SNAP LAKE MINE

North Pile Management Plan V.3

March 2019
## REVISIONS HISTORY

<table>
<thead>
<tr>
<th>Version</th>
<th>Notes/Revisions</th>
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| 1       | August 2014     | - Section 2.2, page 10: Table 2 was updated to provide new projections for paste underground for 2014 and 2015  
- Section 2.3, page 10: Figure 3 was updated to provide a revised project schedule to align with West Cell Design  
- Section 2.3.3, page 14: Figure 5 was provided to show Phase I construction and deposition of the West Cell  
- Section 2.7.2, page 21: Surface Capture and Storage was revised to provide additional capacity through perimeter sump 5 expansion  
- Section 2.7.2, page 22: Table 4 was revised to provide the capacity of perimeter sump 5, post expansion, and overall capacity for all water control structures  
- Section 2.7.2, page 22: The “Starter Cell/East Cell/West Sumps” was updated to provide West Cell water control design parameters and process water from deposited Fine PK  
- Section 2.7.2, page 23: The “Sump Sequencing” section was updated to provide the most recent information for the Water Management Pond capacity  
- Section 3.1, Page 39: Figure 10 was provided to illustrate the instrumentation plan for Phase I of the West Cell |
| 2       | June 11, 2018   | - Section 2.5.2: Added the missing bullets from Section 2.5.2 as requested by ECCC.  
- Appendix C: Recommendation from the Engineer of Record regarding frequency of inspections of the North Pile facility during periodic zero occupancy attached in Appendix C.  
- Section 1.1: Updated Section 1.1 as per the additional De Beers’ response following on from Reviewer Comment ENR-4 regarding information pertaining to zero occupancy.  
- Section 2.0 Updated Section 2.0 to reference the latest Waters Act.  
- Section 1.1: Removed sentence ‘The North Pile will be kept in a stable state that will allow for the re-start of operations of the mine’ in Section 1.1 as per Reviewer Comment Lands-2.  
- Section 3.0: Figure 9 – Starter Cell/East Cell instrumentation was removed – an updated version of all instrumentation locations on the North Pile is within the Golder report regarding ‘Response framework & action levels’ within Appendix A  
- Section 3.0: Figure 10 – Starter Cell/East Cell instrumentation was removed – an updated version of all instrumentation locations on the North Pile is within the Golder report regarding ‘Response framework & action levels’ within Appendix A  
- Multiple figures in different sections: Updated Figure numbers to reference the appropriate information as recommended.  
- Entire Plan: Completion of a quality assurance & quality control review of the entire Plan to ensure all figures & references are correct, and language is up to date. |
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|         |                | • Appendix A: Updated Appendix A with revised ‘Response Framework for the North Pile and WMP’ that better correlates with the current status of Snap Lake Extended Care & Maintenance.  
• Appendix B & C: Added Appendices B & C, entitled ‘Instrumentation Monitoring Frequencies’ and ‘Recommended Inspection and Frequency for Zero Occupancy’ submitted by the Engineer of Record.  
• Section 2.2.2: Removed Table 2 – Waste Rock & Kimberlite ore analyzed for Sulphide and updated text in Section 2.2.2  
• Figure 4 & Figure 5: Updated Figure 4 and added Figure 5 that refers to the current Surveillance network program locations |
| 3       | March 2019     | All Sections: Plan has been updated to align with the Final Closure Plan and water licence application package |
TABLE OF CONTENTS

REVISIONS HISTORY .......................................................................................................................... I
ACRONYMS AND ABBREVIATIONS ................................................................................................. V
UNITS OF MEASURE ......................................................................................................................... VI
1. INTRODUCTION ............................................................................................................................. 1-1
  1.1 History of the North Pile Management Plan .............................................................................. 1-1
  1.2 Background ............................................................................................................................... 1-1
  1.3 General Site Conditions .......................................................................................................... 1-2
    1.3.1 Location ............................................................................................................................ 1-2
    1.3.2 Site Geology ..................................................................................................................... 1-2
    1.3.3 Climate ............................................................................................................................ 1-2
    1.3.4 Permafrost ....................................................................................................................... 1-2
    1.3.5 Seismicity ........................................................................................................................ 1-2
  1.4 Closure Design Work Packages ............................................................................................. 1-4
2. CLOSURE DESIGN DESCRIPTIONS ......................................................................................... 2-1
  2.1 North Pile Closure Cover ....................................................................................................... 2-1
  2.2 North Pile Surface Water Management for Closure ............................................................ 2-2
  2.3 North Pile Passive Treatment Systems .................................................................................. 2-6
3. CONSTRUCTION ......................................................................................................................... 3-1
  3.1 Material Type and Quantities for Construction ..................................................................... 3-1
    3.1.1 Geochemical Characterization ....................................................................................... 3-1
    3.1.2 North Pile Closure Cover Material Quantities ............................................................... 3-1
    3.1.3 Surface Water Management Material Quantities .......................................................... 3-2
    3.1.4 Constructed Wetland Material Quantities ....................................................................... 3-3
  3.2 Construction Specifications ..................................................................................................... 3-3
  3.3 Quality Control ....................................................................................................................... 3-3
4. MONITORING .............................................................................................................................. 4-1
  4.1 Closure and Post-Closure Monitoring .................................................................................... 4-1
5. REFERENCES ............................................................................................................................... 5-1
List of Figures

Figure 1.1 Map of Snap Lake Mine Location ......................................................... 1-3
Figure 2-1 North Pile Cover Design ........................................................................... 2-3
Figure 2-2 Post-Closure Water Management Arrangement ..................................... 2-5
Figure 2-3 Constructed Wetlands Site Layout ............................................................ 2-7

List of Tables

Table 3-1 North Pile Rock Cover Borrow Sources .................................................... 3-2
Table 3-2 Surface Water Management Material Quantities ........................................ 3-2

List of Appendices

APPENDIX A CLOSURE AND POST-CLOSURE GEOTECHNICAL MONITORING PLAN FOR NORTH PILE FACILITY AND PASSIVE TREATMENT SYSTEMS, SNAP LAKE MINE
# ACRONYMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AP</td>
<td>Acid potential</td>
</tr>
<tr>
<td>ARD</td>
<td>Acid rock drainage</td>
</tr>
<tr>
<td>BOD</td>
<td>Biochemical oxygen demand</td>
</tr>
<tr>
<td>CCME/GM</td>
<td>Canadian Council of Ministers of the Environment</td>
</tr>
<tr>
<td>CEMF</td>
<td>Cumulative effects management framework</td>
</tr>
<tr>
<td>De Beers</td>
<td>De Beers Canada Inc.</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td><em>Escherichia coli</em></td>
</tr>
<tr>
<td>EAR</td>
<td>Environmental Assessment Report (De Beers 2002)</td>
</tr>
<tr>
<td>ECM</td>
<td>Extended Care &amp; Maintenance</td>
</tr>
<tr>
<td>EOR</td>
<td>Engineer of Record</td>
</tr>
<tr>
<td>EPTS</td>
<td>East Passive Treatment System</td>
</tr>
<tr>
<td>EQC</td>
<td>Effluent quality criteria</td>
</tr>
<tr>
<td>FWS</td>
<td>Free Water Surface</td>
</tr>
<tr>
<td>HK</td>
<td>Hypabyssal Kimberlite</td>
</tr>
<tr>
<td>ICP-MS</td>
<td>Inductively Coupled Plasma Mass Spectrometry</td>
</tr>
<tr>
<td>IL6</td>
<td>Inland Lake 6</td>
</tr>
<tr>
<td>ISP</td>
<td>Influent Storage Pond</td>
</tr>
<tr>
<td>KNC</td>
<td>Ktunaxa Nation Council</td>
</tr>
<tr>
<td>MG</td>
<td>Multi-Phase Granitoid</td>
</tr>
<tr>
<td>MGF</td>
<td>Multi-Phase Granitoid Fractured rock</td>
</tr>
<tr>
<td>MTVC</td>
<td>Metavolcanic rock</td>
</tr>
<tr>
<td>MVEIRB</td>
<td>Mackenzie Valley Environmental Impact Review Board</td>
</tr>
<tr>
<td>MVLWB</td>
<td>Mackenzie Valley Land and Water Board</td>
</tr>
<tr>
<td>MWTP</td>
<td>Modular Water Treatment Plant</td>
</tr>
<tr>
<td>NP</td>
<td>Neutralization potential</td>
</tr>
<tr>
<td>Non-AG</td>
<td>Non-acid generating</td>
</tr>
<tr>
<td>PAG</td>
<td>Potentially acid generating</td>
</tr>
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</table>
PK  Processed kimberlite
PS  Perimeter sump
PWCS  Perimeter water control structures
SNP  Surveillance network program
TDS  Total dissolved solids
The Mine  Snap Lake Mine
The North Pile  North Pile Waste Rock & Processed Kimberlite Storage Facility
The Plan  North Pile Management Plan
TRP  Technical Review Panel
TS  Temporary Sump
TSS  Total suspended solids
UTM  Universal Transverse Mercator
WCS  Water control structures
WMP  Water Management Pond
WPTS  West Passive Treatment System
WTP  Water Treatment Plant

UNITS OF MEASURE

%  percent
°C  degrees Celsius
kg  kilogram
km  kilometre
M  million
m  metres
m³  cubic metres
m³/d  cubic metres per day
m³/h  cubic metres per hour
mg/L  milligrams per litre
1. INTRODUCTION

The information outlined in this document is based on Snap Lake Mines closure designs for the processed kimberlite facility (North Pile) and associated water control structures. Upon approval of the detailed designs, De Beers will begin construction of these final closure facilities. During construction and prior to plan and design approval, De Beers will adhere to the previously approved North Pile Management Plan for extended care and maintenance (ECM).

1.1 History of the North Pile Management Plan

The Plan was submitted to the Mackenzie Valley Land and Water Board (MVLWB) in January of 2005 for the North Pile Starter Cell perimeter water control structures, and updated in April 2005 for the Starter Cell embankment design and deposition activities. After receiving reviewer comments the Plan was resubmitted in July 2005 and approved in November 2005. In November 2008 a revised Plan was submitted to the MVLWB. The Plan was resubmitted on November 4, 2009 so construction of the East Cell could commence; however, the Plan was denied approval on December 17, 2009. The plan was updated in 2013 to reflect a water license update and more recently, in 2015 to address the construction of the West Cell. This plan was then updated for ECM in March, 2018 in order to allow for a periodic, zero occupancy at site that is in agreement with the Mine Engineer of Record’s recommendations. This latest update to the plan is intended to be reflective of the closure designs for the North Pile, perimeter water control structures and passive treatment systems.

1.2 Background

The Snap Lake Mine is a former underground diamond mine owned and operated by De Beers Canada Inc. (De Beers). The Snap Lake Mine operated from 2008 to 2015. In December of 2015, De Beers ceased diamond mining operations and put the Mine into a temporary closure phase called Care and Maintenance. Since the suspension of operations, the deposition of processed kimberlite and waste rock has ceased.

In December of 2017, De Beers announced its plan to put the Snap Lake Mine into final closure. In 2018 De Beers prepared a Final Closure Plan and updated all the environmental monitoring and management plans to align with plans for final closure of the Mine. These management plans, including this North Pile Management Plan are submitted as part of the water licence renewal process required by the Mackenzie Valley Land and Water Board. The entire package of environmental monitoring and management plans are designed to describe the activities at the Mine during closure and Post-Closure phases of the mine life.

In September of 2018 De Beers closed the camp and related facilities for the winter and began a period of zero occupancy. Remote monitoring and surveillance has continued during this time with a particular focus on all waste and water storage facilities. De Beers has continued to meet the terms and conditions of the water licence and land use permit as well as all approved environmental monitoring and management plans during the extended care and maintenance period. Activities at the Mine are now conducted on a seasonal or campaign basis.
It is assumed that the Closure phase begins upon approval of the Final Closure and Reclamation Plan and issuance of the renewed water license. The Post-Closure phase begins when active management of the Mine has ceased and activities are predominantly limited to monitoring.

1.3 General Site Conditions

The following site conditions at Snap Lake have been used to form the basis for all designs used in the existing general arrangement of the North Pile and perimeter water control structures as well as for the future closure design related to these facilities.

1.3.1 Location

De Beers owns Snap Lake Mine located 220 km Northeast of Yellowknife, Northwest Territories, at a latitude of 63°36’19” N and a longitude of 110°52’00” W as shown on Figure 1-1. The Mine is located on the northeast peninsula of the western shore of Snap Lake, in an isolated area of the Northwest Territories with no permanent access roads (Figure 2-1). Access to the site is by aircraft or a winter ice road that spurs off the main winter road from Yellowknife to the Lupin Mine.

1.3.2 Site Geology

Bedrock outcrops are common on the site with a veneer of Quaternary morainal deposits (mineral soil) of variable thickness. The mineral soil contains cobbles and boulders within a finer-grained matrix of sand and silt. Fields of boulders, felsenmeer and shattered rock debris are found in some topographic depressions on the site. Unconsolidated lacustrine deposits are sporadically located around the lakeshore. Deposits of organic material are also found in low-lying areas at the site.

1.3.3 Climate

The climate generally consists of short cool summers and long cold winters having average monthly surface temperatures between about -32 °C and -15.9 °C, respectively.

1.3.4 Permafrost

Permafrost is defined as bedrock or soil at or below 0 °C for a continuous period of two or more years. The ground above the top of the permafrost is the active layer; this layer freezes and thaws seasonally. The project site is situated just north of the diffuse border between the zones of discontinuous and continuous permafrost.

1.3.5 Seismicity

Snap Lake Mine lies within a region of low seismicity.
Figure 1.1 Map of Snap Lake Mine Location
1.4 Closure Design Work Packages

The closure designs pertaining to the North Pile and water control structures have been developed by Golder Associates Ltd. following a progressive sequence of design stages from an options analysis selection process, concept and finally detailed design over the course of 2017 and 2018. The three major design work packages for closure of the North Pile and water control structures are as follows:

- North Pile Closure Cover Detailed Design;
- North Pile Surface Water Management for Closure Detailed Design; and
- North Pile Passive Treatment Systems Detail Design.

Each work package includes the design criteria, detailed engineering designs, construction and quality control plans, material quantities/source identification and monitoring requirements Post-Closure. More information regarding these design reports can be found in the following sections of this report, as well as with reference to the reports themselves.

The main goal of these designs are that the water management system is:

1. Protective of the environment and consistent with the closure objectives and criteria,
2. Passive; relying only on gravity flow between the integrated design,
3. Requires limited intervention during operations; and,
4. License compliance can be achieved throughout closure and Post-Closure.

Upon achieving the proposed effluent quality criteria and water quality objectives, De Beers has designed its passive management systems to allow for mine relinquishment so the system can flow without intervention via spillways and a robust design.
2. CLOSURE DESIGN DESCRIPTIONS

2.1 North Pile Closure Cover

The main objectives of the North Pile closure cover design are to protect the facility from erosion, to promote dust control and to convey surface water off of the North Pile. Full details are covered in the North Pile Closure Cover Detailed Design report produced by Golder and provided as an appendix to the Final Closure and Reclamation Plan. Refer to Figure 2-1 for a plan view of the closure cover and typical closure cover cross section details.

Activities for implementing the North Pile closure cover design will include the following:

1. Re-grading the slope of the west perimeter embankment of the Starter & East Cells.
2. Infilling of the interior compartments of the Starter & East Cells.
3. Placement of a final cover layer of coarse material over the entire North Pile for erosion protection purposes.
4. Construction of swales and spillways on the final surficial cover of the North Pile to the perimeter ditches and influent storage ponds.

The west perimeter embankment of the Starter & East Cells was intended to join with the West Cell, however the West Cell was never developed due to the cessation of Mine operations and has therefore been left exposed. To promote long-term stability of the North Pile and allow wildlife access and egress, the slope will be re-graded as a simple cut to fill operation from a 1.5H:1V grade to a 3H:1V slope grade where required.

Infilling of the interior compartments of the Starter & East Cells will be developed by a number of separate material layers, dependent on the area. The fine PK that was deposited inside of these compartments during operations will be covered by either a combination of landfill waste materials from onsite demolition activities, followed by a transition layer and a surficial layer of erosion protection cover or otherwise by a transition layer and a surficial layer of erosion protection cover where landfill waste materials are not placed. The transition layer will be the coarse PK that was used in the construction of the North Pile perimeter embankments and will be utilized for grain size compatibility between the erosion protection cover and the underlying deposited fine PK material. The coarse PK layer will also be utilized in combination with the erosion protection layer to cover areas where the landfill waste has been deposited to achieve a total closure cover thickness of 2m to surface as per previous Closure commitments. The erosion protection will be a nominal 0.3m final cover layer over the entire North Pile (outside of spillways and swales that will be constructed with larger rip-rap material) with a nominal 2% gradient toward swales and further to outlet channel spillways at both the western and eastern ends of the East Cell for water conveyance off of the North Pile. Embankment surfaces of the North Pile will only be required to be covered with an erosion protection layer. All material used in the North Pile cover will be non-acid generating.

Components of the surface water management system for the North Pile closure cover are:

- A western swale to convey water flow from the west portion of the East Cell toward the Cell 1 outlet channel located west of Cell 1.
- Cell 1 outlet channel to convey surface water flow from the west swale toward the existing west perimeter drainage ditch.
- An eastern swale to convey surface water flow from the east portion of the East Cell toward the Cell 5 outlet channel located east of Cell 5.
- Starter Cell swale to convey surface water from the entire Starter Cell toward the Cell 5 outlet channel located east of Cell 5.

The two outlet channels located at Cell 1 and Cell 5 of the East Cell will convey surface water to the influent storage ponds and further into the constructed wetlands. A surface water management analysis of the closure cover was performed to adequately size swales and outlet channels on the North Pile to accommodate peak runoff flow rates and volumes. Results of the analyses determined the length, width, depth, side slope, and revetment for the Cell 1 and Cell 5 channel outlets and three cover swales.

Slope stability analyses were performed at selected locations on the North Pile facility to confirm physical stability of the North Pile closure cover detailed design. Results of the stability analyses indicate the North Pile closure cover geometry satisfies the Canadian Dam Association and Anglo-American Standards’ minimum static and pseudo-static factor of safety requirements for a closed facility during post-closure period.

### 2.2 North Pile Surface Water Management for Closure

The main objective of the North Pile surface water management structures presented in this document is to allow gravity collection and conveyance of North Pile drainage (seepage and runoff) to the passive treatment facilities prior to discharge to the environment. Details are provided in Water Management Plan for Snap Lake Mine Closure: With respect to design it is provided in its entirety in the North Pile Surface Water Management for Closure Detailed Design produced by Golder and provided as an appendix to the Final Closure and Reclamation Plan.

With respect to water conveyance from the North Pile into the Passive Management System two design events were considered for the detailed design of the North Pile closure water management structures:

- Environmental Design Flood (EDF): 200-year, 24-hour storm event plus snowmelt.
- Inflow Design Flood (IDF): probable maximum precipitation (PMP) 24-hour storm event plus snowmelt.

For events up to and including the EDF event, drainage from the North Pile will be managed within the passive water management treatment facilities. Potential discharge to the environment during events greater than the EDF event (up to and including the IDF) will occur at controlled locations and without compromising the stability of the North Pile embankments and/or the water control structures around the North Pile facility.

The North Pile closure water management concept and structures are designed to meet the following objectives:

1. to provide gravity conveyance;
2. to be physically stable over the long-term;
Figure 2-1  North Pile Cover Design
3. to not pose a risk to wildlife and human land use (as commensurate with engineering design) and meet general closure criteria and objectives proposed for the closure of the mine;
4. to meet proposed Effluent Quality Criteria at the discharge into Snap Lake;
5. to preserve access to various locations at the site; and
6. to use existing water management infrastructure to the extent practical.

The water management design developed to meet the above criteria includes the following infrastructure:

- Swales to collect runoff on the closure cover of the North Pile, presented in the North Pile Closure Cover Detailed Design report;
- Outlet channels constructed down the east and west embankments of the North Pile to convey runoff from the top surface of the North Pile, considering the detailed design of the North Pile closure cover, and direct it into the passive treatment systems;
- Perimeter channels constructed along the north and south of the North Pile to collect seepage and runoff from the North Pile and direct it into the passive treatment system;
- A channel through the West Cell Divider Dyke to prevent ponding of water behind the dyke and direct drainage to the passive treatment system on the west side of the North Pile; and
- Passive treatment systems to reduce concentration of key parameter of concern (nitrate) prior to discharge to Snap Lake, presented in the North Pile Passive Treatment Systems Detail Design report.

The North Pile perimeter collection system will be compromised of systems on both the north and south of the North Pile (as per Figure 2-2). The north perimeter collection system will incorporate the following works:

- Backfill of PS4 to elevation required to convey North Pile drainage towards the influent storage pond of the WPTS, including ditch on backfill surface and liner to prevent seepage into Snap Lake.

The south perimeter collection system will incorporate the following works:

- Backfill of PS1 to bedrock surface elevation including ditch on backfill surface.
- Connection ditch between PS1 and PS2.
- Backfill of PS2 to bedrock surface elevation.
- Connection ditch between PS2 and PS3 (PS3 will be the influent storage pond of the EPTS).

Two influent storage ponds located at the existing PS3 and PS5 sumps, for the East and West Passive Treatment Systems, will include:

- Emergency spillway to Snap Lake (for events higher than EDF).
- Outlet pipe(s) to constructed wetlands.
Figure 2-2  Post-Closure Water Management Arrangement
2.3 North Pile Passive Treatment Systems

The main objective of the North Pile water treatment systems are to treat surface water originating from the North Pile water management structures and ensure effluent quality are achieved until water can be directly discharged into the environment. Details are provided in Water Management Plan for Snap Lake Mine Closure: With respect to design it is provided in its entirety in the North Pile Passive Treatment Systems Detail Design produced by Golder and provided as an appendix to the Final Closure and Reclamation Plan.

There are two passive treatment systems: a west passive treatment system (WPTS) and an east passive treatment system (EPTS). The WPTS treats water collected from Sump 4 catchment, west cell upper catchment area (former location of TS4), and Sump 5. The EPTS treats water collected from Sump 1, Sump 2, and Sump 3 catchments. This two system configuration allows flow to be conveyed via gravity from the water sources, as described in the previous section 2.2 of this Plan. Each system has the same process train which includes an influent storage pond (ISP) followed by a free water surface constructed wetland, from which treated water is discharged to Snap Lake. During warm months when water on site is above freezing, water will be conveyed through the system by gravity flow and does not require pumping. Flow will stop for a long period of the year when the water on site is frozen.

The design flow for the WPTS is 2,156 m$^3$/d and requires approximately 8.6 hectares of space for the ISP, and 5.2 hectares of space for the FWS constructed wetland. The design flow for the EPTS is 2,286 m$^3$/d and requires approximately 4.3 hectares of space for the ISP, and 6.7 hectares of space for the FWS constructed wetland. The layout of the passive treatment systems can be found in in Figure 2-3. The wetlands are designed for treatment of nitrate, to meet the proposed 25 mg/L (as N) nitrate effluent quality criteria (EQC) objective. The design flows, and wetland sizing are based on a water temperature of 5 degrees Celsius. As the wetlands remove nitrate based on biological activity, they are able to accommodate higher than design flow rates when the temperature increases above 5 degrees Celsius. Further detail regarding the biological treatment process to occur within the constructed wetlands can be referred to in the detailed design report submitted by Golder, entitled North Pile Passive Treatment Systems Detail Design.
Figure 2-3  Constructed Wetlands Site Layout
3. CONSTRUCTION

3.1 Material Type and Quantities for Construction

3.1.1 Geochemical Characterization

During operations, the site technical services department characterized underground rock to determine sulphide content and dictate placement of material that had the potential to be acid generating. Coupled with this, any material that could be potentially acid generating (PAG) was internalized within the pile and the location recorded. Specifically, PAG was to be excluded from zones within 50m of the downstream toe of any perimeter embankment and 3m from the expected ultimate North Pile closure surface. During ECM no ongoing sulphide sampling is occurring. De Beers continues to monitor acid rock drainage and geochemistry and this is reported annually as a component of the Water License Annual Report. Historic placement information is utilized for periodic site model updates and has been used as a part of the final closure designs.

Under closure considerations, the acid based accounting (ABA) data was further evaluated to develop an overall acid generation potential for a blended unit, rather than analyzing singular rock types on a case by case basis for acid generation. As such, only where blended materials contain greater than 0.17% (by weight) of total Sulphur, or where NP:AP is less than 2, will the material now be classified as acid generating. This is considered reasonable in the case of Snap Lake Mine closure when considering that materials were well mixed through blasting, trucking, dumping, and dozing processes as a part of the North Pile construction.

Where material contains greater than 0.17% (by weight) of total Sulphur, or where NP:AP is less than 2, the following measures will be taken where related to the North Pile for closure:

- Exclude possible PAG material from cover construction for both surface and on side slopes.
- As an added mitigation measure for the west perimeter embankment where PAG material may have been placed closer than 3m to surface and within 50m of the downstream toe (due to the fact that the west perimeter embankment was expected to be covered during the construction of the West Cell), place a small amount of PK (toe berm of approximately 1m in thickness extending 3m laterally, at the base of any seepage faces) to supply excess buffering capacity in this area.

3.1.2 North Pile Closure Cover Material Quantities

Four different types of rock material are required for construction of the North Pile closure cover: transition, erosion protection cover, embankment, and riprap. In total, 566,300 m$^3$ of borrow material is required, which are locally available; no off-site material will be required. Available borrow material sources are summarized in Table 3-1.

These borrow source material quantities do not require blasting. In certain cases, buildings in the area will need to be demolished and removed prior to material being directly accessible for use. Note all specifications regarding the grain size distributions for the different material uses can be referred to in the associated quality control plan of the North Pile Closure Cover Detailed Design.
Table 3-1  North Pile Rock Cover Borrow Sources

<table>
<thead>
<tr>
<th>Borrow Area</th>
<th>Location</th>
<th>Primary Use</th>
<th>Available Quantity Estimate (m$^3$)</th>
</tr>
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<tbody>
<tr>
<td>Embankment/rib berm</td>
<td>within North Pile</td>
<td>Transition + Erosion protection cover</td>
<td>118,800</td>
</tr>
<tr>
<td>Crusher Stockpile</td>
<td>west of North Pile</td>
<td>Erosion protection cover material</td>
<td>11,200</td>
</tr>
<tr>
<td>Explosive Management Bunker</td>
<td>west of East Cell</td>
<td>Erosion protection cover material</td>
<td>1,700</td>
</tr>
<tr>
<td>Laydown Area</td>
<td>southeast of North Pile</td>
<td>Erosion protection cover and/or transition material</td>
<td>256,000</td>
</tr>
<tr>
<td>Organic Stockpile</td>
<td>former AN storage facility</td>
<td>Riprap</td>
<td>29,400</td>
</tr>
<tr>
<td>SP5 Quarry</td>
<td>North of East Cell, Cell 1</td>
<td>Erosion protection cover and/or transition material</td>
<td>68,200</td>
</tr>
<tr>
<td>West Cell Divider Dyke</td>
<td>North Pile West Cell</td>
<td>Embankment fill and/or erosion protection cover materials</td>
<td>81,000</td>
</tr>
</tbody>
</table>

3.1.3  Surface Water Management Material Quantities

Table 3-2 shows the material quantities required for all surface water management structures to be constructed for Mine closure.

Table 3-1  Surface Water Management Material Quantities

<table>
<thead>
<tr>
<th>Structure</th>
<th>Type and Quantities (m$^3$)</th>
</tr>
</thead>
</table>
| Cell 5 outlet channel            | Excavation of 21,000 m$^3$  
Common fill of 100 m$^3$  
Transition material of 1,400 m$^3$  
Various rip-rap material sizes total of 8,400 m$^3$ |
| South perimeter ditch            | Bedrock blasting of 36,500 m$^3$  
Excavation of 66,100 m$^3$  
Common fill of 45,400 m$^3$  
Erosion protection of 4,800 m$^3$  
Transition material of 6,100 m$^3$  
Various rip-rap material sizes total of 8,700 m$^3$ |
| North perimeter ditch            | Common fill of 75,300 m$^3$  
Type 4/Type 5 of 12,200 m$^3$  
Erosion protection of 20,400 m$^3$  
Transition material of 4,800 m$^3$  
Various rip-rap material sizes total of 4,800 m$^3$  
Liner bedding of 3,900 m$^3$ |
| West Cell initial divider dyke channel | Excavation of 5,500 m$^3$  
Transition of 600 m$^3$  
Various rip-rap material sizes total of 600 m$^3$ |
Note all specifications regarding the grain size distributions for the different material uses can be referred to in the associated quality control plan of the North Pile Surface Water Management Plan for Closure - Detailed Design.

### 3.1.4 Constructed Wetland Material Quantities

Estimated construction material quantities for the WPTS and EPTS can be referred to in the North Pile Passive Treatment Systems Detail Design.

### 3.2 Construction Specifications

Each detailed design report addresses the associated construction specifications including suggested equipment to be used, sequence of construction activities and estimated durations for scheduling purposes.

### 3.3 Quality Control

Quality control for all closure activities related to the North Pile and water control structures is important such that all construction work is completed as per the detailed designs and associated specifications. This Plan outlines the following general quality control practices for all closure related construction activities:

- Survey measurement will be provided for all work as per the information provided in the construction drawings.
- The survey measurements will be checked in the field by the geotechnical engineer and owner’s representative for any errors or omissions prior to proceeding with the construction work.
- All work will be inspected at least daily by the owner’s representative and Quality Assurance personnel to ensure conditions encountered in the field correspond with those conditions assumed by the design. Reports (suggested daily) will be carried out to report progress of the work and become a part of the as-build documentation.
- Instrumentation installation will be completed by qualified personnel and documented in as-build reporting. All instrumentation will be tested to ensure functionality once installed.
- All fill materials, particularly for liner support, will be observed by Quality Assurance personnel to ensure proper compaction of the material is achieved. In-situ density testing will be completed to confirm appropriate fill compaction is achieved. Where the required material density is not achieved, the affected area will be removed of material and re-compacted.
- Grain size distribution analysis will be completed where appropriate to ensure correct material is being used.
- An as-built survey of the entire construction works will be completed and submitted to the geotechnical engineer for review.
4. Monitoring

4.1 Closure and Post-Closure Monitoring

The North Pile performance monitoring instrumentation consists of series of existing and proposed prisms, thermistors, standpipe piezometers, and vibrating wire piezometers (VWPs) for monitoring the physical stability and performance during the closure and post closure phases. The closure and post closure monitoring program is provided in Appendix A, This geotechnical monitoring plan encompasses:

- the North Pile facility;
- east and west passive treatment systems (EPTS, WPTS); and
- perimeter embankments and divider berm between influent storage pond (ISP) and free water surface constructed wetland (wetland).

The quality of water collected in the system will be monitored as per the Water Management Plan and associated Surveillance Network Program (SNP).
5. REFERENCES


MVLWB (Mackenzie Valley Land and Water Board), 2004. Water License MV2001L2-0002, Type A. Yellowknife, NT

MVLWB (Mackenzie Valley Land and Water Board), 2010. Land Use Permit D201000053, Type A. Yellowknife, NT

MVLWB (Mackenzie Valley Land and Water Board), 2012. Water License MV2011L2-0004, Type A. Yellowknife, NT
APPENDIX A  CLOSURE AND POST-CLOSURE GEOTECHNICAL MONITORING PLAN FOR NORTH PILE FACILITY AND PASSIVE TREATMENT SYSTEMS, SNAP LAKE MINE
1.0 INTRODUCTION

This technical memorandum presents the geotechnical monitoring plan for North Pile facility and east and west passive treatment systems (EPTS, WPTS) perimeter embankments and divider berm between influent storage pond (ISP) and free water surface constructed wetland (wetland) at the De Beers Group of Companies (De Beers) Snap Lake Mine. The plan covers the following monitoring through geotechnical inspections and instrumentation during the closure and post closure phases:

- physical stability and performance monitoring
- North Pile freeze-back and baseline monitoring

The North Pile performance monitoring instrumentation consists of series of existing and proposed prisms, thermistors, standpipe piezometers, and vibrating wire piezometers (VWPs) for monitoring the physical stability and performance during the closure and post closure. The planned North Pile performance monitoring instrumentation is presented in Figure 1.

The North Pile freeze-back monitoring instrumentation consists of existing and proposed thermistors for the monitoring of subsurface and deposited PK conditions. Existing and proposed standpipe piezometers will be used and collection of water samples. The instrumentation plan for closure and post closure is presented in Figure 2.

The performance monitoring instrumentation for EPTS and WPTS perimeter embankments and divider berms between ISPs and wetlands will consist of monitoring prisms, thermistors, and VWPs. The EPTS and WPTS instrumentation plan is presented in Figures 3 and 4 respectively.

Dam 2 will be decommissioned as part of closure works. An “Issued for Construction” package for the decommissioning of Dam 2 will include instructions for dam decommissioning, and identification of any needed instrumentation monitoring for the decommissioned dam.
2.0 CLOSURE AND POST CLOSURE PHASES

For dams, closure is the process of establishing a configuration with the objective of achieving long terms physical, chemical, ecological and social stability and a sustainable, environmentally appropriate after use. This configuration can be achieved during and after mine operation (CDA 2014). There are three main phases in closure of mining dams that includes transition, closure-active (closure) and closure-passive case (post closure).

This memorandum addresses monitoring for both the planned closure and post closure phases.

2.1 Closure Phase

The closure phase involves active care with monitoring, inspection, water management, and operation of the water treatment system.

During closure, North Pile, EPTS and WPTS perimeter embankments and divider berms will require surveillance, maintenance (e.g., inspections, maintenance of erosion protection, inspection of cover system), and monitoring to verify the performance that was expected during the design stage. The active water treatment system (reverse osmosis) will remain in operation and will be decommissioned once the EPTS and WPTS have been commissioned.

The North Pile and the EPTS and WPTS perimeter embankments and divider berms are expected to achieve a steady state condition during closure. To achieve a steady state during closure, North Pile and PTS perimeter embankments and divider berms must satisfy the following (developed based on CDA 2014):

- North Pile freeze-back is achieved (remains fully frozen for at least two years) and/or the North Pile is fully drained or no potential for flow of waste material exists.
- Any erosion gullies that form self-heal to a stable final configuration that does not represent a physical or environmental risk, and North Pile cover is performing as designed.
- Deformations are either non-existent or at a steady state and do not present a concern with respect to the stability of the facilities.

The closure phase may last for years depending when North Pile, EPTS and WPTS will achieve steady state condition. One structure may achieve steady state earlier than another and be ready for post closure earlier. Note that this only addresses the geotechnical stability of the structures. Transition to post closure in the case of the EPTS and the WPTS may require completion of water treatment functions that are outside the scope of this memorandum.

2.2 Post Closure Phase

Geotechnically, the North Pile, EPTS and WPTS perimeter embankments and divider berms can transition to the post closure phase once monitoring demonstrates that no further intervention by De Beers is required for regular surveillance, and that the structures will not require operational people on site or regular surveillance. This is effectively a demonstration that that the North Pile and PTS perimeter embankments and divider berms have become stable landforms where the risk of release of solids or water that would have significant negative impacts is negligible.
Freezing of the North Pile is expected to be an important contributor to its long term stability. As part of the transition from closure to post closure, thermistor data will need to be evaluated, and the contribution of freezing to the long term post closure stability considered in terms of global warming projections the time of transition.

The dams in the passive treatment systems may be decommissioned when or if drainage (surface runoff and seepage) from North Pile has been demonstrated to be in compliance with effluent quality criteria and water treatment will no longer be required. In this case, the PTS perimeter embankments and divider berms no longer be needed and can be breached. Once breached and the breaches have stabilized, ongoing monitoring and maintenance will not be needed and the former dams can transition to the post closure phase.

3.0 GEOTECHNICAL MONITORING PROGRAM

A geotechnical monitoring program has been developed for the closure and post closure phases. This monitoring program has been developed based on consideration of baseline monitoring initiated prior to the start of construction and experience with on-site monitoring throughout operation of the site and into the care and maintenance phase.

The monitoring program includes visual monitoring (inspections) and monitoring of both existing and proposed North Pile closure surface and passive treatment system instrumentation.

The frequency of monitoring is addressed in Section 4.0.

3.1 Visual Monitoring

Visual monitoring includes inspections of the North Pile and PTS perimeter embankments and divider berms. Inspections will be focused on the condition of:

- the crest and downstream slopes of North Pile perimeter embankment
- PTS perimeter embankments and divider berms
- North Pile closure cover
- closure surface water management structures (water conveyance ditches and channels and liner system(s))

The inspection will focus on observations of any:

- displacement, settlements, sloughing, or bulging of embankments or berms
- cracking
- sinkholes
- erosion channels
- water ponding
changes in the closure cover slope
- seepage
- ground instability
- changes in site drainage, such as blockages or erosion
- ISP and wetland water levels

3.2 Instrumentation

The geotechnical monitoring program will require the use of instrumentation to complement the information obtained through visual inspections. Where possible, existing instrumentation will be used to provide continuity with past measurements. New instrumentation is required as part of closure monitoring due to both needs to replace existing/baseline instrumentation, and new monitoring needs that are present due to the construction of new closure structures (such as the cover and the passive treatment systems). Existing and proposed instrumentation are described in the following subsections.

In a harsh northern environment, it is expected that over time some instrumentation will cease to function. A limited amount of redundancy has been considered in the development of the proposed instrumentation network. If a given instrument becomes inoperative during the closure or post closure period, the acceptability of its removal from the monitoring program (or possible need for its replacement), should be evaluated by the responsible engineer, taking into account trends observed at the instrument, performance of the structure to date, and the number and type of nearby instruments.

3.2.1 Existing Instrumentation

The objective of the North Pile existing instrumentation, as series of prisms, thermistors, standpipes piezometers and vibrating wire piezometers (VWPs), has been to identify conditions that would compromise the integrity of the facility during operations and extended care and maintenance. These instruments will largely remain operational during closure and post closure phases, except for some instrumentation that will be decommissioned or relocated as part of closure works.

The geotechnical monitoring program objectives focused on three areas of interest:

- slope stability and deformation monitoring
- thermal condition monitoring
- water level and seepage monitoring
There are two main instrumentation categories for the existing instrumentation, baseline and operations:

1) Baseline instrumentation provided the following:
   a. fulfillment of regulatory requirement for installation before development
   b. pre-construction conditions and, with monitoring, documentation of the effects during operations, closure, and post closure

2) Operational instrumentation and monitoring enabled the following:
   a. Enabled the assessment of the performance and behaviour of embankments during construction, operations and extended care and maintenance. This will continue into closure and post closure.
      b. Based on instrumentation type:
         i. standpipe piezometers to monitor water levels within the embankment and to provide an opportunity for water quality sampling during summer conditions
         ii. vibrating wire piezometers to monitor the phreatic surface
         iii. vertical and horizontal thermistors to monitor thermal conditions of the foundation, embankment fills, and deposited material
         iv. survey prisms to monitor deformation and displacement

During closure and post closure, some of the existing instrumentation will be decommissioned as part of the closure strategy and associated earthworks (i.e., decommission of Rib Berm 1 and 4 instrumentation) or will require instrumentation extension and relocation such as the water management pond Dam 1 select thermistors and VWP.

3.2.2 Proposed Instrumentation

Additional instruments are proposed for performance monitoring of the North Pile closure cover, perimeter embankments and divider berms of the EPTS and WPTS. The proposed new instrumentation includes thirty-three monitoring prisms, fourteen thermistors, and five VWPs, distributed in these areas.

Prisms

A total of thirty-three monitoring prisms are proposed for closure and post closure monitoring. The prisms are planned to capture deformations in various cover categories, physical elements (e.g., swales), and sections of the west perimeter embankment that will be regraded to support the closure cover design.

- Sixteen prisms to monitor the newly constructed cover on the North Pile closure cover for changes in grade or differential settlement.
- Four prisms to monitor the west perimeter embankment after re-sloping for displacement at two cross-section locations along the slope similar to the Starter Cell and East Cell prisms locations.
- Thirteen monitoring prisms are to be installed to monitor the crest and downstream slopes of EPTS and WPTS perimeter embankments and divider berms for any displacement.
Location of proposed prisms is provided in Table 1 and Figures 1, 3, and 4.

**Table 1: Proposed Closure Surface and Passive Treatment Systems Monitoring Prisms**

<table>
<thead>
<tr>
<th>Prism ID</th>
<th>Area</th>
<th>Location</th>
<th>Cell/PTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>P19-01 to P19-10</td>
<td>Starter Cell</td>
<td>top of regarded surface or closure cover transition material surface</td>
<td>Cell D to Cell LF</td>
</tr>
<tr>
<td>P19-11 to P19-16</td>
<td>East Cell</td>
<td>top of regarded surface or closure cover transition material surface</td>
<td>Cell 1 to Cell 5</td>
</tr>
<tr>
<td>P19-17 to P19-18</td>
<td>East Cell</td>
<td>side slope of the west perimeter embankment</td>
<td>Cell 1</td>
</tr>
<tr>
<td>P19-19 to P19-20</td>
<td>Starter Cell</td>
<td>side slope of the west perimeter embankment</td>
<td>Cell A</td>
</tr>
<tr>
<td>P121 to P122</td>
<td>EPTS</td>
<td>divider berm crest</td>
<td>divider berm between ISP and wetland</td>
</tr>
<tr>
<td>P123 to P125</td>
<td>EPTS</td>
<td>embankment crest</td>
<td>ISP northern perimeter embankment</td>
</tr>
<tr>
<td>P126 to P132</td>
<td>WPTS</td>
<td>embankment crest</td>
<td>wetland northern perimeter embankment</td>
</tr>
<tr>
<td>P133</td>
<td>WPTS</td>
<td>divider berm crest</td>
<td>divider berm between ISP and wetland</td>
</tr>
</tbody>
</table>

EPTS = east passive treatment system; ISP = influent storage pond; PTS = passive treatment system; WPTS = west passive treatment system.

**Thermistors**

A total of fourteen additional thermistors are planned for monitoring during closure and post closure.

- Eight thermistors are planned for thermal profiling through natural ground, deposited PK, and landfill waste materials for the North Pile.
- Six thermistors will be installed within the downstream foundation and within the footprint of the EPTS and WPTS perimeter embankments and divider berms for thermal profiling through natural ground and rockfill material, to help identify warming trends with possible impacts on seepage.

Details of additional thermistors are provided in Table 2, with locations are in Figures 2 to 4.
Table 2: Proposed Additional Thermistors

<table>
<thead>
<tr>
<th>Vertical Thermistor ID</th>
<th>Area</th>
<th>Nearby Existing Thermistor</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPC-TH19-01</td>
<td>East Cell, Cell 5</td>
<td>Baseline TH06-01 is damaged</td>
<td>thermal profile through deposited PK and natural ground (base node installation at 40 m below original ground surface (surveyed in 2000))</td>
</tr>
<tr>
<td>NPC-TH19-02</td>
<td>East Cell, Cell 4</td>
<td>n/a</td>
<td>no existing thermistor in Cell 4; thermal profile through deposited PK and natural ground (base node installation at 40 m below original ground surface (surveyed in 2000))</td>
</tr>
<tr>
<td>NPC-TH19-03</td>
<td>Starter Cell, Cell D</td>
<td>Baseline TH06-02, operational</td>
<td>thermal profile through deposited PK; TH06-02, Nodes 1, 8 and 10 damaged (no new data)</td>
</tr>
<tr>
<td>NPC-TH19-04</td>
<td>East cell, Cell 3</td>
<td>Baseline TH06-04 is damaged</td>
<td>thermal profile through deposited PK and natural ground (base node installation at 40 m below original ground surface (surveyed in 2000))</td>
</tr>
<tr>
<td>NPC-TH19-05</td>
<td>Starter Cell, Cell B</td>
<td>TH06-05, operational</td>
<td>thermal profile through deposited PK</td>
</tr>
<tr>
<td>NPC-TH19-06</td>
<td>East cell, Cell 2</td>
<td>TH06-07, operational</td>
<td>thermal profile through deposited PK</td>
</tr>
<tr>
<td>NPC-TH19-07</td>
<td>Starter Cell, Cell B</td>
<td>TH06-08, operational</td>
<td>thermal profile through deposited PK</td>
</tr>
<tr>
<td>NPC-TH19-08</td>
<td>Starter Cell, Cell A</td>
<td>n/a</td>
<td>no existing thermistor in Cell A; thermal profile through deposited PK</td>
</tr>
<tr>
<td>PT-TH-19-01</td>
<td>EPTS</td>
<td>BH 00-16</td>
<td>nearby thermistor will be decommissioned during construction stage; thermal profiling of the divider berm rockfill material</td>
</tr>
<tr>
<td>PT-TH-19-02</td>
<td>EPTS</td>
<td>BH2000-2 is damaged</td>
<td>thermal profiling of the northern perimeter berm rockfill material</td>
</tr>
<tr>
<td>PT-TH-19-03</td>
<td>EPTS</td>
<td>n/a</td>
<td>thermal profiling of the area downstream of the northern perimeter berm</td>
</tr>
<tr>
<td>PT-TH-19-04</td>
<td>WPTS</td>
<td>n/a</td>
<td>thermal profiling of the northern perimeter berm rockfill material</td>
</tr>
<tr>
<td>PT-TH-19-05</td>
<td>WPTS</td>
<td>n/a</td>
<td>thermal profiling of the northern perimeter berm rockfill material</td>
</tr>
<tr>
<td>PT-TH-19-06</td>
<td>WPTS</td>
<td>n/a</td>
<td>thermal profiling of the northern perimeter berm rockfill material</td>
</tr>
</tbody>
</table>

EPTS = east passive treatment system; n/a = not applicable; PK = processed kimberlite; WPTS = west passive treatment system.
Vibrating Wire Piezometers
A total of five VWPs are proposed for the EPTS and WPTS perimeter embankments and divider berms. These will be installed downstream of the bitumen liner through rockfill material and within foundations to monitor phreatic surface and potential seepage. Details of new VWPs locations are summarized in Table 3 and shown in Figures 3 and 4.

Table 3: Proposed Vibrating Wire Piezometers

<table>
<thead>
<tr>
<th>VWP ID</th>
<th>Area</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT-VWP-19-01</td>
<td>EPTS</td>
<td>wetland southern perimeter embankment</td>
</tr>
<tr>
<td>PT-VWP-19-02</td>
<td>EPTS</td>
<td>divider berm between ISP and wetland</td>
</tr>
<tr>
<td>PT-VWP-19-03</td>
<td>EPTS</td>
<td>ISP northern perimeter embankment</td>
</tr>
<tr>
<td>PT-VWP-19-04</td>
<td>WPTS</td>
<td>ISP northern perimeter embankment</td>
</tr>
<tr>
<td>PT-VWP-19-05</td>
<td>WPTS</td>
<td>wetland northern perimeter embankment</td>
</tr>
</tbody>
</table>

EPTS = east passive treatment system; ISP = influent storage pond; PTS = passive treatment system; VWP = vibrating wire piezometer; WPTS = west passive treatment system.

4.0 INSTRUMENTATION MONITORING FREQUENCY
Table 4 provides a summary of the monitoring program, indicating the proposed frequency of monitoring over both the closure and post closure periods.

As defined in Section 2.0, structures enter into the post closure phase once they have achieved a steady state condition, and can be considered landforms rather than dams or retaining structures. As such, the transition from closure to post closure will depend on assessment of the monitoring results, and the date shown in this section is only indicative.

In general terms, the frequency of monitoring is expected to decrease over time as the structures demonstrate stability and progress towards their steady state conditions. During closure, a constant frequency of monitoring has been shown over each monitoring period. However, as a result of monitoring, it may be appropriate to reduce the frequency if monitoring based on observed trends. Re-assessment of monitoring frequency may be done by the responsible geotechnical engineer.

Similarly, the expectation is that the majority of monitoring may be discontinued as the facility enters into post closure. As a conservative measure, a nominal frequency of monitoring in post closure has been indicated for some parameters/locations in Table 4. It is expected that these frequencies and locations will be re-evaluated based on interpretation of monitoring results through the closure period (and later in the post closure period).

The recommended minimum frequency for North Pile facility, EPTS and WPTS instrumentation for closure and post closure monitoring is listed in Table 4.
**Table 4: Expected North Pile and Passive Treatment System Dams Instrumentation and Visual Monitoring Frequencies**

<table>
<thead>
<tr>
<th>Visual Inspections/Instrumentation type/</th>
<th>Frequency During Closure</th>
<th>Frequency During Post Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>North Pile Facility Performance, Baseline and Freeze-Back Monitoring</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>visual inspections of the crest and downstream slopes of North Pile perimeter embankment and water management structures</td>
<td>monthly, weekly/fortnightly at the time of freshet and/or heavy precipitation event</td>
<td>nominally every 5 years</td>
</tr>
<tr>
<td>annual inspection by Engineer of Record (EoR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>monitoring prisms</td>
<td>quarterly (a) until trend established, then annual monitoring</td>
<td>nominally every 5 years</td>
</tr>
<tr>
<td>VWPs</td>
<td>monthly, until trend established, then annual monitoring</td>
<td></td>
</tr>
<tr>
<td>standpipe piezometers</td>
<td>quarterly (a) until trend established, then annual monitoring</td>
<td></td>
</tr>
<tr>
<td>baseline thermistors</td>
<td>quarterly, until trend established, then annual monitoring</td>
<td></td>
</tr>
<tr>
<td>operational monitoring thermistor</td>
<td>monthly, until trend established then quarterly monitoring</td>
<td></td>
</tr>
<tr>
<td>closure thermistors</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PTS Perimeter Embankment and Divider Berm Performance Monitoring</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>visual inspections of the crest and downstream slopes of PTS perimeter embankments and divider berms</td>
<td>monthly, weekly/fortnightly at the time of freshet and/or heavy precipitation event</td>
<td>annual until North Pile water quality meets closure EQC and PTS perimeter embankment and divider berms will be breached</td>
</tr>
<tr>
<td>annual inspection by EoR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>water level</td>
<td>monthly for water management pond (WMP) and more frequent during freshet and heavy precipitation event once the WMP transitions into the east wetland, monthly monitoring for both EPTS and WPTS until trend established then quarterly</td>
<td></td>
</tr>
<tr>
<td>monitoring prisms</td>
<td>monthly(a), until trend established then quarterly</td>
<td></td>
</tr>
<tr>
<td>VWPs</td>
<td>monthly, until trend established then quarterly</td>
<td></td>
</tr>
<tr>
<td>thermistors</td>
<td>monthly, until trend established then quarterly</td>
<td></td>
</tr>
</tbody>
</table>

(a) Quarterly readings during snow-free conditions.

EPTS = east passive treatment system; EoR = Engineer of Record; n/a = not applicable; PTS = passive treatment system; VWP = vibrating wire piezometer; WPTS = west passive treatment system.
5.0 CLOSING

The reader is referred to the Study Limitations, which follows the text and forms an integral part of this memorandum.

We trust that this document provides the sufficient details for your current needs. Should you have any questions, please contact the undersigned.

Golder Associates Ltd.

Abdul Sattar Khan, M.A.Sc.
Project Manager

Reviewed by:

Björn Weeks, Ph.D., P.Eng.
Principal, Geo-Environmental Engineer

ASK/JEK/ BW/cmm

Attachments: Study Limitations
Figures 1 to 4

REFERENCE


STUDY LIMITATIONS

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