit extent grows over time. As the open pit expands and pit water is diverted elsewhere, the catchment area reporting to the KM105 Pond will decrease over the mine life, thereby increasing the equivalent storm event that can be contained. This is presented in Table 4.2 for the current (2021) active mining area, the 2025 mine plan, and the ultimate pit. Based on the current conceptual designs, Options A and B will provide the required storage once the open pit reaches its ultimate extent, the timing of which is dependent on the mine production rate. Option C will provide the required storage based on the current active mining footprint. The feasibility of constructing one of Options A through C will be explored further with the intent to construct such add-ons in the summer of 2022 to achieve the required capacity to contain the design meteorological event.

With respect to reference to a smaller KM104 Pond, the previous (Rev 0) version of this WMP considered a larger KM104 Pond than that shown on Figure 4.2. The south and northwest embankments of the larger KM104 Pond would be 12 m and 17 m in height, respectively (compared to 4 m and 9 m in the current smaller version). Permanent infrastructure is located immediately downgradient of the south embankment, including several workshops and the existing crusher pad. Geotechnical investigations undertaken in April-May 2021 identified ice-rich soils at both embankment locations. Due to the possible loss of life in the event of a hypothetical embankment failure, both KM104 embankments were classified as “High” to “Very High” according to CDA (2013). We understand from Baffinland that relocating the downstream infrastructure is not an option. Based on the potential for loss of life as well as significant embankment heights on ice-rich soils, KP recommended against constructing the larger KM104 Pond.

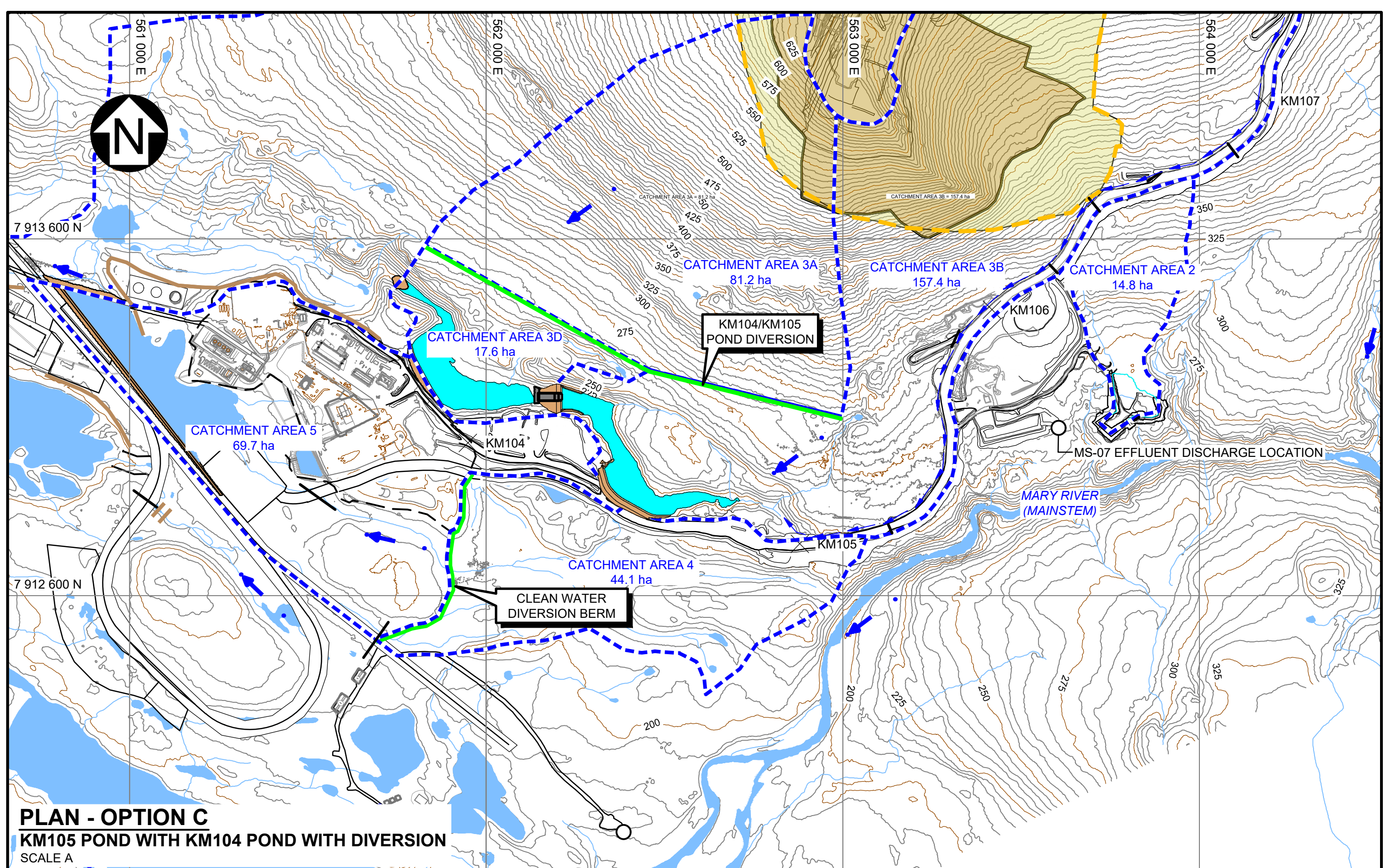
The KM105 Pond option is preferred because it does not conflict with existing infrastructure and does not present the same risk of potential loss of life. Ground conditions are believed to be similar throughout the area (to be confirmed with geotechnical investigations).




**PLAN - OPTION A**
**KM105 POND WITH DIVERSION**
SCALE A




**PLAN - OPTION B**
**KM105 POND WITH KM104 POND**
SCALE A




**PLAN - OPTION C**
**KM105 POND WITH KM104 POND WITH DIVERSION**
SCALE A

**LEGEND:**

- CURRENT
- ULTIMATE
- WATER
- ESTIMATED MAXIMUM POND (EXTREME PRECIPITATION CONDITIONS)
- SEDIMENTATION POND EMBANKMENT (APPROXIMATE)
- DRAINAGE DIRECTION
- WATER MANAGEMENT PLAN CATCHMENT (APPROXIMATE)
- ULTIMATE DEPOSIT NO. 1 PIT LIMITS
- ULTIMATE WASTE ROCK STOCKPILE LIMITS
- ROCK BERM
- CULVERT (APPROXIMATE)
- COLLECTION/DIVERSION BERM
- EFFLUENT DISCHARGE LOCATION

**NOTES:**

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. DETAILED WATER FROM EAGLE MAPPING (2005). CONTOUR PROVIDED BY BAFFINLAND (2019) INTERVAL IS 5 m.
3. CURRENT MINE AREA FROM THE WASTE DUMP TO THE CRUSHER PAD, AND DITCHES ALONG THE HAUL ROAD PROVIDED BY BIM (MARCH 12, 2018).
4. MINE HAUL ROAD AS-BUILT PROVIDED BY BAFFINLAND IRON MINES CORPORATION (MAY 2021).
5. ALL OTHER SITE INFRASTRUCTURE PROVIDED BY HATCH (AUGUST 2, 2016) AND SIMPLIFIED BY KP STAFF (JANUARY 2018).
6. LOCATIONS AND DETAILS OF PROPOSED WATER MANAGEMENT MEASURES TO BE CONFIRMED BASED ON ACTUAL SITE CONDITIONS.

SCALE A 200 100 0 200 400 600 800 1000 m

| REV | DATE | DESCRIPTION | DESIGNED | DRAWN | REVIEWED |
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| 0 | 24JUN'21 | ISSUED WITH REPORT | DMMD | AS | RAC |

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MARY RIVER PROJECT

**KM105 POND WITH POTENTIAL EXPANSION OPTIONS**

Knight Piésold CONSULTING

| P/A NO. | REF NO. |
|---|---|
| NB102-181/63 | 1 |

**FIGURE 4.2** REV 0

SAVED: I:\102\00181\63\A\Acad\FIGS\B31 R0, 6/24/2021 4:08:05 PM , ASIMPSON PRINTED: 6/24/2021 4:09:06 PM, FIG 1, ASIMPSON ACAD VERSION: 23.1S (LMS TECH)

**Table 4.2 Available Storage at KM105 Pond and Optional Expansions**

| Pond Option | Catchments and Corresponding Capacities[1] | 2021 Mining Extents | 2025 Mining Extents | Ultimate Pit Extents |
|---|---|---|---|---|
| KM105 Pond (Base Case) | Contributing Catchment ($km^2$) | 2.46 | 2.09 | 1.76 |
| | Available Storage Capacity ($m^3$) | 178,000 | 178,000 | 178,000 |
| | Equivalent Storm Event (mm) | 72 | 85 | 101 |
| Option A: KM105 Pond + Diversion[2] | Contributing Catchment ($km^2$) | 2.23 | 1.88 | 1.55 |
| | Available Storage Capacity ($m^3$) | 178,000 | 178,000 | 178,000 |
| | Equivalent Storm Event (mm) | 80 | 95 | 115 |
| Option B: KM105 Pond + KM104 Pond | Contributing Catchment ($km^2$) | 3.24 | 2.84 | 2.47 |
| | Available Storage Capacity ($m^3$) | 297,000 | 297,000 | 297,000 |
| | Equivalent Storm Event (mm) | 92 | 105 | 121 |
| Option C: KM105 Pond + KM104 Pond + Diversion[2] | Contributing Catchment ($km^2$) | 2.43 | 2.07 | 1.74 |
| | Available Storage Capacity + Diversion ($m^3$) | 297,000 | 297,000 | 297,000 |
| | Equivalent Storm Event + Diversion (mm) | 123 | 144 | 171 |

**Note(s):**

1. Storage capacity volumes and equivalent runoff depths are preliminary and are subject to change during detailed engineering.
2. Equivalent runoff depths for options with a diversion assume 100% diversion, which may not be achievable.
3. Shaded cells approach or exceed the design flood event of 116 mm.

The MHR ditch upgrade will include the removal/plugging of culverts and re-sloping of the MHR so that runoff from the road surface reports to the inside ditch. This will reduce flows on the downstream side of the MHR, including the explosive magazine area. Once these changes have been realized, further study can determine if additional mitigation is required within the explosive magazine area. If additional mitigation is required, this may include measures to stabilize exposed slopes, improvements to existing rock check dams and sediment traps, or the construction of a new sedimentation pond.

## 4.4 OTHER MEASURES CONSIDERED

Several options for water management in the Mary River Catchment were considered and included the following:

- Multiple sedimentation ponds positioned either upslope or downslope of the MHR along its length - this would require multiple ponds with significant fill requirements on steep slopes with ice-rich foundations.
- A diversion berm that would direct non-contact runoff from the undisturbed tundra between the Active Mining Area and the MHR to Tributary 1 of Sheardown Lake - this extensive berm would involve significant earthworks on very steep terrain and would interfere with the ultimate pit boundary.
- Various configurations of the KM104 Pond to achieve adequate temporary storage of collected runoff - as discussed above, the high embankment version was considered an unacceptable risk, but a lower embankment version will be evaluated further.
- A sedimentation pond at KM105 south of the MHR - this option would conflict with the future south railway operation’s stockyard.

# 5.0 AREA 2 - SHEARDOWN LAKE AND TRIBUTARIES

## 5.1 APPLICABLE COMPONENTS

Area 2 currently consists of the following components (Figure 5.1):

- Crusher Facility
- Mine Site Complex (MSC)
- 800-person Sailiivik camp
- Tank farm
- Landfill
- Landfarm (proposed)
- Emulsion plant and explosives storage area
- Snow stockpile areas

All these components are located within the small Sheardown Lake Catchment. Each of these components are described below.

### 5.1.1 CRUSHER FACILITY

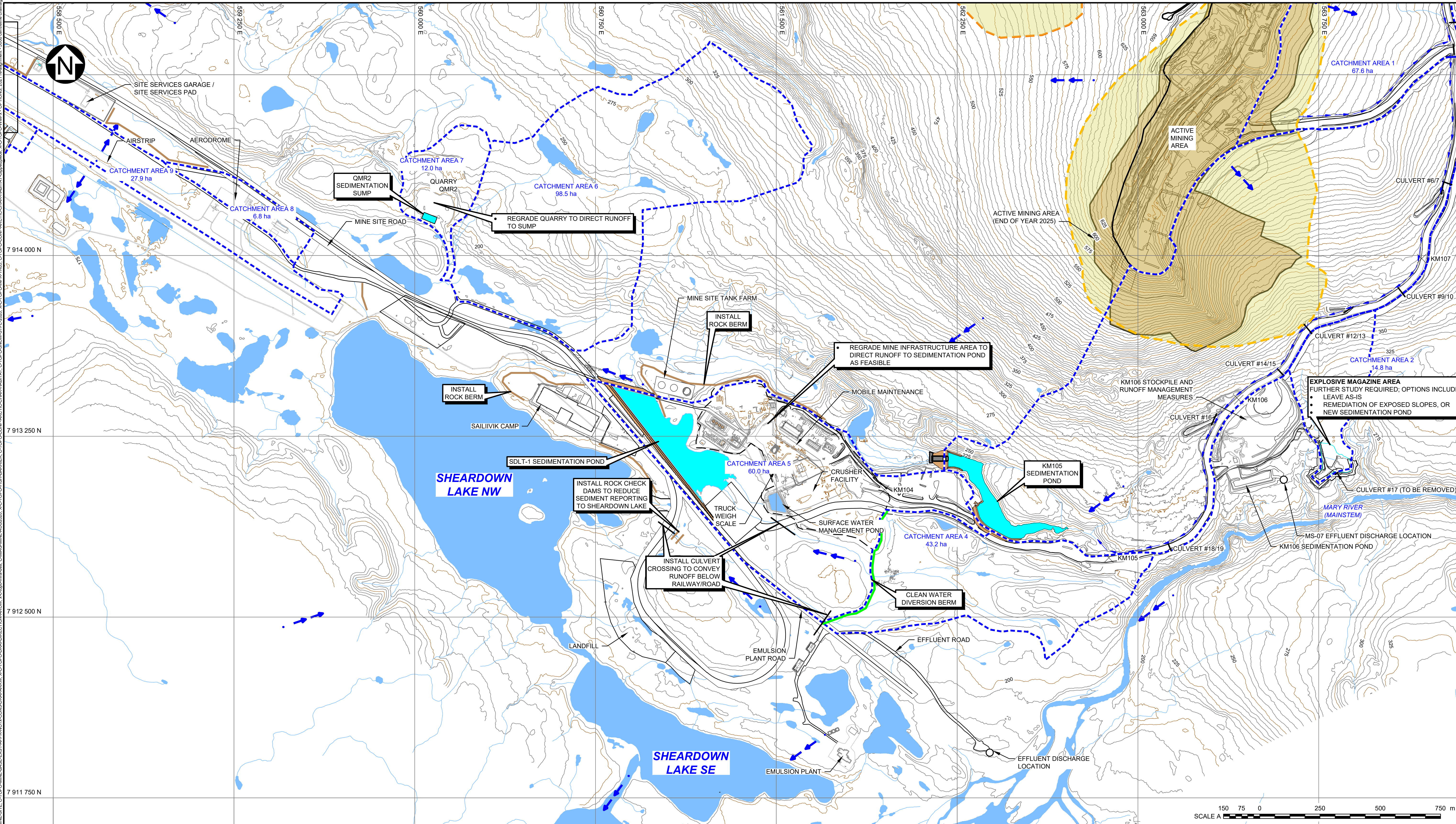
Mining trucks deliver ROM ore to the Crusher Facility where it is subject to primary and secondary crushing before being stockpiled. Stockpiled ore is reclaimed using front end loaders for placement into long-haul ore trucks. Runoff within the Crusher Facility area is collected in a surface water management pond which is decanted using a pump and pipeline to the Mary River.

The Crusher Facility is a major source of dust within the mine infrastructure area. A portion of the site runoff from the area outside of the Crusher Facility passes through rock check dams before reporting to Sheardown Lake Tributary 1 (SDLT-1). The nearby water bodies include Sheardown Lake, SDLT-1 and a Tributary 12 (SDLT-12; more recently referred to as LDFG-OUT in monitoring).

### 5.1.2 OTHER INFRASTRUCTURE

Other infrastructure located within the Sheardown Lake Catchment includes the following components and associated water management features:

- Buildings such as the MSC and Sailiivik Camp (including laydown area), equipped with potable water and sewage tanks but with no meaningful site drainage measures except some rock berms at the camp laydown area (Photo 13, Appendix B)
- Tank farm, which collects precipitation that is tested before being discharged to the environment adjacent to the tank farm
- Landfill, which was designed to have perimeter diversion ditching, however that ditching has not been constructed yet
- Landfarm, which once constructed will be equipped with perimeter ditching; the landfarm will also collect precipitation which will be treated with the mobile oily water treatment system prior to discharge to the receiving environment
- Emulsion plant and explosives storage area, which do not discharge effluents
- The truck weigh scale and Mine Site roadways




**LEGEND:**

- CURRENT
- ULTIMATE
- WATER
- SEDIMENTATION POND EMBANKMENT (APPROXIMATE)
- DRAINAGE DIRECTION
- WATER MANAGEMENT PLAN CATCHMENT (APPROXIMATE)
- ULTIMATE DEPOSIT NO. 1 PIT LIMITS
- ULTIMATE WASTE ROCK STOCKPILE LIMITS
- ROCK BERM
- CULVERT (APPROXIMATE)
- COLLECTION/DIVERSION BERM
- EFFLUENT DISCHARGE LOCATION
- ESTIMATED MAXIMUM POND (EXTREME PRECIPITATION CONDITIONS)

**NOTES:**

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. DETAILED WATER FROM EAGLE MAPPING (2005). CONTOUR PROVIDED BY BAFFINLAND (2019) INTERVAL IS 5 m.
3. CURRENT MINE AREA FROM THE WASTE DUMP TO THE CRUSHER PAD, AND DITCHES ALONG THE HAUL ROAD PROVIDED BY BIM (MARCH 12, 2018).
4. MINE HAUL ROAD AS-BUILT PROVIDED BY BAFFINLAND IRON MINES CORPORATION (MAY 2021).
5. ALL OTHER SITE INFRASTRUCTURE PROVIDED BY HATCH (AUGUST 2, 2016) AND SIMPLIFIED BY KP STAFF (JAN, 2018).
6. LOCATIONS AND DETAILS OF PROPOSED WATER MANAGEMENT MEASURES TO BE CONFIRMED BASED ON ACTUAL SITE CONDITIONS.

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| 1 | 24JUN'21 | ISSUED WITH REPORT | DMMD | AS | RAC |
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BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

**SHEARDOWN LAKE CATCHMENT PROPOSED WATER MANAGEMENT MEASURES**

Knight Piésold CONSULTING

| P/A NO. | REF NO. |
|---|---|
| NB102-181/63 | 1 |

**FIGURE 5.1** REV 1

### 5.1.3 CHANGES RESULTING FROM THE PHASE 2 PROPOSAL

The Phase 2 Proposal will see construction of a rail loading facility that will include primary crushing (for approximately 30% of ROM ore), stockpiling, reclaim and loading of rail cars. Runoff within the rail loading facility will report to a new stormwater pond. The new pond will discharge through the shared stormwater/sewage effluent pipeline to the Mary River.

The current crusher facility will continue to be used through the Phase 2 Proposal.

## 5.2 KEY ISSUES

Unlike the Mary River Catchment, the project-affected portion of the Sheardown Lake Catchment is relatively flat. As such, erosion is less of an issue. The ore handling (crushing, stockpiling, reclaiming) activities, however, generate a considerable amount of dust. Baffinland has implemented several dust control measures at the crusher (installing shrouds, etc.).

Six sediment spills have been reported in the past five years (Table 1.1), and each of the spills occurred in May when the snowpack is melting but the ground is still frozen. The heaviest dustfall has typically occurred during the winter period (Figure 5.2). Not only does the heaviest dustfall occur during the winter, dustfall accumulates over the long winter and is released during the comparatively short snowmelt period.

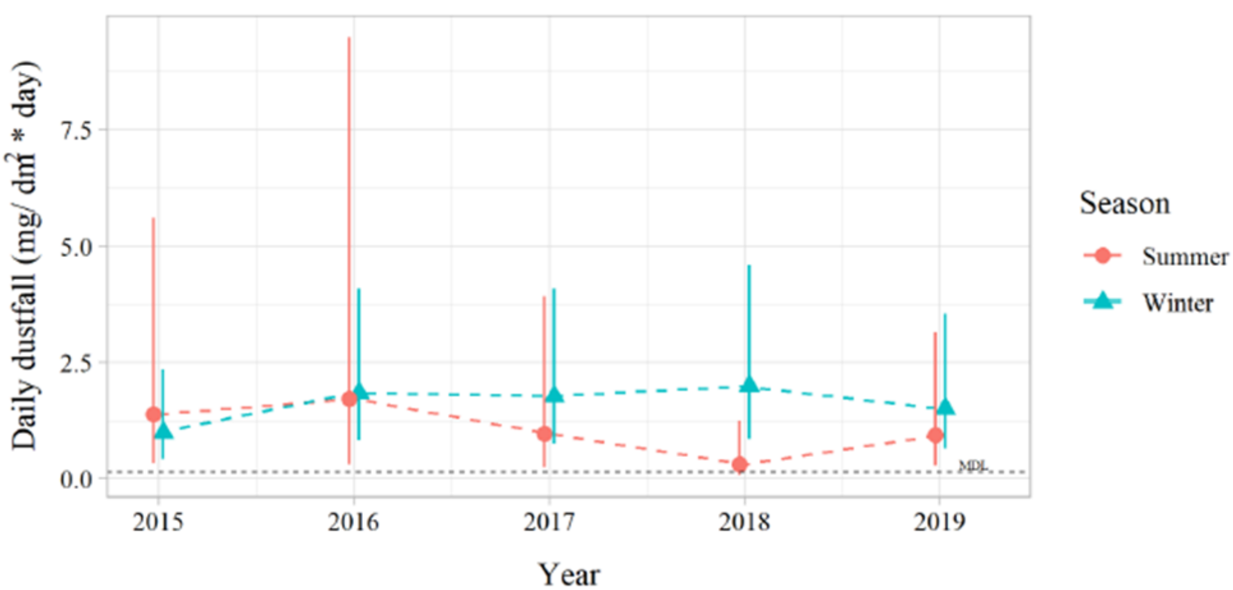



**Figure 5.2 Daily Dustfall Rates at Mine Site Dustfall Stations (EDI, 2020)**

Key water management issues related to this area include:

- Runoff management in the Truck Weigh Scale area needs to be improved for effective operation of the scale to be maintained (Photo 10, Appendix B).
- Surface water runoff does not drain by gravity from all parts of the Crusher Facility to the perimeter ditches or the surface water management pond (Photo 12, Appendix B). To better manage runoff from the Crusher Facility, Baffinland has needed to construct a temporary sump with pump and pipeline as well as local ditches to drain low areas that pool with water.

- There is surface water runoff originating on the crusher pad that seeps through the underlying pad fill and directly to the environment, therefore bypassing the surface water management pond. This is currently captured by temporary sumps and pumped to the pond.
- The presence of finer grained material on the Mine Site Road slopes and over culverts results in blockage of culverts and possible sediment being washed downstream of the culverts (Photo 14, Appendix B).

## 5.3 CONCEPTUAL WATER MANAGEMENT MEASURES

Proposed water management measures in the Sheardown Lake catchment include operational improvements, remedial measures, and new water management measures, as summarized in Table 5.1 and shown on Figure 5.1.

New water management measures include construction of a new SDLT-1 Pond to collect runoff from a large portion of the mine infrastructure area including the existing Crusher Facility and future Phase 2 Proposal rail loadout facility.

Additional details for the SDLT-1 Sedimentation Pond are provided as follows:

- The purpose of this pond would be to receive sediment laden runoff from the disturbed mine infrastructure areas between the MHR and future North Railway. The water would be temporarily retained in the pond to allow for sufficient settling of solids and potential in situ treatment of other water quality issues.
- The pond would be formed by constructing a perimeter berm along its northwest and southwest sides.
- Due to the potential for water quality issues in the surface runoff other than TSS (i.e., unionized ammonia), the embankments will be lined at a minimum.

The locations of the proposed water management measures for the Sheardown Lake Catchment are shown on Figure 5.1, while typical sections and details are provided on Figures 3.1 and 3.2.

## 5.4 OTHER MEASURES CONSIDERED

No other options were identified.

**Table 5.1 Proposed Water Management Measures - Sheardown Lake Catchment**

| Project Component | Consideration | Category | Proposed Measure/Action |
|---|---|---|---|
| Crusher Facility | Dust generation at Crusher Facility. | Operational improvement | Dust minimization and suppression. |
| | Surface water runoff does not drain by gravity from all parts of the Crusher Facility to the perimeter ditches or the Surface Water Management Pond.<br>To better manage the water from the Crusher Facility, Baffinland has constructed a temporary sump with pump and pipeline as well as local ditches to drain low areas that pool with water. | Remedial measure | Divert runoff from the Crusher Facility around the existing Surface Water Management Pond to report to the future SDLT-1 Sedimentation Pond (see Table 3.3).<br>Excess material will need to be removed periodically to maintain gravity drainage. |
| | Surface water runoff that originates from the Crusher Facility seeps through the underlying pad fill and directly to the environment, bypassing the Surface Water Management Pond. | | Ensure existing ditches drain to the future SDLT-1 Sedimentation Pond. |
| Mine Site Complex, Mobile Maintenance Pad, etc. | Runoff from these areas needs to be managed as per MDMER (i.e., disturbed area adjacent to mining activity). Runoff management in the Truck Weigh Scale area needs to be improved for effective operation of the scale to be maintained. | New water management measures | Install sedimentation pond; install ditches/berms as required to route runoff from disturbed areas to the pond; and divert runoff from undisturbed areas away from the pond as much as possible. |
| | | | Install rock berms along edges of disturbed areas or rock check dams in non-fish bearing watercourses where runoff cannot be directed to a sedimentation pond. |
| Emulsion Plant Road, Effluent Road and Undisturbed Areas in the Vicinity | Similar to above, dust originating from the Crusher Facility falls on the undisturbed tundra and is free to be carried to the natural receiving waterbodies rather than being captured by sediment control measures. | | Install rock berms and/or rock check dams. |

# 6.0 AREA 3 - CAMP LAKE AND TRIBUTARIES

## 6.1 APPLICABLE COMPONENTS

Area 3 currently consists of the following components (Figure 6.1):

- Airstrip and apron
- A section of the Mine Site Road
- Quarry QMR2
- Weatherhaven Camp
- Snow stockpile areas
- Water Jetty area (i.e., water take location)

Currently, runoff from this area generally reports directly to the environment, with little to no water management measures in place. The exceptions to this are the temporary (seasonal) use of silt fences downstream of the quarry QMR2 and the check dams and sediment ponds that were constructed in the Water Jetty area.

During freshet 2020, emergency sediment and erosion control measures consisting of a low height berm and sump were established at the Weatherhaven Camp to minimize runoff from flowing from the camp laydown area to Camp Lake (by the Water Jetty). The collected water was diverted from the laydown area sump to just upstream of the snow stockpile area located behind the camp.

Within the planning horizon of this WMP (5 years) and contingent on approval of the Phase 2 Proposal, the North Railway could be constructed alongside Camp Lake Tributary 1, requiring its realignment. No other major changes are expected in this area.

## 6.2 KEY ISSUES

The project-affected portion of the Camp Lake Catchment is relatively flat, except for where runoff from the Weatherhaven Camp drains to Camp Lake. As such, project activities impacting erosion are less of an issue. The airstrip and adjacent Mine Site Road are the primary sources of dust in this area. Seven sediment spills have occurred to Camp Lake or its tributaries over the period of 2016 to 2020, all during the month of May (Table 1.1), suggesting that dustfall into the snowpack is likely a major contributor of sediment during these spills.

Key water management issues related to this area include:

- Surface water runoff and snowmelt around the airstrip pooling and then eroding downstream slopes (Photo 15, Appendix B)
- Surface water runoff from the airstrip contributing to elevated TSS levels in tributaries to Camp Lake
- Dust generation from planes taking off and landing
- Erosion of the Mine Site Road banks (Photo 16, Appendix B)
- Sediment from Quarry QMR2 being transported into the downstream water body and resulting in elevated TSS levels in the natural pond west of the quarry access road, and ultimately Camp Lake (Photo 17, Appendix B)

- Elevated TSS levels in Camp Lake Tributary 1 attributed to runoff from the Weatherhaven Camp and the airstrip, and snowmelt from the snow stockpile area
- Rock check dams and sediment traps by the Water Jetty installed as emergency measures do not adequately manage runoff and sediment (Photos 19 and 20, Appendix B)
- Several culvert inlets and/or outlets were not visible along the Mine Site roadway because finer grained material had covered them (Photo 14, Appendix B). As mentioned previously, some of the culverts are damaged due to snow removal from upstream or downstream of the culverts in preparation for freshet.
- Once the snow stockpiles melt, these areas are left with a significant amount of deposited soil and rocks (Photo 21, Appendix B). This material is presumably picked up during the snow removal activities. As the snow melts or during heavy rain events, this material can be carried to downstream tributaries/water courses and therefore, contribute to elevated TSS levels in these areas.

## 6.3 CONCEPTUAL WATER MANAGEMENT MEASURES

Proposed water management measures in the Camp Lake catchment include operational improvements, remedial measures, and new water management measures, as summarized in Table 6.1 and shown on Figure 6.1.

New water management measures include construction of new sedimentation ponds to collect runoff from the QMR2 Quarry and the Camp Lake exploration camp area, and additional sediment and erosion control measures (rock check dams, sediment traps, gravel cover) in the Camp Lake Jetty area.

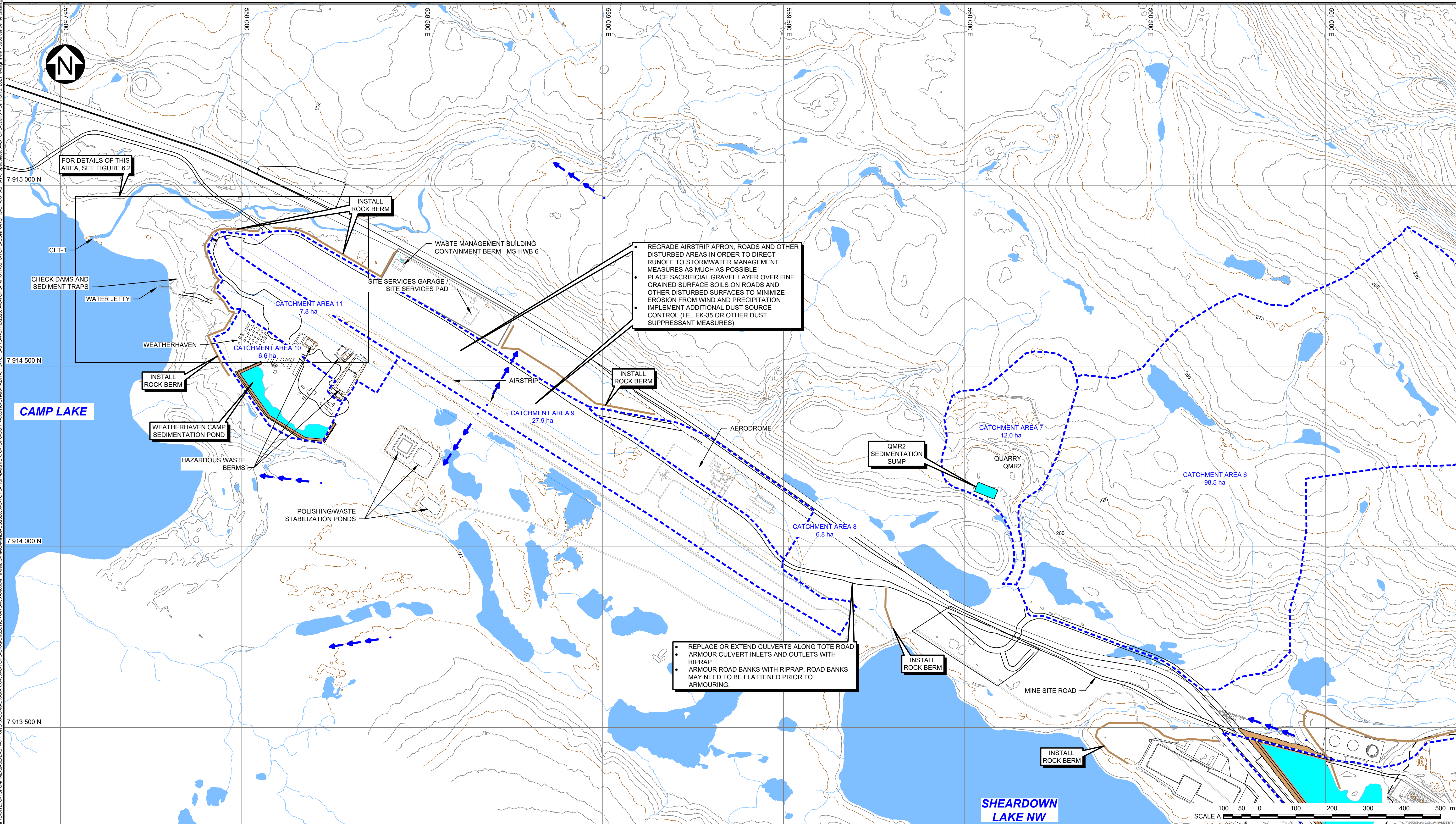
Additional details for the new sedimentation ponds are provided as follows:

- QMR2 Sedimentation Pond:
    - The purpose of this pond is to receive sediment laden runoff from Quarry QMR2. The collected water could be pumped to a water treatment plant, if required.
    - The pond would be formed by drilling and blasting a basin into the quarry floor
    - If not excavated in bedrock, this pond will be lined due to the potential for water quality issues other than TSS
- Weatherhaven Camp Sedimentation Pond:
    - The purpose of this pond is to receive sediment laden runoff from a portion of the Weatherhaven Camp and airstrip areas. The water would be retained in the pond to allow for sufficient settling of solids.
    - The pond would be formed by constructing a perimeter berm along two or three sides of the pond footprint
    - A few options for the location and configuration of this pond were considered. Some of the options provided little capacity for water management. The preferred option is shown on Figure 6.1.

    Typical sections and details associated with the sedimentation ponds are provided on Figures 3.1 and 3.2.
    A conceptual layout of the proposed water management measures at the Camp Lake Jetty area are on Figure 6.2.

### Table 6.1 Proposed Water Management Measures - Camp Lake Catchment

| Project Component | Consideration | Category | Proposed Measure/Action |
|---|---|---|---|
| Airstrip and Apron | Dust is generated from planes taking off and landing. | Operational improvement | Implement additional dust source control (i.e., EK-35 or other dust suppressant). |
| | Surface water runoff from the airstrip contributes to elevated TSS levels in drainages and tributaries to Camp Lake and the Water Jetty area. Dust deposition and snowmelt are key contributors. Erosion is evident at some locations on the apron side of the airstrip. Water pools in some areas, and when operators drain these pools (i.e., cut swales in the safety berm), the runoff erodes downstream slopes and releases elevated TSS runoff. | Remedial measure | Regrade areas that pond with water; minimize erosion from airstrip runoff by armouring slopes with riprap /sacrificial gravel cover and installing small check dams, etc.<br>Install rock berms along the downstream edges of disturbed areas, including snow stockpiles.<br>Regrade the airstrip apron, roads and other disturbed areas<br>Stabilize regraded and other disturbed surfaces to minimize erosion. |
| Mine Site Road | The presence of finer grained material on Mine Site Road banks and over culverts results in erosion of road material, blockage of culverts and possible sediment being washed downstream of the culverts. | | Replace or extend culverts and armour culvert inlets and outlets and road banks with riprap.<br>Implement localized remediation measures along the road near fish habitat areas (i.e., silt fence, small check dams, armouring of road embankments and ditches). Road bank slopes need to be flattened at some locations. |
| Quarry QMR2 | Sediment-laden runoff from Quarry QMR2 and its access road is entering the natural pond west of the quarry access road, which contains fish. | New water management measure | Construct a small sedimentation pond in the quarry floor (to be formed by blasting). |
| Water Jetty Area and Camp Lake Tributaries | TSS levels are elevated in Camp Lake drainage behind (south of) the Weatherhaven Camp. Primary contributors are the snow stockpile, laydown construction material and dust generated by the airstrip and deposited in the area. | | Install rock berms/sedimentation pond upstream of drainage.<br>Raise the roadbed in the water jetty area, increase the capacity of existing rock check dams, and install new sediment traps. |
| | Existing check dams and sediment traps by the Water Jetty are undersized for the amount of runoff reporting to them. | | Divert or collect and pump runoff to a new sedimentation pond proposed south of the camp and thereby increase the water management capacity of existing structures. |




**LEGEND:**

- CURRENT
- ULTIMATE
- WATER
- SEDIMENTATION POND EMBANKMENT (APPROXIMATE)
- DRAINAGE DIRECTION
- WATER MANAGEMENT PLAN CATCHMENT (APPROXIMATE)
- ULTIMATE DEPOSIT NO. 1 PIT LIMITS
- ULTIMATE WASTE ROCK STOCKPILE LIMITS
- ROCK BERM
- CULVERT (APPROXIMATE)
- EFFLUENT DISCHARGE LOCATION
- ESTIMATED MAXIMUM POND (EXTREME PRECIPITATION CONDITIONS)

**NOTES:**

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4. MINE HAUL ROAD AS-BUILT PROVIDED BY BAFFINLAND IRON MINES CORPORATION (MAY 2021).
5. ALL OTHER SITE INFRASTRUCTURE PROVIDED BY HATCH (AUGUST 2, 2016) AND SIMPLIFIED BY KP STAFF (JAN, 2018).
6. LOCATIONS AND DETAILS OF PROPOSED WATER MANAGEMENT MEASURES TO BE CONFIRMED BASED ON ACTUAL SITE CONDITIONS.

| REV | DATE | DESCRIPTION | DESIGNED | DRAWN | REVIEWED |
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| 1 | 24JUN'21 | ISSUED WITH REPORT | DMMD | AS | RAC |
| 0 | 09APR'21 | ISSUED WITH REPORT | DMMD | AS | RAC |

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

**CAMP LAKE CATCHMENT**
**PROPOSED WATER MANAGEMENT MEASURES**

Knight Piésold CONSULTING

P/A NO. NB102-181/63 | REF NO. 1

**FIGURE 6.1** | REV 1

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**LEGEND:**

- PLACED SACRIFICIAL GRAVEL COVER
- CAMP LAKE CATCHMENTS
- DRAINAGE DIRECTION

**NOTES:**

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
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4. MINE HAUL ROAD AS-BUILT PROVIDED BY BAFFINLAND IRON MINES CORPORATION (MAY 2021). ALL OTHER SITE INFRASTRUCTURE PROVIDED BY HATCH (AUGUST 2, 2016) AND SIMPLIFIED BY KP STAFF (JAN, 2018).
5. IMAGERY PROVIDED BY BAFFINLAND AND IS GENERALLY FROM SUMMER 2019 WITH ADDITIONAL IMAGERY FOR MAIN INFRASTRUCTURE AREAS FROM SUMMER 2020.
6. LOCATIONS AND DETAILS OF PROPOSED WATER MANAGEMENT MEASURES TO BE CONFIRMED BASED ON ACTUAL SITE CONDITIONS.

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MARY RIVER PROJECT

**CAMP LAKE JETTY AREA**
**PROPOSED WATER MANAGEMENT MEASURES**

Knight Piésold CONSULTING

| P/A NO. | REF NO. |
|---|---|
| NB102-181/63 | 1 |

**FIGURE 6.2** REV 1

SAVED: I:\102\00181\63\A\Acad\FIGS\B24 R1, 6/24/2021 4:06:54 PM , ASIMPSON PRINTED: 6/24/2021 4:07:38 PM, FIG 3 (2), ASIMPSON ACAD VERSION: 23.1S (LMS TECH)

## 6.4 OTHER MEASURES CONSIDERED

A sedimentation pond was considered in the Water Jetty area; however, insufficient space is available.

A sedimentation pond was also considered downgradient of Quarry QMR2, east of the quarry access road, which is a low-lying area upstream of fish habitat in Camp Lake Tributary 1. The contributing catchment is large and thus insufficient capacity is available at this location without significant embankments along the Mine Site Road.

# 7.0 IMPLEMENTATION PLAN

This WMP identifies conceptual water management measures that fall into three categories:

- Operational improvements
- Remedial measures
- New water management structures

These actions are summarized in Tables 4.1, 5.1 and 6.1.

Operational improvements and remedial measures can be implemented by Baffinland through 2021. New structures/facilities will be implemented over a longer period as they each require an investigation of geotechnical conditions, prior to detailed design. Should challenging ground conditions (i.e., massive ice lenses or other geotechnical issues) be identified, some aspects of the WMP may need to be revisited.

A high-level schedule to complete the required geotechnical investigations, design work, internal budget approvals, delivery of materials (i.e., liners and geotextile) via sealift, and construction is shown in Table 7.1.

**Table 7.1 Implementation Schedule**

| No. | Activity | Proposed Timing |
|---|---|---|
| 1 | Baffinland implements operational improvements and remedial measures | Winter/Spring/Summer 2021 |
| 2 | Complete geotechnical site investigations to confirm new water management structure locations and to provide foundation and permafrost information to help define the structure arrangements | Spring/Summer 2021 |
| 3 | Conduct particle size testing of surface soils and fill materials to estimate settling times for suspended solids (Note: this will assist in the sizing of the ponds) | Spring 2021 |
| 4 | Complete detailed design and Issued for Construction (IFC) drawings; prepare material and quantity estimates; prepare cost estimates for onsite QA/QC for any engineered structures (this will be completed sequentially for different project components starting with the KM105 Sedimentation Pond) | Spring 2021 through 2022 |
| 5 | Baffinland submits Water Licence modification requests to NWB with design briefs and IFC drawings | Spring 2021 through 2022 |
| 6 | Baffinland constructs water management facilities (ponds, ditches, etc.) | Summer 2021 through summer 2023 |
| 7 | Incorporate as-built documentation and OMS manuals into relevant environmental management plans:<br>• Surface Water and Aquatic Ecosystem Management Plan<br>• Fresh Water Supply, Sewage and Wastewater Management Plan<br>• Environmental Protection Plan | As infrastructure is built |

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# 9.0 CERTIFICATION

This report was prepared and reviewed by the undersigned.

Prepared:

Deena Duff, P.Eng.
Senior Engineer

Prepared:

Richard Cook, P.Geo. (Ltd.)
Specialist Environmental Scientist | Associate

PERMIT TO PRACTICE
KNIGHT PIESOLD LTD.
Signature
Date 2021-06-30
PERMIT NUMBER: P 547
The Association of Professional Engineers, Geologists and Geophysicists of NWT/NU

REGISTERED PROFESSIONAL ENGINEER
K.E. HAWTON
LICENSEE
2021-06-30
NWT/NU

Reviewed:

Kevin Hawton, P.Eng.
Specialist Engineer | Associate



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

# APPENDIX A

## Proposed Design Criteria

(Pages A-1 to A-2)

**TABLE A.1**

**BAFFINLAND IRON MINES CORPORATION**
**MARY RIVER PROJECT**

**MINE SITE WATER MANAGEMENT PLAN**
**PROPOSED DESIGN CRITERIA**

Print Jun-30-21 14:35:00

| Item No. | Item | Design Criteria | Reference |
|---|---|---|---|
| **1.0** | **GENERAL** | | |
| 1.1 | Regulatory | • Water Licence No. 2AM-MRY1325 Amendment No. 1, including Phase 2 Amendment Application | NWB, 2015 |
| | | • *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, 2018 |
| | | • *Fisheries Act* | Fisheries Act, 2016 |
| 1.2 | Guidelines and Reference | • Civil Design Philosophy and Criteria | Hatch, 2013 and 2018a |
| | | • Canadian Dam Association's Dam Safety Guidelines | CDA, 2013 |
| **2.0** | **WATER MANAGEMENT** | | |
| 2.1 | General | • Contact water will be directed to sedimentation ponds using berms/ditches | - |
| | | • Sedimentation ponds will manage runoff from disturbed areas (contact water). | |
| | | • Clean runoff (non-contact water) will be diverted around sedimentation ponds using diversion berms/ditches if possible/feasible | - |
| 2.2 | Design Storm Events and Discharge Criteria | • Conveyance berms and ditches will be sized to convey flows resulting from the 1 in 25-year flood event (50.6 mm for 24-hour duration) (with provision to ensure a safe flood path for events up to the 1 in 100-year flood event (64.2 mm for 24-hour duration) | Hatch, 2018a; KP, 2012 |
| | | • Ultimate water management system will be sized to manage runoff from the 1 in 50-year, 3-day snowmelt and rainfall event (116 mm). The KM105 Pond is capable of managing approximately 60% of the runoff reporting to the KM105 Pond area as a result of this event based on the current active mining area extent, increasing to approximately 85% once the ultimate open pit has been developed. | KP Estimate; Golder, 2018 |
| | | • Emergency spillways for sedimentation ponds will be sized to convey Inflow Design Flood (IDF) flows as required by CDA, based on Dam Hazard Classification or the Civil Design Philosophy (flood resulting from the 1 in 200-year, 24-hour event (71 mm), whichever is greater | CDA, 2019; Hatch, 2013 and 2018a; KP, 2012 |
| | | • The discharge limit for TSS released from sedimentation ponds is TSS <30 mg/L (single sample) and <15 mg/L (monthly average). Settling aids such as flocculants or geotubes will be used to meet discharge limits if the settling velocities cannot be met in the ponds. | Type A Water Licence (NWB, 2015) |
| | | • Diversion berms and ditches will be sized to convey flows resulting from the 1 in 100-year flood event (64.2 mm for 24-hour duration) | Hatch, 2018a; KP, 2012 |
| 2.3 | Hydrological Parameters | • Catchment areas estimated from mapping provided by Baffinland | Baffinland, 2019, 2020 and 2021 |
| | | • Runoff Coefficients: 1.0 for frozen, undisturbed and disturbed areas | KP Estimate |
| | | • SCS Curve Number: | |
| | | o Buildings, Prepared Ground Surfaces (including Mine Haul Road): 97 | Golder, 2018; KP Estimate |
| | | o Non-Contact/Upstream (Frozen Tundra): 90 (unfrozen = 86) | KP Estimate |
| | | • Time of Concentration Method: | |
| | | o Disturbed Areas: Kirpich (1940) | KP Estimate |
| | | o Upstream Areas: USDA SCS (1972) | KP Estimate |
| | | • Rainfall Distribution: SCS Type I | KP Estimate |
| **3.0** | **SEDIMENTATION PONDS** | | |
| 3.1 | Geometry | • Embankment Side Slopes: 3H:1V (upstream); 2H:1V (downstream) (or flatter) | KP Estimate |
| | | • Embankment Crest Width: 6 m (minimum) | KP Estimate |
| | | • Dry Freeboard: 0.5 m (above peak IDF water level) | KP Estimate |
| | | • Wet Freeboard: 1 m | KP Estimate |
| | | • Sediment Storage: approximately 0.5 m deep | KP Estimate |
| | | • Minimum set back of 31 m from the high-water mark of nearby waterbodies | Type A Water Licence (NWB, 2015) |
| 3.2 | Liner | • Geomembrane Liner: Layfield's EL6060, 60 mil low linear density polyethylene geomembrane | Baffinland |
| | | • Liner Installation: Liner to be pre-welded in large panels as feasible | Baffinland |
| | | • Non-Woven Geotextile: Layfield's LP7, 7 oz/yd$^2$ | Baffinland |
| 3.3 | Water Removal Systems | • Sedimentation Ponds: Water will be removed from sedimentation ponds as follows: | |
| | | o Runoff contained below the spillway invert will be pumped to water treatment or will be treated in the pond and pumped to the environment once it meets discharge requirements | Golder, 2018; KP Estimate |
| | | o Runoff from events larger than the pond storage capacity but less than or equal to the IDF will be conveyed to the environment via the emergency spillway | Hatch, 2013 and 2018a |
| | | • Emergency spillways for sedimentation ponds will have the following configuration: | |
| | | o Shape: Trapezoidal or rectangular cross section | KP Estimate |
| | | o Depth: up to 1.5 m | KP Estimate |
| | | o Side Slopes: 2H:1V or vertical | KP Estimate |
| | | o Minimum slope in the direction of flow of 1% | KP Estimate |
| 3.4 | Stability | • Factors of Safety: | CDA, 2013 and 2019 |
| | | o Static: 1.5 (overall embankment stability); 1.3 (slip surface along geomembrane) | |
| | | o Pseudo-Static: 1.0 | |
| | | o Post-Earthquake: N/A | |
| 3.5 | Seismic Design Criteria | • Embankments to be designed to withstand Annual Exceedance Probability (AEP) Earthquake, based on Dam Hazard Classification | CDA, 2013 and 2019, and NRC, 2015 |
| **4.0** | **OTHER WATER MANAGEMENT STRUCTURES** | | |
| 4.1 | General | • Minimum set back of 31 m from fish-bearing streams and lakes or water bodies shall be provided | Hatch, 2018a |
| 4.2 | Diversion/Collection Ditches | • Shape: Trapezoidal cross section | Hatch, 2013 |
| | | • Base Width: 0.5 m minimum | Hatch, 2013 |
| | | • Side Slopes: 2H:1V (soil); 1H:4V (rock) | Hatch, 2018a |
| | | • Grade: 0.2% minimum | Hatch, 2018a |
| | | • Depth: 0.3 m minimum | Hatch, 2013 |
| | | • Freeboard: 0.3 m | Hatch, 2018a |
| | | • Minimum set back distance of structures from top of ditch slopes: 3 m | Hatch, 2018a |
| | | • Riprap and other energy dissipation measures shall be provided to protect against erosion (as required) | Hatch, 2018a |
| | | • Manning's "n" Value: 0.025 (gravel); 0.040 (riprap) | Hatch, 2018a |
| 4.3 | Diversion/Collection Berms | • Shape: Trapezoidal cross section | Hatch, 2013 |
| | | • Side slopes: 2H:1V | Hatch, 2018a |
| | | • Freeboard: 0.3 m | Hatch, 2018a |
| | | • Height: 1 m minimum (including 0.3 m freeboard) | Hatch, 2013 |
| | | • Top Width: 0.5 m | Hatch, 2018a |
| | | • Riprap and other energy dissipation measures shall be provided to protect against erosion (as required) | Hatch, 2018a |
| 4.4 | Culverts | • Material: Corrugated Steel Pipe (CSP) | Hatch, 2018a |
| | | • Minimum Diameter: 600 mm (1,000 mm for fish-bearing and only one pipe embedded by 10% of the pipe diameter) | Hatch, 2018a |
| | | • Minimum cover: 600 mm | Hatch, 2018a |
| | | • Manning's "n" Value: 0.024 | Hatch, 2018a |

Knight Piésold CONSULTING

**TABLE A.1**

**BAFFINLAND IRON MINES CORPORATION**
**MARY RIVER PROJECT**

**MINE SITE WATER MANAGEMENT PLAN**
**PROPOSED DESIGN CRITERIA**

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| Item No. | Item | Design Criteria | Reference |
|---|---|---|---|
| **5.0** | **CONSTRUCTION** | | |
| 5.1 | General | ● During construction, sediment and erosion control measures will be used as outlined in the following: | |
| | | o Environmental Protection Plan | Baffinland, 2021a |
| | | o Surface Water and Aquatic Ecosystems Management Plan | Baffinland, 2021b |
| 5.2 | Source of Materials | ● Approved sources following Water Licence No. 2AM-MRY1325 Amendment No. 1 | NWB, 2015 |
| 5.3 | Quality of Materials | ● Clean, free of debris and organics | KP Estimate |
| 5.4 | Description of Materials | ● Potential Construction Materials (to be confirmed with Baffinland and design analyses): | |
| | | o 500 mm Minus Rockfill: Well graded; consisting of hard, durable, fresh rockfill | KP Estimate |
| | | o Transition Zone 2: Well graded, 150 mm minus processed rockfill | KP Estimate |
| | | o Transition Zone 1: 32 mm minus medium sand and gravel, locally borrowed and processed | Baffinland and KP Estimate |
| | | o Liner Bedding: 19 mm minus sand and gravel | Baffinland and KP Estimate |
| | | o Glacial Till: 38 mm minus till, locally borrowed | |
| | | o Gabion Rockfill: Stone size 120 to 250 mm; $D_{50}$ of 190 mm | KP Estimate |
| | | o 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, 2018) |
| | | - Fine Riprap: $D_{50}$ of 150 mm | |
| | | - Coarse Riprap: $D_{50}$ of 300 mm | |
| **6.0** | **OPERATING CRITERIA** | | |
| 6.1 | Inspections and Maintenance | ● As required, based on Baffinland's standard operating procedures (in progress): | |
| | | o Inspect the water removal system from the ponds to ensure each component is performing as designed | |
| | | o Inspect the ponds to ensure the liners are in good condition, there are no visible holes or leaks, there is no erosion of the embankments or spillways, and the embankments and spillways are performing as designed | |
| | | o Inspect the diversion/collection ditches and berms to ensure there is no erosion of the ditches or berms, and no material is blocking flow along the ditches or berms | |
| | | o Inspect the culverts to ensure there is no erosion of the fill material surrounding each culvert or of the erosion protection material upstream or downstream of each; ensure no material is blocking flow through the culvert | |
| | | ● Prior to, during or following freshet, and after any large storm event: | |
| | | o Inspect the ponds to ensure the lining systems are in good condition, there are no visible holes or leaks, there is no erosion of the embankments or spillways, and the embankments and spillways are performing as designed | |
| | | o Ensure the ponds are emptied prior to freeze up and shortly following freshet or a storm event, while meeting discharge water quality requirements | |
| | | o Inspect the diversion/collection ditches and berms to ensure there is no erosion of the ditches or berms, and no material is blocking flow along the ditches or berms | |
| | | o Inspect the culverts to ensure there is no erosion of the fill material surrounding each culvert or of the erosion protection material upstream or downstream of each; ensure no material is blocking flow through the culvert | |
| 6.2 | Operations | ● In general, sedimentation ponds should be operated at the top of the dead storage | |
| | | ● Decant outlet pipes will be drained and capped prior to winter in order to minimize ice build up in the pipes prior to freshet | |
| | | ● When decants can not be used, pumps will be used instead to drain the ponds | |
| | | ● Flocculants, geotubes or other approved methods may be required in order to meet sedimentation requirements | |

I:\1\02\00181\71\A\Data\Work Files\WF02 - Updated Design Criteria\[Table A1 Proposed Design Criteria Rev 1.xlsx]Table

| | | | | |
|---|---|---|---|---|
| 1 | 24JUN'21 | REVISED WATER MANAGEMENT MEASURES | DMMD | RAC |
| 0 | 09APR'21 | ISSUED WITH REPORT NB102-181/63-1 | DMMD | RAC |
| REV | DATE | DESCRIPTION | PREP'D | RVW'D |

# APPENDIX B

## Site Visit Photo Log

(Pages B-1 to B-11)

**PHOTO 1** - Graded material and swale cut through material to ditch along Mine Haul Road (MHR).

**PHOTO 2** - Erosion of cut overburden slope along MHR.

**PHOTO 3** - Seepage daylighting along MHR.

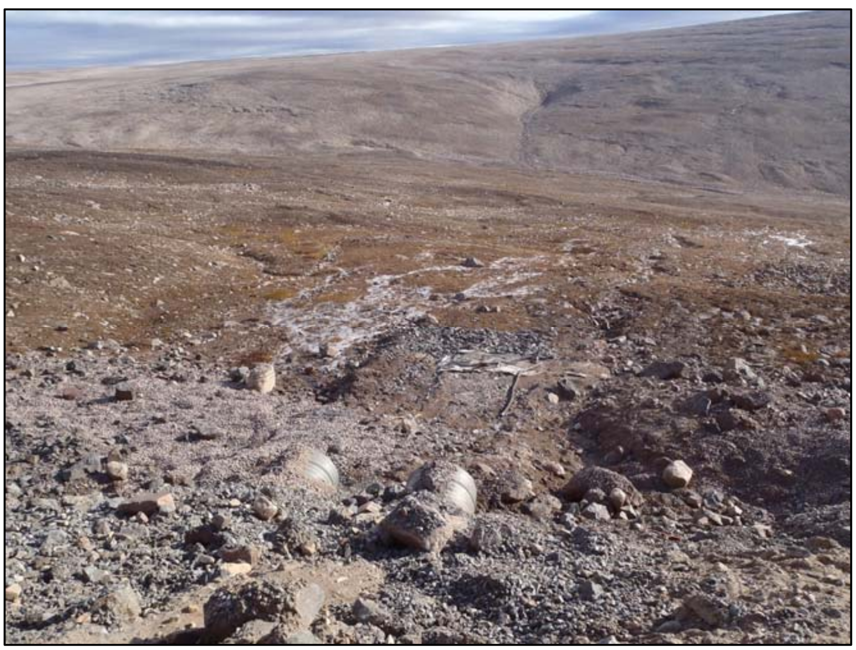

**PHOTO 4** - Outlet of MHR culverts.

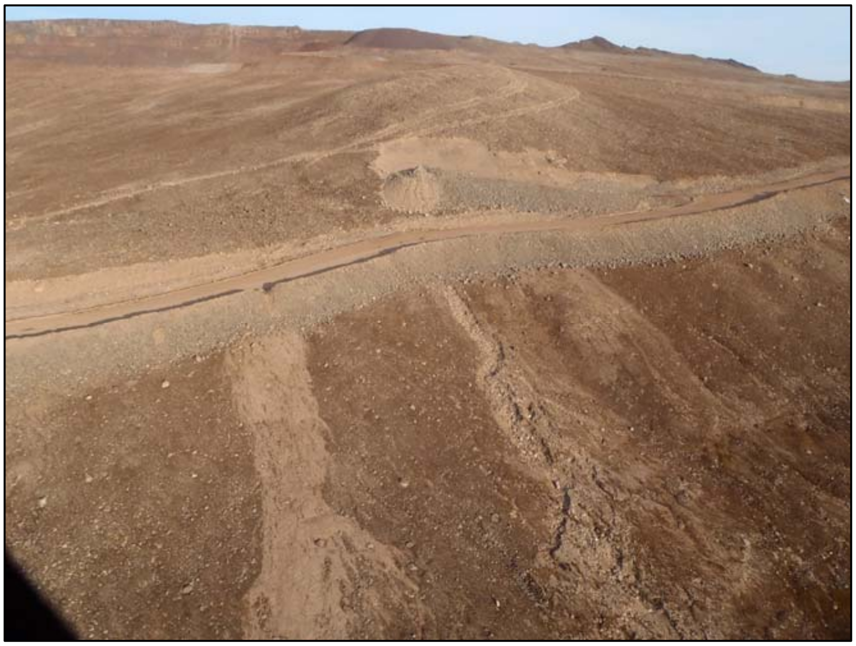

**PHOTO 5** - Erosion of slope downstream of MHR culverts and cut in safety berm.

**PHOTO 6** - Culvert inlet with steel rod and remnants of geotextile.

**PHOTO 7** - Check Dam #1 along MHR.

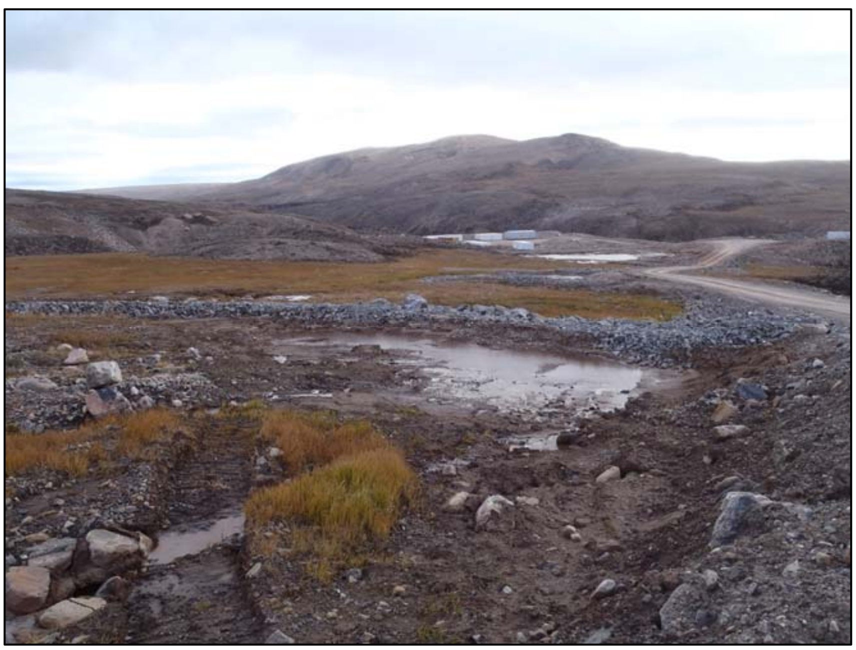

**PHOTO 8** - Check dams by explosive magazine.

**PHOTO 9** - Check dam in explosive magazine area.

**PHOTO 10** - Truck weigh scale and trench for drainage.

**PHOTO 11** - Berm and perimeter ditch around Crusher Facility.

**PHOTO 12** - Crusher Facility Surface Water Management Pond.

**PHOTO 13** - Sailiivik Camp laydown area check dams.

**PHOTO 14** - Finer material on bank of the Mine Site Road in culvert area.

**PHOTO 15** - Eroded material downslope of airstrip area.

**PHOTO 16** - Erosion along Mine Site Road at Tributary 3 to Camp Lake.

**PHOTO 17** - Silt fences downstream of Quarry QMR2.

**PHOTO 18** - Quarry QMR2 and berm.

**PHOTO 19** - Check dams and sediment traps by Water Jetty.

**PHOTO 20** - Check dams near Water Jetty.

**PHOTO 21** - Remnants of snow stockpile near Weatherhaven Camp.