Appendix 67

Meadowbank Tailings Storage Facility OMS Version 10

MEADOWBANK COMPLEX

TAILINGS MANAGEMENT

Operation, Maintenance and Surveillance Manual

Prepared by
Agnico Eagle Mines Limited

Version 10
July 2021

TAILINGS MANAGEMENT

OPERATION, MAINTENANCE AND

SURVEILLANCE MANUAL

MEADOWBANK COMPLEX

AGNICO EAGLE MINES LIMITED

DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
(first revision)	February 2012	All	All	
V2	August 27, 2013	All	All	
V3	September 15, 2013	All	All	Updated items mentioned by MDRB and the Mine Inspector in the Annual Geotechnical Inspection in September 2013
V4	January 2015	All	All	
V5	October 2015	All	All	
V6	February 2016	All	All	
V7	March 2017	All	All	
V8	February 2018	All	All	Integration of the updated Central Dike TARP
V9	February 2019	All	All	
V10	July 2021	All	All	Review to add in-pit tailings deposition and comply with MAC Revised OMS Guide (2019)

Approved by:

July 7 2021
Thomas Lepine
Engineer of Record - Nunavut

Alexandre Lavallee
Environment & Critical Infrastructure Superintendent

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SECTION 1 • INTRODUCTION

1.1 OBJECTIVE OF THE OMS MANUAL

This Operation, Maintenance and Surveillance Manual has been prepared by Agnico Eagle Mines Limited (AEM) and is to be used for the operation, maintenance, and surveillance (OMS) of Tailings Management at the Meadowbank Complex.

This manual is intended as a practical document used by the personnel involved with the Tailings Management at the Meadowbank Complex. It incorporates Industry Standards as well as AEM Corporate Standard and Policy on Tailings Management.

The objectives of this OMS manual are to define and describe:

- Roles, responsibilities, and level of authority of personnel who perform activities related to the Tailings Management
- The infrastructures covered in the scope of this OMS manual
- Plans, procedures and processes for:
    - The operation, maintenance, and surveillance of the Tailings Management to ensure that it functions in accordance with the design, meets performance objectives, and links to emergency response planning
    - Evaluating performance of the structures, and reporting performance results
    - Managing change

This manual contains protocols and information that will assist AEM to operate, maintain, and monitor tailings management in a safe manner and identify early signs of malfunction.

Elements related to design, construction, and closure of Tailings Management Infrastructures, and to the process plant is out of scope of this manual.

1.2 CONTROL OF DOCUMENTED INFORMATION

This OMS manual is a controlled document. The latest version of this document is available in Intelex.

The Responsible Person (RP) is in charge of the preparation, update and distribution of this manual. Any change to this OMS manual must be submitted to and approved by the RP and the Engineer of Record (EoR). The RP is responsible to update the OMS manual in Intelex.

It is each user's responsibility to ensure that they are using the latest version of this document. In case of issues with retrieving the electronic version of this document, the most up to date paper version of this document will always be kept in the RP Office.

The RP is responsible to communicate any change to this manual by e-mail to the distribution list in Table 1-1. He is responsible for maintaining an up-to-date distribution list of this manual.

Table 1-1: OMS Manual Distribution List

Position	Name
General Manager	Alexandre Cauchon
General Superintendent	Sebastien Michel / Michel Lavoie
Environment & Critical Infrastructure Superintendent	Alexandre Lavallee
Process Plant Superintendent	Marc-André Leblanc
Engineering Superintendent	Pierre McMullen
Maintenance Superintendent	Dave Jean
Energy & Infrastructures Superintendent	Guillaume Gemme
Health & Safety Superintendent	Normand Ladouceur
Engineer of Record, Nunavut Division	Thomas Lepine
MDRB – Meadowbank Dike Review Board	Don Hayley / Anthony Rattue / Kevin Hawton

1.3 MANAGEMENT OF CHANGE

This manual will be reviewed on an annual basis and revised as necessary to accommodate changes in the condition and operation of the facilities. The RP will be responsible to coordinate this review process.

In conducting the review and update of the OMS manual the following must be considered:

- Performance of the structures
- Current life cycle of the structures
- Change since the last review (site condition, critical control, risk profile, personnel, methodology and technology for OMS activities)

In addition to the annually scheduled review, a review may be triggered by a significant event or may need to be updated in response to:

- Planned changes, such as change in surveillance instrumentation or methodologies, or introduction of new instrumentation methodology
- Changes in personnel or roles referred to in the OMS manual
- Other changes that may occur that need to be addressed prior to the next scheduled review of the OMS manual

The update needs to be completed in a timely manner following the document control criteria specified in Section 1.2.

As a good practice, the RP should organise on a yearly basis a session to present the changes in the OMS manual to the persons in its distribution list.

1.4 REQUIRED LEVELS OF KNOWLEDGE

To ensure safe operation of these structures, the personnel involved in the OMS activity must have a good comprehension of this manual and the factors that can impact the performance of these structures.

It is the responsibility of each person in the distribution list of this manual to be familiar with its content. They must also ensure that everyone under their supervision whose duty involves tasks related to the operation, maintenance or surveillance of any component associated with the Meadowbank Tailings Management have the appropriate level of knowledge and the resources to comply with the protocol presented in this document.

Table 1-2 below indicate a summary of the required level of knowledge of this Manual. General Knowledge refer to having read and understood the information. Detailed knowledge refers to having sufficient understanding, training and knowledge of the processes within a section to be able to carry them out as required.

Record that the requirements of this manual have been reviewed and that each person involved in OMS activity understand the process and procedure relevant to their task should be keep to date by each department and updated each time a new manual revision is done. This can be done by using a sign-off sheet.

Table 1-2: Summary of Required Level of Knowledge of this Manual

Position or Task	**Level of Knowledge**	**Objective**
In the Manual Distribution List	General Knowledge of All Section Detailled Knowledge of Section 1 and 2	• Understand their R&R related to OMS process • Ensure that the task are delegated to the people directly carrying the activity and that they have the proper resource to accomplish them • Ensure that required training is provided
Supervise or Perform Operation Task	Detailled Knowledge of Section 6 General Knowledge of Section 3, Table 6-3 and Section 6.3.1	• Have an in depth understanding of the Operation Process and their requirement • Be able to recognize visible sign of defiency and to know how to communicate those
Supervise or Perform Maintenance Task	Detailled Knowledge of Section 5 General Knowledge of Section 3, Table 6-3 and Section 6.3.1	• Have an in depth understanding of the Maintenance Process and their requirement • Be able to recognize visible sign of defiency and to know how to communicate those
Supervise or Perform Surveillance Task	General Knowledge of All Sections Detailled Knowledge of Section 3, 4, 5,6	• Have an in depth understanding of the Surveillance Process and their requirement • Be able to recognise when there is a defiency in an operation and maintenance process
Work Routinely Bring them in the vicinity of tailings management component for Task not Directly link to Operation, Maintenance or Surveillance	General Knowledge of Section 3, Table 6-3 and Section 6.3.1	• Understand how their work might impact tailings management • Be able to recognize visible sign of defiency and to know how to communicate those

1.5 ALIGNMENT WITH POLICIES, GUIDELINES, AND REQUIREMENTS

This OMS manual aligns with the following regulator requirements, guidelines and Standards. These documents can be found on Intellex :

- AEM, Corporate Standard on Water Management (AEM, in progress)
- AEM, Corporate Standard on Tailings Storage Facilities and Heap Facilities (AEM, January 2020)
- AEM, Sustainable Development Policy (AEM, 2019)
- AEM, Tailings Management Policy (AEM, 2020)

- AEM Geochemical Characterization Guide (AEM, 2017)
- International Cyanide Management Code (ICMC, 2016)
- Canadian Dam Association ‘Dam Safety Guidelines’ (CDA 2013) and ‘Application of Dam Safety Guidelines to Mining Dams’ (CDA 2019)
- Mining Association of Canada ‘Guide to the Management of Tailings Facility (MAC, Version 3.1 2019)
- Mining Association of Canada ‘Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities (Mac, Second edition 2019)
- Mining Association of Canada ‘Toward Sustainable Mining Protocol, Water Stewardship (MAC, November 2018)
- Mining Association of Canada ‘Toward Sustainable Mining Protocol, Tailings Management (MAC, November 2019)
- Nunavut Water Board, Meadowbank Water License (No. 2AMMEA0815)

1.6 LINKAGE WITH EMERGENCY RESPONSE PLAN

An emergency is a situation that poses an impending or immediate risk to health, life, property, or the environment and which requires urgent intervention to prevent or limit the expected outcome.

This OMS manual addresses conditions related to operation under normal or unusual conditions, as opposed to emergency situations. An Emergency Preparedness Plan and an Emergency Response Plan (EPP/ERP) describes measures the Owner and, in some cases, external parties will take to prepare for an emergency, and to respond if an emergency occurs.

An OMS and ERP manual must be aligned. As a result, this OMS manual contains the following information (refer to Section 4, 5 and 6):

- Performance, occurrences, or observations that would result in an emergency being declared
- Roles and responsibilities of key personnel in transition from normal or unusual conditions to an emergency
- Actions to be taken to transition from normal or unusual conditions to an emergency situation

Once an emergency has been declared, reference must be made to the Emergency Response Plan (Reference included in Table 1-3). The most recent version of the ERP can be found on Intelex and in the Emergency Control Room.

Table 1-3 : Emergency Response Reference Documents

Document	Current Revision
Emergency Response Plan	Updated by AEM. Version 16, March 2021. (Intelex)

SECTION 2 • ROLES AND RESPONSIBILITIES

The roles and responsibilities of the key personnel involved in the Meadowbank Tailings Management Infrastructure are shown in Table 2-1. Contact information for each position is indicated in Table 2-2. Terms of reference for the Accountable Executive Officer, Responsible Person, Engineer of Record, Independent Reviewer and Tailings Working Group are planned to be added into Intelex and are otherwise available by asking the EoR.

2.1. Training and Qualification

Personnel who have tasks directly related to the Meadowbank Tailings Management need to be qualified for the task and receive and maintain sufficient training to ensure they can perform their required roles and responsibilities. Defining the requiring qualification and ensuring proper training and qualification of personnel is a Responsibility defined in Table 2-1.

Qualification requirement of personnel is managed on a by department basis and are captured in the R&R of each position and are ensured as part of the HR Process to fulfill each position

Training requirement and record are defined and managed on a by department basis.

Table 2-1 : Responsibilities of Key Members of the OMS Related to Meadowbank Tailings Management Infrastructure

Role	Responsibilities
Accountable Executive Officer (AEO)	As emphasized by MAC (2017), the accountability for decisions related to tailings management rests with the Owner's Board of Directors or Governance Level. The Board of Directors or Governance Level is expected to designate an Accountable Executive Officer (AEO) for tailings management. More specifically, the following responsibilities are assigned to the AEO: • Needs to be aware of key outcomes of water management risk assessment and of how these risks are being managed • Has accountability and responsibility for putting in place appropriate management structure • Assign responsibility and appropriate budgetary authority for tailings management • Define the personnel duties, responsibility and reporting relationships, supported by job description and organisational charts to implement the tailings management system through all stages in the facility life cycles • Provide assurance to AEM and its Community of Interest that tailings are managed responsibly
General Manager	• Identify the scope of work and budget requirement for all aspects of tailings management • Approve budget for OMS related activity • Establish an organisational structure with Roles and Responsibilities that meets the Governance Standard on Critical Infrastructure • Identify and retain a Responsible Person (RP) • Liaise with independent reviewer (MDRB) as required
General Superintendents	• Ensure the OMS responsibilities delegated to the departments they oversee are carried out as described in this section of the OMS Manual
Engineer of Record (EoR)	The function of EoR is to support AEM in ensuring that mine waste and water management infrastructure are designed and operated properly. The owner, in assuring that these facilities are safe, has the responsibility to identify and retain an EoR, who provides technical direction on behalf of the owner. Having an EoR for mine waste and water infrastructure is recognized as one of the best practices for responsible management of mine waste and water management facilities. • Support and give technical advice to the RP and the AEO on geotechnical and operational challenges • Participate if possible, in Dam Safety Inspections and associated reports for tailings facilities that include retention structures/dams • Verify if the tailings storage facility (TSF), waste rock storage facility (WRSF), and Water Retaining Infrastructures are designed and are operating in accordance with the best standards in the industry and the AEM corporate standards • Verify if the waste and water management plans are developed and followed to ensure safety of the operation and the business; • Review and provide agreement on the procedural documents related to waste and water management (including OMS, ERP and TARP); • Be available for the Independent Review (IR) Panel; • Participate in IR meetings and assist the RP in their preparation if required; • Participate in the facility's risk assessments; • Be available for dam safety reviews; • Identify other internal or external professionals (such as hydrogeologists, geologists, hydrologists, etc.) to provide their support when required; • Propose a schedule of site visits and required meetings during the course of the year.

Role	Responsibilities
Responsible Person (RP)	The Responsible Person(s) identifies the scope of work and budget requirements (subject to final approval) for all aspects of tailings management, including the Engineer of Record (EoR), and will delegate specific tasks and responsibilities for aspects of tailings management to qualified personnel." The RP is directly responsible for the management of critical infrastructure on a specific site with the objective of compliance with the Governance. The management of critical infrastructure includes design, construction, operation and closure. • Ensure the implementation and sustainability of the Governance model at the site level; • Management of critical infrastructure, as well as appurtenant structures that may affect the critical infrastructure; • The management of personnel, budget and external resources for the critical infrastructure (external resources include the Design Engineer (DE), Independent Review Board (IRB) and any other necessary consultants/contactors); • Close collaboration with the EoR and communication with the Design Engineer and Independent Review Board IRB); • Preparation for, and coordination of, IRB meetings and site visits; • Preparation for, and coordination of, annual geotechnical inspections; • Responding to, and implementation of, the recommendations of the IRB; • Annual review and up-date of the OMS Manual in collaboration with the EoR; • Continued application of the requirements of the OMS; • In collaboration with the EoR, preparation of an annual report on the status of the critical infrastructure; • Management of all documents and data related to design, construction, operation, closure, surveillance and monitoring in a secure, accessible and permanent manner; • Revise and update the OMS Manual to reflect as-built conditions and any other changes. Review and update the OMS manual into Intelex. Maintain up to date distribution list of the OMS Manual
Independent Review Board (IRB) – Meadowbank Dike Review Board (MDRB)	IR Panels are a mechanism to obtain independent, expert commentary, advice, guidance and where appropriate, recommendations to assist owners/operators in identifying, understanding, and managing risks associated with TSF, WRSF, WSF, HLF and water-retaining infrastructures. The Independent Reviewer(s) does not have decision-making authority. Accountability and responsibility for decisions rests with AEM. • Review mine waste management strategy (including tailings and waste rock storage facilities); • Review water management infrastructure designs and performance (including water retaining infrastructures); • Review on-going construction works and monitoring data; • Comment on implementation progress of proposed mine waste management improvement measures; • Provide opinions and guidance to the operation on the physical integrity, safety, behavior, and performance of the confinement systems for mine waste and water retaining infrastructures; and • Comment on management systems, emergency preparedness and overall management approach of the different mine waste management facilities and water retaining infrastructures.
Design Engineer	• Advise on contemplated changes to the structure operation • Advise on structure performance and mitigation work as required • Present during independent review board meeting to provide input and context on the structure performance

Role	Responsibilities
Tailings Working Group (TWG)	Tailings working group is a mechanism to facilitate the communication between the different key stakeholder involved in tailings management. • Improve ability to achieve tailings management objectives • Review deposition plan, water balance and operational compliance • Review facility performance • Discuss IRB recommendation and develop implementation plan
Process Plant Superintendent	The Process Plant Department is the owner of the process plant. They work in close collaboration with the other stakeholder to ensure the success of tailings management. The Process Plant Superintendent is in charge of the Process Plant and ensure that: • The Process Plant team as sufficient resource (qualified manpower, material, budget, training) to fulfill the OMS obligation defined in this manual • A structure is in place that define the R&R, qualification, training requirement and a staffing strategy to fulfill the obligation of the OMS Manual • The process plant operates and maintain the infrastructure required to produce and transport (i.e pump) the tailings to tailings management area • The process plant tracks the parameter and characteristic of the tailings produced to ensure that targets are reached • The process plant operates the reclaim water system and track the water consumption to ensure that targets are reached • The process plant stops the transport of tailings if required in case of upset or emergency condition
Environment & Critical Infrastructure Superintendent	The Environment Department ensures compliance with Environment Regulation and the Water License and is the owner of the water & tailings management infrastructures outside of the process plant. They ensure reporting and liaison with the NIRB, NWB, NGO's and other government agencies. The Environment & Critical Infrastructure Superintendent is in charge of the Environment & Critical Infrastructure Department and ensure that: • The Environment team as sufficient resource (qualified manpower, material, budget, training) to fulfill the OMS obligation defined in this manual • A structure is in place that define the R&R, qualification, training requirement and a staffing strategy to fulfill the obligation of the OMS Manual • Environment review monitoring data for compliance with Water License and regulations and to determine dike performance with respect to design parameters • The Environment team carry out the surveillance of the structures as required in the OMS Manual (visual inspection and instrument monitoring) • The Environment team identify and perform the maintenance work (predictive, preventive and corrective) on the earthwork and instrumentation system • The Environment team review and analyse the surveillance data to evaluate dike performance with respect to design parameters and that surveillance reporting is distributed • The Environment team ensure that the other OMS tasks related to a dewatering dike component are planned and have an owner (i.e pump and pipe, access maintenance)
Energy & Infrastructures Superintendent	The E&I Department has the manpower and equipment to manage road, electricity and dewatering at the Meadowbank Site. They fulfill the planning done in collaboration with the Environment & Critical Infrastructure team to ensure the fulfilment of the OMS requirement. The E&I Superintendent is in charge of the E&I Department and ensure that :

Role	Responsibilities
	• The E&I team has sufficient resources (qualified manpower, material, budget, training) to fulfill the OMS obligation defined in this manual • A structure is in place that defines the R&R, qualification, training requirement and a staffing strategy to fulfill the obligation of the OMS Manual • E&I maintain access to the structure and tailings management systems. This include making road repairs, controlling dust and managing snow and water. • E&I install, operate, maintain and monitor all the components of pumps and piping system associated with water management. They also perform operation, maintenance and surveillance work on the piping system. This work is planned in collaboration with the Environment & Critical Infrastructure Department. • Update and maintain a list of operational pumping equipment
Maintenance Superintendent	The Maintenance Department has the manpower and equipment to maintain mobile equipment and pump. They fulfill maintenance of some of the mechanical equipment component of the dewatering dike as requested by the E&I department. The Maintenance Superintendent is in charge of the Maintenance Department and ensure that : • Ensure preventive, predictive and corrective maintenance is carried out regularly on pumping equipment related to water management as requested by E&I • Keep records of maintenance performance on pumping equipment
Health and Safety Superintendent	The Health and Safety Department is responsible to update and manage the site wide emergency response plan. The Health and Safety Superintendent is in charge of the Health and Safety Department and ensure that : • The emergency response plan is updated and is aligned with the OMS manual • The trigger to raise an emergency defined in the OMS manual and the communication pathway to do so is understood and aligned with the ERP

Table 2-2 : Contact Information

Role	Name	Work Contact Info
Environment and Critical Infra VP / Accountable Executive Officer	Michel Julien	michel.julien@agnicoeagle.com 416-947-1212 x3738 514-244-5876
Engineer of Record (EoR) / Technical Specialist, Environmental Management	Thomas Lepine	thomas.lepine@agnicoeagle.com 418-473-8077
Design Engineer – Golder	Yves Boulianne	514 383 6196 x7434 514 207-0264
Independent Reviewer – Meadowbank Dike Review Board (MDRB)	• Anthony Rattue • Don Hayley • Kevin Hawton	anthony.rattue@bell.net don.hayley@icloud.com khawton@knightpiesold.com
General Manager	Alexandre Cauchon	819-759-3555 x4606896
General Superintendent (Mine)	Sebastien Michel	819-651-2096
General Superintendent (Maintenance, E&I, Operation)	Michel Lavoie	819-759-3555 x4606555 819-355-0791
Process Plant Superintendent	Marc-André Leblanc	819-759-3555 x4606814
Engineering Superintendent	Pierre McMullen	819-860-2556
Environnent & Critical Infrastructures Superintendant / Responsible Person	Alexandre Lavallee	819-860-0804
Energy & Infrastructures Superintendent	Guillaume Gemme	819-759-3555 x4606632 819-856-3073
Maintenance Superintendent	Dave Jean	819-759-3555 x4606722 819-763-9185
Health and Safety Superintendent	Normand Ladouceur	819-759-3555 x4606720 819-856-9615

SECTION 3 • TAILINGS MANAGEMENT INFRASTRUCTURE DESCRIPTION

The Tailings Management Infrastructures at Meadowbank represent the infrastructure required to transport and store tailings produced by the process plant. They can be divided into the following category :

- The Tailings Storage Facility (TSF) and associated dikes (North Cell and South Cell)
- The pits used to store tailings and associated reclaim system to the mill (Portage Pit and Bay Goose Pit)
- Piping used for tailings conveyance to the TSF or pits
- Sumps, pumps and ditches use to manage water from tailings management area

The tailings management includes the operation of a series of Infrastructures as shown in Table 3-1. The general layout of the Tailings Management Infrastructure is provided in Appendix A. The design criteria of the earthwork infrastructure are presented in Appendix B. References to design and construction documents are presented in Section 3.2 to 3.6.

Table 3-1: Description of the Tailings Management Infrastructure

Infrastructure	Function
TSF North Cell Peripheral Structures: Saddle Dam 1, Saddle Dam 2, RF1, RF 2	Peripheral tailings retention structures for tailings containment within the North Cell
TSF North Cell Internal Structure	Upstream raise built on the tailings to increase capacity of the North Cell
TSF South Cell Peripheral Structures: Saddle Dam 3, Saddle Dam 4, Saddle Dam 5, Central Dike	Peripheral tailings retention structures for tailings containment within the South Cell
TSF Stormwater Dike	Internal structure that divides the TSF into the North and the South Cell
TSF Diversion Ditches	Non-contact water diversion structures. Prevent runoff from the watershed from reaching the TSF
In-Pit : Goose Pit, Pit A and Pit E	Mined out pits that are used for tailings storage
Tailings Conveyance System	Pumping and piping system used to send the tailings from the process plant to either the TSF or the Pits
Reclaim System	Pumping and piping infrastructure used to recirculate water to the process plant from either the TSF or the in-pit to minimise freshwater consumption at the mill and minimise water to store on site

3.1 SITE CONDITIONS

The Meadowbank mine is located within a low Arctic Eco climate described as one of the coldest and driest regions of Canada. Arctic winter conditions occur from October through May, with temperatures ranging from +5°C to -40°C. Summer temperatures range from -5°C to +25°C with isolated rainfall increasing through September. The long-term mean annual air temperature for Meadowbank is estimated to be approximately -11.1°C.

The prevailing winds at Meadowbank for both the winter and summer months are from the northwest. A maximum daily wind gust of 93 km/h was recorded on September 1, 2009. August is the wettest month, with a total precipitation of 43.4 mm, and February is the driest month, with a total precipitation of 6.1 mm. During an average year, the total precipitation is 249.6 mm, split between 147.5 mm of rainfall and 102.1 mm of snowfall precipitation.

Two main faults are inferred in the Portage deposit area and are the Bay Zone Fault and the Second Portage Fault. The Second Portage fault trends to the northwest under Central Dike and the Tailings Storage Facilities (TSF), roughly parallel to the orientation of Second Portage Lake. The Bay Zone Fault trends from South to North and crosses Third Portage Lake, Goose Pit and Portage Pit.

Meadowbank is in an area of continuous permafrost. Lake ice thicknesses of between 1.5 m and 2.5 m have been encountered during mid to late spring. Taliks (areas of permanently unfrozen ground) could be expected where water depth is and/or has been greater than about 2 to 2.5 m. The depth of permafrost at site is estimated to be in the order of 450 to 550 m, depending on proximity to lakes. The depth of the active layer ranges from about 1 to 1.5 m.

The site area consists of low, rolling hills with numerous small lakes. It is covered by laterally extensive deposits of glacial till with a thickness from 0 to 5 m. The glacial till is variable but generally is made up of sand and gravel with cobbles and boulders and a fines content between 15% and 40%. Lakebed sediment consisting of sand, silt, and clay sized particles overlies the till in the lakes.

The site is underlain by a sequence of Archaean greenstone (ultramafic and mafic flow sequences) and metasedimentary rocks that have undergone polyphase deformation resulting in the superposition of at least two major structural events. Within the greenstone are volcaniclastic sediments, felsic-to-intermediate flows and tuffs, sediments (greywackes) and oxide iron formations. Ultramafic rocks are variably altered, and the ore is hosted in the iron formation rocks. The four main rock types are iron formation, intermediate volcanic, ultramafic volcanic, and quartzite.

The Meadowbank site is a remote site that is only accessible from the all-weather access road from the town or Baker Lake (with entry gates at the mine and at Baker Lake), or by aerial link with AEM hubs in Quebec. As such, access from unauthorized members of the public is very unlikely.

3.2 TAILINGS STORAGE FACILITY (TSF)

The tailings storage facility (TSF) is located within the dewatered portion of the northwestern arm of Second Portage Lake and consists of the North Cell and the South Cell. The South Cell is comprised of Central Dike, Saddle Dam 3, Saddle Dam 4 and Saddle Dam 5, all built to El. 145 m. The North Cell is comprised of peripheral structures Saddle Dam 1, Saddle Dam 2, RF1 and RF2. Stormwater Dike is an internal structure separating the North Cell from the South Cell. The North Cell was internally raised with the construction of the North Cell Internal Structure to a variable elevation ranging from 152 to 154 m.

The North Cell and South Cell are currently inactive, however additional capacity remains to accommodate future tailings deposition.

A retention basin and a series of diversion ditches surround the catchment basin of the North Cell. These structures are designed to convey surface water runoff away from the TSF. Three temporary retention basins and one ditch are constructed within the North Cell, at the downstream toe of the North Cell Internal Structure to collect seepage through and runoff from this structure.

Table 3-2 and Table 3-3 summarise the design criteria for the peripheral dikes of the TSF. Figure 3-1 shows a plan view of the TSF infrastructure.

Table 3-2: Design Criteria Summary for TSF Peripheral Dikes of the North Cell

Design Criteria – North Cell Peripheral Structure (SD1, SD2) & Stormwater Dike							
Use	Classification (CDA, 2007)	Design Earthquake	Inflow Design Flood	Water Level (m)		Max Tailings Elevation (m)	Crest Elevation (m) (max elevation)
				Max Operation	Design Flood*		
Tailings Retention	High	1:2500 years	1/3 between 1000-year and PMF	148	149	149.5	150.0

Table 3-3: Design Criteria Summary for TSF Peripheral Dikes of the South Cell

Design Criteria – South Cell Peripheral Structure (SD3, SD4, SD5, CD)							
Use	Classification (CDA, 2007)	Design Earthquake	Inflow Design Flood	Water Level (m)		Max Tailings Elevation (m)	Crest Elevation (m) (max elevation)
				Max Operation	Design Flood*		
Tailings Retention	High	1:2500 years	1/3 between 1000-year and PMF	143	144	144.5	145

*Reference : \\Cambfs01\groups\Engineering\05-Geotechnic\05-WaterManagement\2021

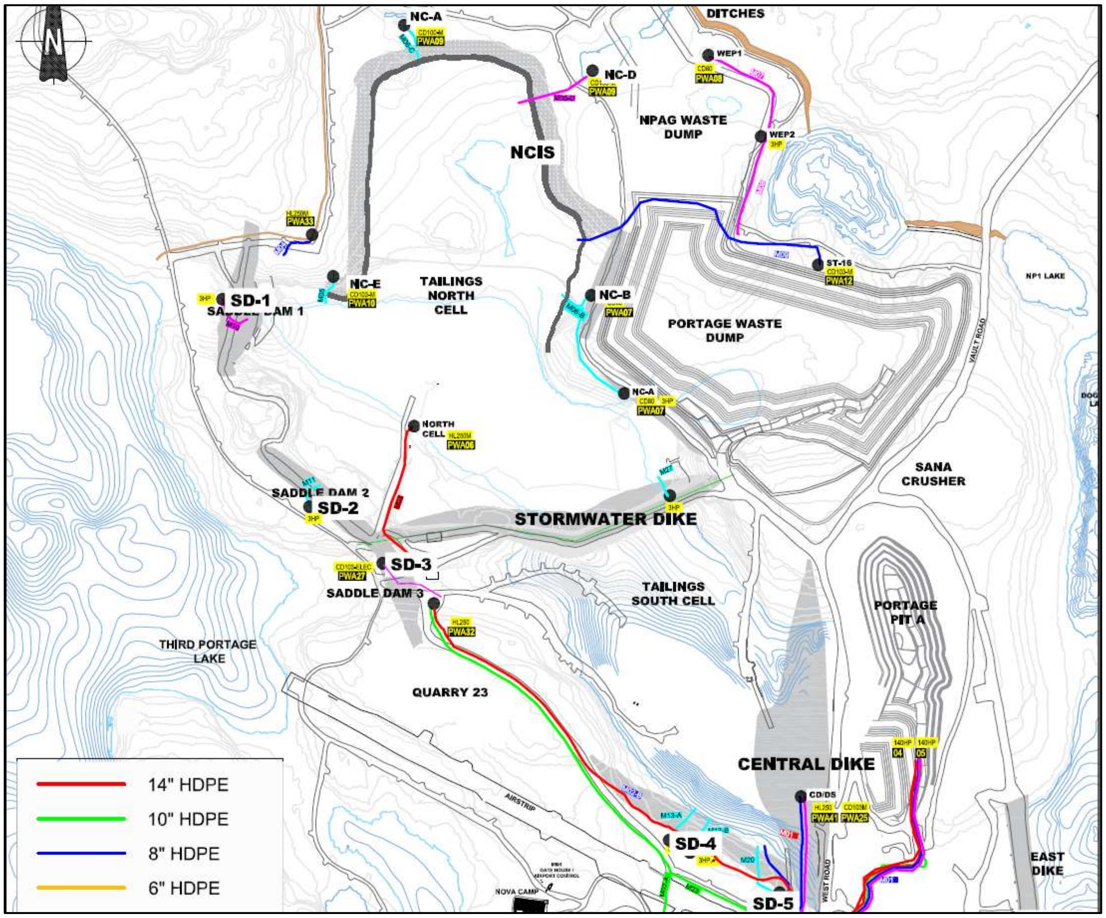


Figure 3-1 – Meadowbank TSF Infrastructure

3.2.1 Saddle Dam 1 – North Cell

Saddle Dam 1 is located in the northwestern corner of the TSF and forms one of the perimeter structures of the North Cell intended to retain tailings and supernatant fluid during the operation of the TSF. Saddle Dam 1 crosses a depression between the northwestern arm of Second Portage Lake and Third Portage Lake.

Saddle Dam 1 was constructed in two stage using the downstream method from 2009 to 2010. Stage 1 of Saddle Dam 1 was constructed in the fall of 2009 to a height of 10 m (crest elevation of 141 m) and a length of 250 m. Stage 2 was constructed in 2010 to an overall height of 20 m (final crest elevation of 150 m) and length of about 400 m.

Saddle Dam 1 is a rockfill embankment with an 3H:1V upstream slope and a 1.3H:1V downstream slope. This structure has inverted base filters, upstream graded filters, and a linear low density polyethylene (LLDPE) geomembrane liner on the upstream dike face. The geomembrane liner is placed between an upper and lower non-woven geotextile layer for protection, and is covered by approximately 0.3 m of granular material up to El. 140 m. No granular layer was placed above El. 140 m and the liner is exposed above that elevation. According to the design, a tailings beach has to be maintained on the face of the structure to reduce the potential for ice damage to the liner. The abutments are founded on bedrock, while the central portion of the dike is founded on ice-poor soil. Till and/or crushed aggregate mixed with dry bentonite powder have been placed above the toe of the liner.

A permanent dewatering pump is installed downstream within a seacan container. It is used as required during freshet and in the summer to manage runoff water.

References to key documents for the design and construction of Saddle Dam 1 are presented in Table 3-4.

Table 3-5 summarizes the main highlights of Saddle Dam 1.

Table 3-4: Reference Documents for Saddle Dam 1 Design and Construction

Dike	Type of Information	Reference Document	Link to retrieve document
Saddle Dam 1	Design Report	Detailed Design of Tailings Storage Facility Dike (Golder, 2008) Doc 784 Rev 0 (08-1428-0029)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\1- Saddle Dam 1\1- Engineering\3- Deliverable\1-Design Report\Doc 784 1217_08 RPT-Detailed Design of Tailings Storage Facility Dike-Meadowbank Ver 0.pdf
	Drawings	Drawings in Detailed Design of Tailings Storage Facility Dike (Golder, 2008) Doc 784 Rev 0 (08-1428-0029)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\1- Saddle Dam 1\1- Engineering\3- Deliverable\1-Design Report\Doc 784 1217_08 RPT-Detailed Design of Tailings Storage Facility Dike-Meadowbank Ver 0.pdf
	Technical Specifications	Specifications for TSF Dike Construction (Golder, 2009) Doc 795 Rev 0 (08-1428-0029/6000)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\1- Saddle Dam 1\1- Engineering\3- Deliverable\3-Specifications\Doc 795 1020_09 Specification-TSF Dike Construction Meadowbank Rev 0.pdf
	As-Built	Construction Report TSF 2009-2011 (AEM 2013)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\1- Saddle Dam 1\2- Construction\4- Deliverable\1-As-Built Report

Table 3-5 : Saddle Dam 1 Summary

Saddle Dam 1
Designer : Golder **Construction Period :** 2009-2010 (2 stage using downstream method) **Operation Period :** 2009 - 2026 **Planned Closure Period :** 2026-2042
Design Criteria: Refer to Table 3-2
Part of the TSF North Cell. Zoned rockfill dike with an upstream low-permeability element (LLDPE liner) with an upstream toe liner tie-in. The structure is in operation.
Operation Highlight • North Cell inactive since 2019
No risk assessment performed on this structure Design Factor of Safety in Appendix B

Figure 3-2 : Aerial View of Saddle Dam 1

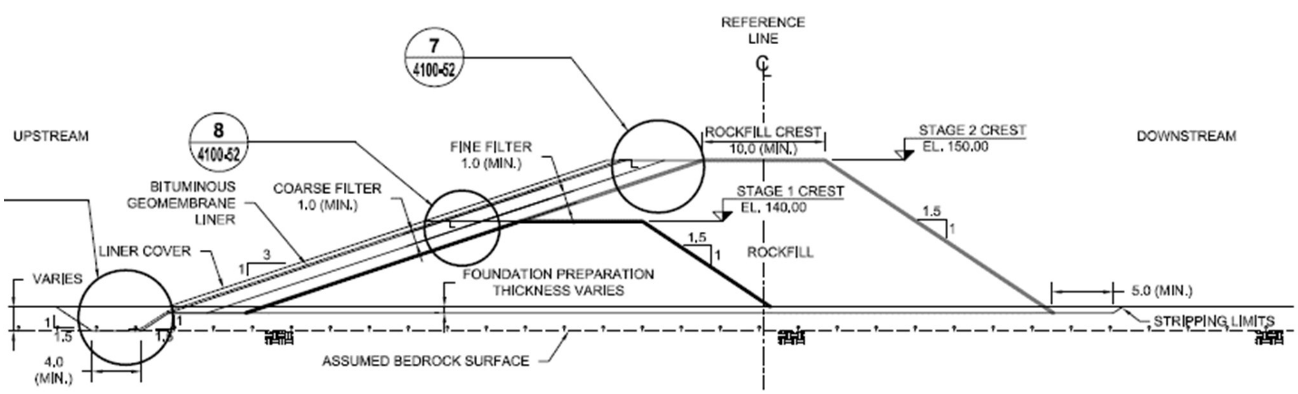


Figure 3-3: Typical Cross-section of Saddle Dam 1

3.2.2 Saddle Dam 2 – North Cell

Saddle Dam 2 is located along the western side of the TSF and connects to the western corner of Stormwater Dike. Along with Saddle Dam 1, it forms one of the perimeter structures of the TSF's North Cell which retain tailings and supernatant fluid during the operation of the TSF. Saddle Dam 2 crosses a depression between the northwestern arm of Second Portage Lake and Third Portage Lake. Its construction and design is similar to Saddle Dam 1. Saddle Dam 2 has a maximum height of about 10 m and a crest length of 460 m.

Saddle Dam 2 was constructed in two stage to El. 150 m in 2010 and 2011. The upstream foundation of the dike and abutments are primarily founded on bedrock; however, some portions of the structure, underneath the inverted filter, are founded on ice-poor soil. During construction, a thin layer of low permeability till was placed and compacted along the toe liner tie-in connection with bedrock. A thin layer of crushed aggregate (0-22 mm) mixed with dry bentonite powder was also placed under the thin layer of low permeability till in areas where open fractures were observed within the bedrock. The toe liner tie-in was then covered with till.

There is no pumping system associated with Saddle Dam 2.

References to key documents for the design and construction of Saddle Dam 2 are presented inTable 3-6.

Table 3-7 summarizes the main highlights of Saddle Dam 2.

Table 3-6: Reference Documents for Saddle Dam 2 Design and Construction

Dike	Type of Information	Reference Document	Link to retrieve document
Saddle Dam 2	Design Report	Detailed Design of Tailings Storage Facility Dike (Golder, 2008) Doc 784 Rev 0 (08-1428-0029)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\1- Saddle Dam 1\1- Engineering\3- Deliverable\1-Design Report\Doc 784 1217_08 RPT-Detailed Design of Tailings Storage Facility Dike-Meadowbank Ver 0.pdf
	Drawings	Drawings in Detailed Design of Tailings Storage Facility Dike (Golder, 2008) Doc 784 Rev 0 (08-1428-0029)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\1- Saddle Dam 1\1- Engineering\3- Deliverable\1-Design Report\Doc 784 1217_08 RPT-Detailed Design of Tailings Storage Facility Dike-Meadowbank Ver 0.pdf
	Technical Specifications	Specifications for TSF Dike Construction (Golder, 2009) Doc 795 Rev 0 (08-1428-0029/6000)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\1- Saddle Dam 1\1- Engineering\3- Deliverable\3-Specifications\Doc 795 1020_09 Specification-TSF Dike Construction Meadowbank Rev 0.pdf
	As-Built	Construction Report TSF 2009-2011 (AEM 2013)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\2- Saddle Dam 2\2- Construction\4- Deliverable\1-As-Built Report

Table 3-7 : Saddle Dam 2 Summary

Saddle Dam 2
Designer : Golder **Construction Period :** 2010 & 2011 **Operation Period :** 2011 - 2026 **Planned Closure Period :** 2026-2042
Design Criteria : Refer to Table 3-2
Part of the TSF North Cell. Zoned rockfill dike with an upstream low-permeability element (LLDPE liner) with an upstream toe liner tie-in. The structure is in operation.

Operation Highlight • North Cell inactive since 2019.
No risk assessment performed on this structure Design Factor of Safety in Appendix B

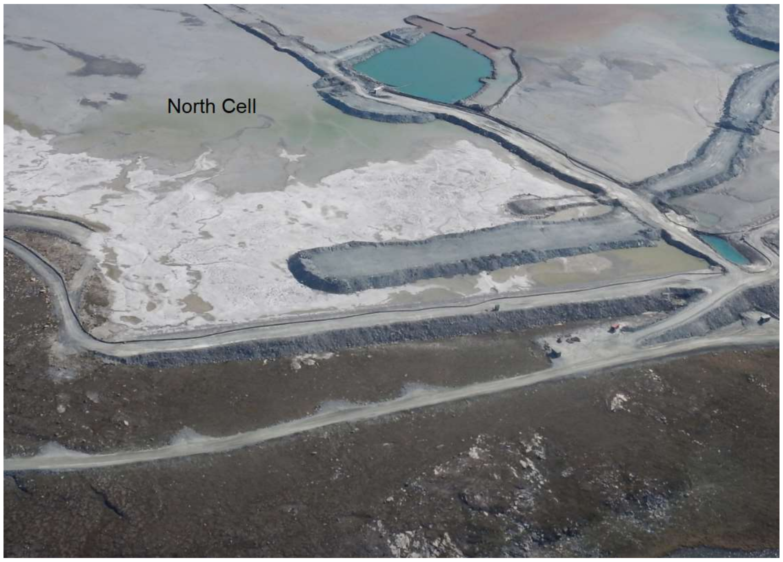


Figure 3-4 : Aerial View of Saddle Dam 2

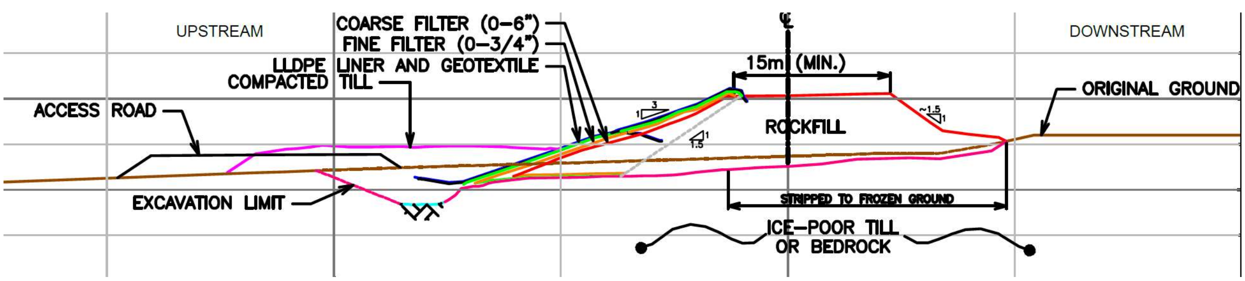


Figure 3-5: As-built Cross-section of Saddle Dam 2

3.2.3 RF1 and RF2 – North Cell

RF1 and RF2 are two rockfill access roads located on the eastern side of the North Cell at the toe of the Portage Waste Rock Storage Facility. They were constructed in 2009 with run of mine rockfill.

These access roads were not designed as a containment structure but during the operation of the North Cell, water and tailings ponded against them. In June 2013 water going through these structures infiltrated the Portage WRSF and then reached Lake NP2. Following this seepage event, a filter system was constructed in August 2014 on the upstream side of RF1 and RF2 to promote the build up of a tailings beach and prevent water exfiltration from the TSF at that location. The constructed filter berm consisted of till and/or coarse filter, geotextile and fine filter. Since the construction of that structure a tailings beach covers these structures. Since the construction of the North Cell Internal Structure on the upstream side of RF1 and RF2 in 2018 these structures are now confined between the NCIS and the Portage WRSF.

An as-built report is available for the 2009 construction of RF1 and RF2. There is partial documentation of the filter berm design and construction in 2014. Table 3-8 and

Table 3-9 summarizes the available information for RF1 and RF2.

Table 3-8: Reference Documents for RF1/RF2 Design and Construction

Dike	Type of Information	Reference Document	Link to retrieve document
RF1/RF2	Design Report	-	-
	Drawings	Filter Concept (AEM, 2014). Does not represent what was built	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\10- RF1 and RF2\1- Engineering\design
	Technical Specifications	-	-
	As-Built	Construction Report TSF 2009-2011 (AEM 2013)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\10- RF1 and RF2\2- Construction\As-Built

Table 3-9 : RF1/RF2 Summary

RF1/RF2
Designer : AEM **Construction Period :** 2009 & 2010 (rockfill road) / 2014 (upstream filter) **Operation Period :** 2013 - 2026 **Planned Closure Period :** 2026-2042
Design Criteria : No documented design criteria
Part of the TSF North Cell. Rockfill dike/road with an upstream filter. The structure is in operation.
Operation Highlight • Seepage observed in 2013 from this area. Upstream filter added in 2014 to promote tailings beach build-up • North Cell inactive since 2019
No risk assessment performed on this structure Design Factor of Safety in Appendix B

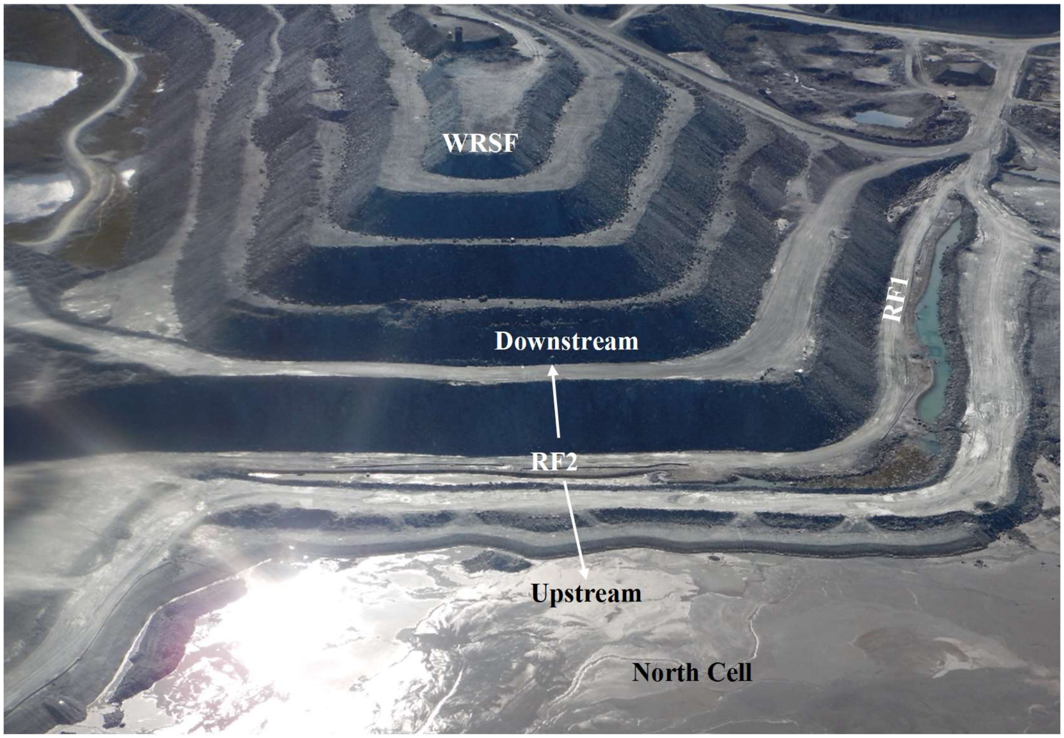


Figure 3-6 : Aerial View of RF1/RF2

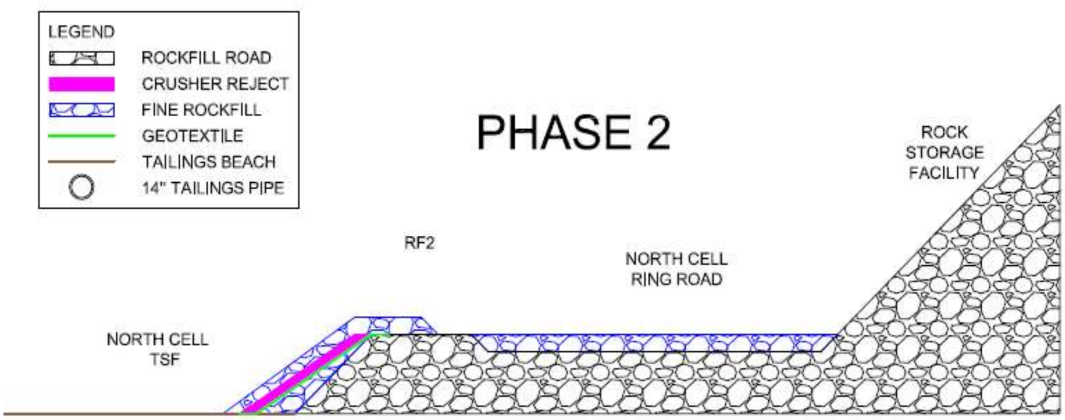


Figure 3-7: Typical Cross-section of RF1/RF2 (not representative of actual as-built condition of upstream filter)

3.2.4 North Cell Internal Structure – North Cell

The North Cell Internal Structure is located within the North Cell of the TSF, in its northern section. It is built as an upstream raise over the existing tailings of the North Cell and the rockfill cover placed over the last years for closure operations. It was constructed in 2018 and is 2160 m in length with a variable Elevation between El. 152 m (2+750 to 3+260) and El. 154 m (1+660 to 2+750).

The North Cell Internal Structure is designed and constructed as a permeable zoned rockfill dam with filter zones, built on the top surface dried tailings of the North Cell and on the existing rockfill cover. The bulk part of the North Cell Internal Structure consists of coarse rockfill material. The upstream face is designed at a 3H:1V slope and the downstream faces are designed at a 1.5H:1V slope. The upstream face of the North Cell Internal Structure comprises two granular filter zones. The filter zones are designed to prevent tailings migration and internal erosion, while allowing water to flow through the embankment.

Channelling of water has been observed since 2019 at the upstream toe of the eastern part of the dike. The water flow is eroding fine filter material at the toe. Sloughing, deformation and tension cracks in the upstream filter layer has been observed since 2020 in the eastern area and are caused by water eroding and undercutting the toe of the filters.

Following the construction of the North Cell Internal Structure, internal ditches and sumps (NC-A, NC-B, NC-C, NC-D, NC-E) were constructed over the existing tailings surface. A ditch connecting to a sump was built on the western side of the North Cell internal structure and two sumps were built on the eastern side. The objective of these structures is to collect water that would seep through the internal structure during operation. Water collected in these structures is pumped back into the TSF. These structures are operational only during deposition from the internal structure of the North Cell.

References to key documents for the design and construction of the North Cell Internal Structure are presented in

Table 3-10.

Table 3-11 summarizes the main highlights of the North Cell Internal Structure.

Table 3-10: Reference Documents for the North Cell Internal Structure Design and Construction

Dike	Type of Information	Reference Document	Link to retrieve document
North Cell Internal Structure	Design Report	Detailed Design of North Cell Internal Raise (Golder, 2018) Rev 0 (1784383)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\9- North Cell Internal Structure (NCIS)\1- Engineering\2 - Detailled Engineering\3-Reporting\1-Design Report\Design report Rev 0 (final)\1784383_North Cell Internal Dike Raise - Design Report_Rev0_19Apr2018.pdf
	Drawings	Drawings for North Cell Internal Raise (Golder, 2018) Rev 0 (1784383)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\9- North Cell Internal Structure (NCIS)\1- Engineering\2 - Detailled Engineering\3-Reporting\3-Drawings\Final\1784383-Meadowbank-Construction Drawings Stamped.pdf
	Technical Specifications	Specifications for North Cell Internal Raise (Golder, 2018) Rev 0 (1784383)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\9- North Cell Internal Structure (NCIS)\1- Engineering\2 - Detailled Engineering\3-Reporting\2-Specification\Rev 0\1784383 - 4000 TSF Spec Meadowbank_Tech Specs_Rev0_7Feb2018.docx
	As-Built	North Cell Internal Structure As-built Report (Golder, 2018) Doc 1578 Rev0 (1897439)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\9- North Cell Internal Structure (NCIS)\2-Construction\2018\4-Deliverable\1- As-Built Report\1897439-1578-R-Rev0 As-built report 2018.pdf

Table 3-11 : North Cell Internal Structure Summary

North Cell Internal Structure							
Designer : Golder **Construction Period :** 2018 (upstream raise on tailings) **Operation Period :** 2018 - 2026 **Planned Closure Period :** 2026-2042							
Design Criteria							
Use	**Classification (CDA, 2007)**	**Design Earthquake**	**Inflow Design Flood**	**Water Level (m)**		**Max Tailings Elevation (m)**	**Crest Elevation (m) (max elevation)**
				Max Operation	**Design Flood**		
Tailings Retention	Significant	1:2500 years	-	-	-	Variable (0.5 m freeboard)	152 to 154 m
Part of the TSF North Cell. Zoned rockfill permeable dike with an upstream filter system. The structure is in operation.							
Operation Highlight • Tension cracks, depression and sloughing of filter observed in 2020 due to erosion of upstream team • North Cell inactive since 2019							
No risk assessment performed on this structure Design Factor of Safety in Appendix B							

Figure 3-8 : Aerial View of the North Cell Internal Structure

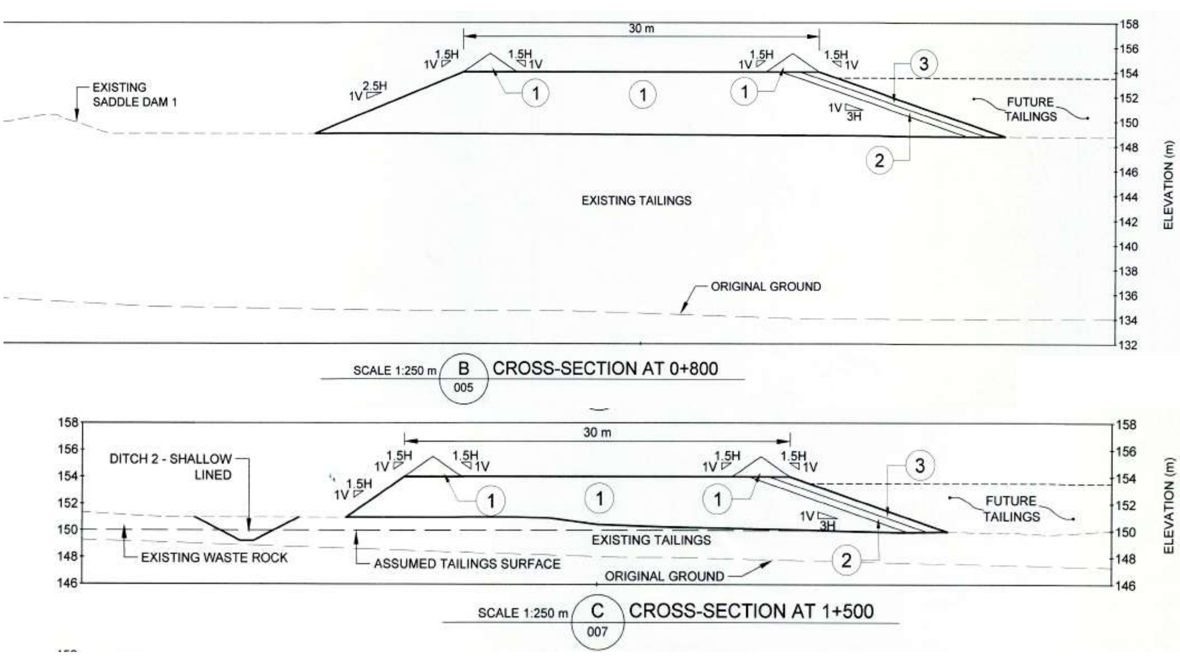


Figure 3-9: Typical Cross-section of the North Cell Internal Structure

3.2.5 Saddle Dam 3, Saddle Dam 4 and Saddle Dam 5 – South Cell

Saddle Dam 3 is located in the northwestern corner of the South Cell and merges into Saddle Dam 2 to El. 145 m. Saddle Dam 4 is located in the southwestern corner of the South Cell and merges into Saddle Dam 5, which merges with the southern end of Central Dike, to El. 145 m. These structures were constructed from 2015 to 2018 as a series of downstream raises.

- Stage 1 of Saddle Dam 3, 4 and 5 was constructed in 2015. During Stage 1, Saddle Dam 3 and 4 were constructed to El. 140 m and Saddle Dam 5 to El. 137 m.
- Stage 2 of Saddle Dam 3, 4 and 5 was constructed to El. 143 m in 2016.
- Stage 3 of Saddle Dam 3, 4 and 5 was constructed to El. 145 m in 2017.
- The filter and liner installation at Saddle Dam 3 was finalized in 2018.
- The completed crest length is approximately 245 m for Saddle Dam 3, 365 m for Saddle Dam 4, and 255 m for Saddle Dam 5.

Saddle Dams 3, 4, and 5 are designed and constructed as zoned rockfill dams with filter zones, low permeability upstream liners, and upstream toe liner tie-in key trenches. Cross-sections of Saddle Dams 3, 4 and 5 consist of a rockfill embankment, constructed from run-of-mine waste rock, placed in lifts and compacted. The upstream faces are designed at a 3H:1V slope and the downstream faces are designed at a 1.5H:1V slope. The upstream faces of Saddle Dams 3, 4 and 5 are comprised of two granular filter zones and a LLDPE liner extending along the upstream foundation. The filter zones are meant to keep the tailings inside the facility in a case of liner puncture, but mainly act as appropriate bedding for the liner. An upstream liner tie-in key trench excavated to bedrock and filled with compacted till is located along the upstream area of the structures.

The design of Saddle Dam 3 includes an additional protection cover over the liner made of till and rockfill. This protection was added to the design as this structure will not be protected with a tailings beach during operation as water needs to be maintained in that area for reclaim.

Saddle Dam 3/4/5 have sumps located downstream to collect runoff water and to pump it back in the South Cell.

These structures are designed to be able to be raised to El. 150 m and the final crest elevation of these structures is subject to review by AEM.

References to key documents for the design and construction of Saddle Dams 3/4/5 are presented in Table 3-12.

Table 3-13 summarizes the main highlights of Saddle Dams 3/4/5.

Table 3-12: Reference Documents for the Saddle Dams 3/4/5 Design and Construction

Dike	Type of Information	Reference Document	Link to retrieve document
SD3/4/5	Design Report	Detailed Design Report for Saddle Dams 3, 4 and 5 (Golder, 2015) Doc 1504 Rev1 (1416081)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\3- Saddle Dam 3\1- Engineering\3- Deliverable\1-Design Report\Doc 1504 1416081 RA Rev1 SD345 Design Report – final.pdf
	Drawings	Construction Drawings for Saddle Dams 3,4 and 5 (Golder, 2015) Rev0 (1416081)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\3- Saddle Dam 3\1- Engineering\3- Deliverable\2-Drawings\1416081-SD345-Drawings-rev0.pdf
	Technical Specifications	Saddle Dams 3,4 and 5 Construction Technical Specifications (Golder, 2015) Doc 1498 RevA (1416081)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\3- Saddle Dam 3\1- Engineering\3- Deliverable\3-Specifications\Doc1498-1416081 0127_15 SD 3-4-5 Specifications_MB Ver A.pdf
	As-Built	Construction As-Built Reports for Stages 1 to 3 (Golder, 2015 to 2018)	**Stage 1 (2015):** \\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\3- Saddle Dam 3\2- Construction\2015 (Phase 1)\4-Deliverable\1- As-Built Report **Stage 2 (2016):** \\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\3- Saddle Dam 3\2- Construction\2016 (Phase 2)\4-Deliverable\1- As-Built Report **Stage 3 (2017):** \\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\3- Saddle Dam 3\2- Construction\2017 (Phase 3)\4-Deliverable\1- As-Built Report\Final **Stage 3 finalization (2018):** \\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\3- Saddle Dam 3\2- Construction\2018 (Phase 3 Finalisation)\4- Deliverable\1- As-Built Report

Table 3-13 : Saddle Dams 3/4/5 Structure Summary

Saddle Dams 3/4/5
Designer : Golder **Construction Period :** 2015-2018 **Operation Period :** 2015 - 2026 **Planned Closure Period :** 2026-2042
Design Criteria : Refer to Table 3-3
Part of the TSF South Cell. Zoned rockfill dike with an upstream low-permeability element (LLDPE liner) with an upstream toe liner tie-in. The structure is in operation.
Operation Highlight • South Cell inactive since 2019.
No risk assessment performed on these structures Design Factor of Safety in Appendix B

Figure 3-10 : Aerial View of Saddle Dams 3

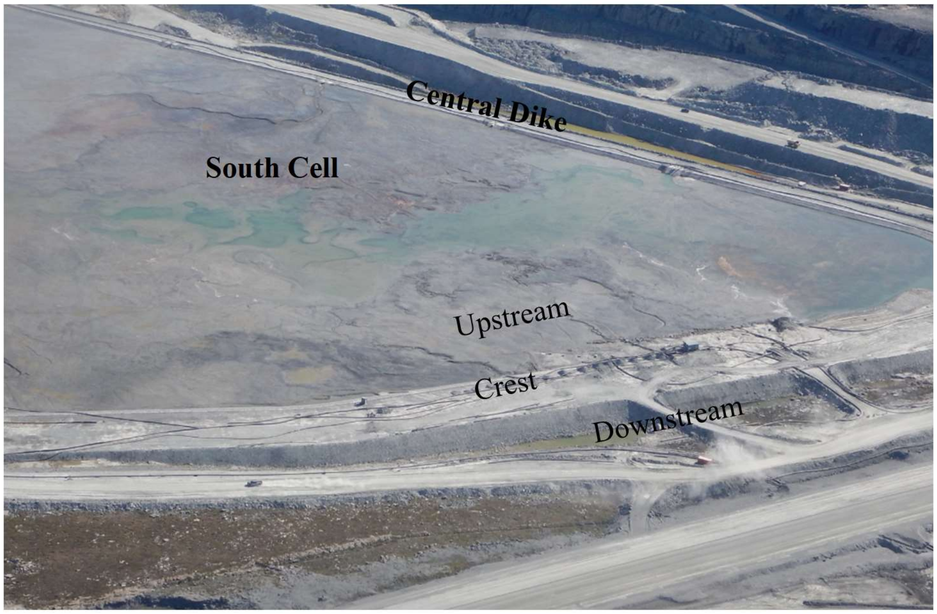


Figure 3-11 : Aerial View Saddle Dam 4

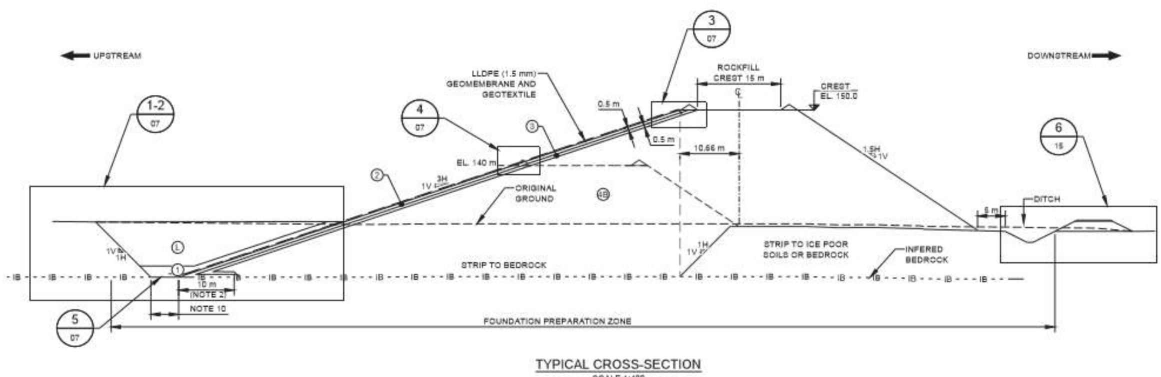


Figure 3-12: Typical Cross-section of the Saddle Dams 3/4/5

3.2.6 Central Dike – South Cell

Central Dike is located along the eastern side of the TSF and crosses a depression within Second Portage Lake. It forms one of the perimeter structures of the South Cell. The dike was constructed from 2012 to 2018 as a series of 5 downstream raise to El. 145 m.

Central Dike design includes a compacted rockfill embankment with an upstream seepage barrier, granular filters and a key trench along the centerline of the dike transitioning on the upstream toe near both abutments. The foundation soils include lakebed sediments and till overlying bedrock. Soft and ice-rich soils were removed from the Central Dike footprint during construction.

Central Dike is designed to be able to be raised to El. 150 m and the final crest elevation is subject to review by AEM. The completed crest length is approximately 900 m.

References to key documents for the design and construction of Central Dike are presented in Table 3-14. Table 3-15 summarizes the main highlights of Central Dike.

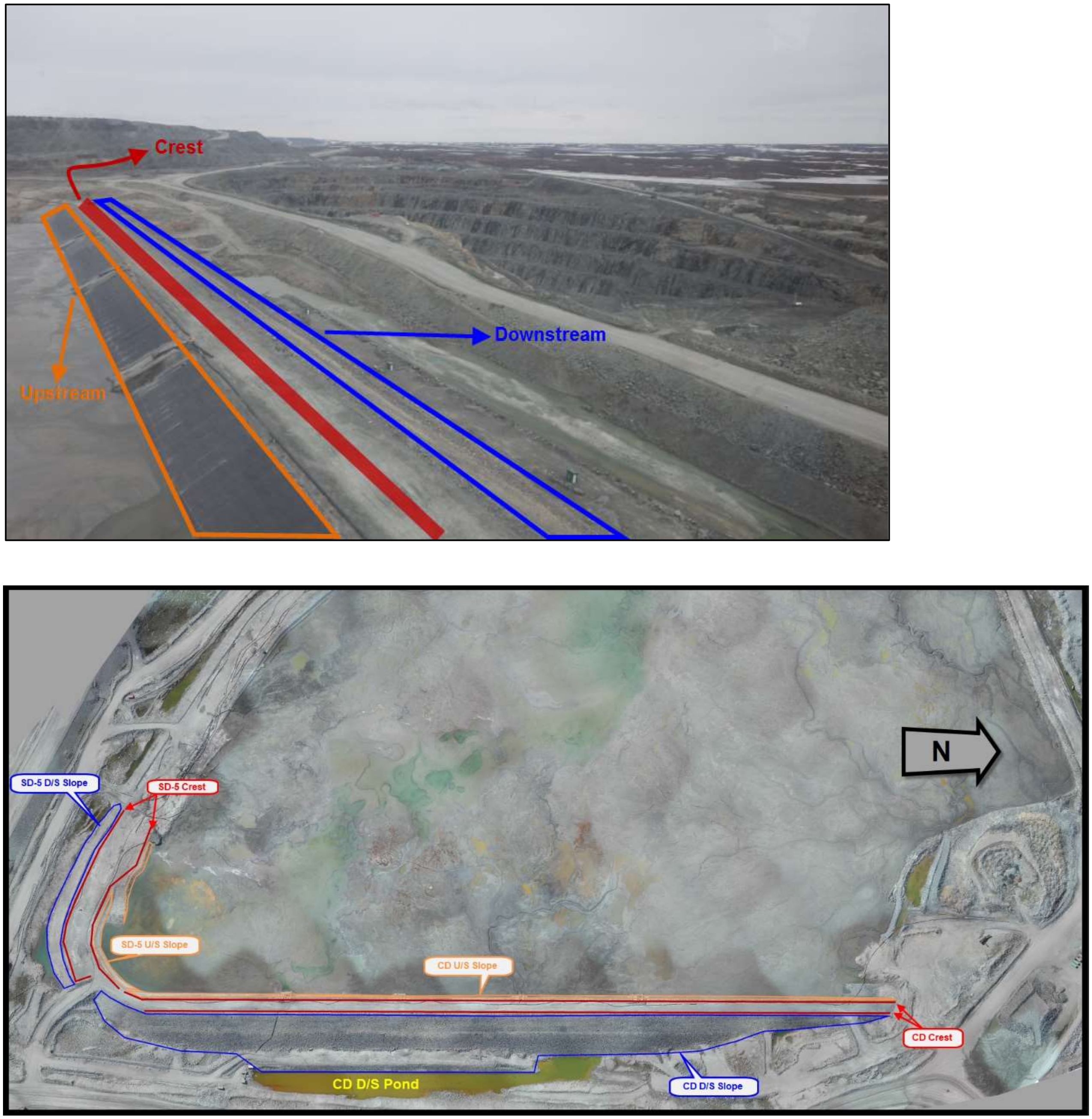


Figure 3-13 : Aerial View of Central Dike and SD5

Table 3-14: Reference Documents for Central Dike Design and Construction

Dike	Type of Information	Reference Document	Link to retrieve document
Central Dike	Design Report	Detailed Design Report for Central Dike (Golder, 2012) Doc 1349-1112210035-0511-12 Rev1	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\8- Central Dike\2012\F10 - Design\Dikes Design Report_Golder\Central Dike\Doc 1349-1112210035_0511_12 RP CD Design-MB Ver 0 Rev1.pdf
	Drawings	Construction Drawings in Detailed Design Report for Central Dike (Golder, 2012) Doc 1349-1112210035-0511-12 Rev1	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\8- Central Dike\2012\F10 - Design\Dikes Design Report_Golder\Central Dike\Doc 1349-1112210035_0511_12 RP CD Design-MB Ver 0 Rev1.pdf
	Technical Specifications	Technical Specifications in Detailed Design Report for Central Dike (Golder, 2012) Doc 1349-1112210035-0511-12 Rev1	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\8- Central Dike\2012\F10 - Design\Dikes Design Report_Golder\Central Dike\Doc 1349-1112210035_0511_12 RP CD Design-MB Ver 0 Rev1.pdf
	As-Built	Construction As-Built Reports (Golder, 2012 to 2018)	**2012:** \\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\8- Central Dike\2012\F32-As-Built Report\Stage 1 2012\FINAL - PDF **2014** : \\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\8- Central Dike\2014\F25-As-Built Report\Final - PDF **2015** : \\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\8- Central Dike\2015\F25-As-Built Report **2016:** \\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\8- Central Dike\2-Construction\2016\4- Deliverable\1- As-Built Report\Doc 1552 1656047 RPA Rev0 As-built report.pdf **2017:** \\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\8- Central Dike\2-Construction\2017\4- Deliverable\1- As-Built Report\Final\1777687-1572-RP-Rev0 As-built report PROTECTED.pdf **2018:** \\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\8- Central Dike\2-Construction\2018 (Phase 6)\4- Deliverable\1- As-Built Report\1897439-1578-R-Rev0 As-built report 2018.pdf

Table 3-15 : Central Dike Structure Summary

Central Dike
Designer : Golder **Construction Period :** 2012-2018 **Operation Period :** 2013 - 2026 **Planned Closure Period :** 2026-2042
Design Criteria : Refer to Table 3-3
Part of the TSF South Cell. Zoned rockfill dike with an upstream low-permeability element (LLDPE liner) with a centreline liner tie-in or an upstream toe liner tie-in (North abutment only). The structure is in operation.
Operation Highlight • Seepage observed since 2014 and managed by active pumping. Significantly reduced through adaptive tailings deposition and supernatant pond reduction. • Orange coloration observed in the downstream pond since 2017 (due to bacteria activity). • TARP level of the structure is at Yellow since 2014 due to higher seepage rate than anticipated • South Cell inactive since 2019
No risk assessment performed on this structure yet, planned for 2021. Design Factor of Safety in Appendix B

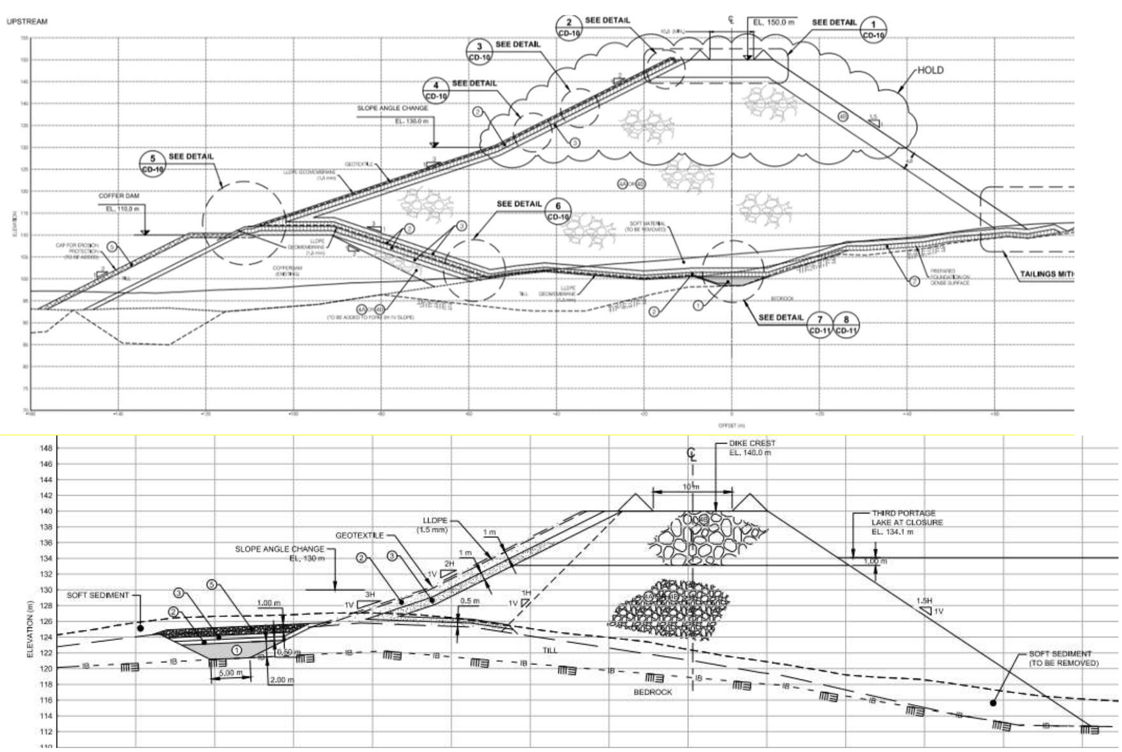


Figure 3-14: Typical Cross-sections of the Central Dike (top: highest dike section, bottom: section with upstream liner tie-in).

3.2.6.1 Central Dike Seepage System

Seepage into the basin at the downstream toe of Central Dike was observed accumulating in a low spot between the dike and the West Road when the South Cell was commissioned in 2014. The rate of seepage started to increase proportionally to the rise of the pond level of the South Cell and reach a peak of 900 m^3/h in 2015.

A seepage pumping system was installed in the low spot control the water level at the downstream toe. The pump is operated year round. All seepage is collected within the downstream area of the dike. The average seepage rate at Central Dike has significantly decreased since 2015 as tailings were deposited in the South Cell and has been following the trend from the 2017 seepage model. The water from the seepage system can either be sent to the South Cell or the Portage Pit.

In the summer of 2017, the water in the downstream pond became orange and this was associated with rapid temperature variation. This event was investigated by chemical analysis and was found to be caused by the precipitation of iron oxide from bacterial process. As predicted this event has re-occurred yearly in the summer season.

Table 3-16: Summary of Central Dike seepage areas

Seepage area	Dike Station	Average[1] seepage rate (flowmeter)	Water quality
Downstream toe	500 to 850 (at El. 115m)	50 m^3/h in winter to 200 m^3/h in summer	Clear with orange coloration in summer

From 2015 to 2017 the following work was done to better understand the seepage situation at Central Dike :

- Desktop studies were undertaken in 2015 to estimate the seepage flows and pore water pressures, verify the dike stability, and attempt to predict the eventual flow volume that would report to the downstream toe for higher pond elevation. The seepage pathway used in the 2015 model was through a layer of fine material in the till layer of the foundation as it was deemed the most critical scenario for the structure stability. The main recommendation from this desktop study was to maintain beaches adjacent to Central Dike and to maintain a 'back pressure' on the downstream side of Central Dike in order to reduce the hydraulic gradient by holding the downstream pond at El. 115 m.
- In 2015 Willowstick was hired to carry out geophysical soundings (electromagnetic survey) to detect seepage paths. The geophysical campaign led to additional recommendations and identified possible seepage path locations through the bedrock.
- Following the geophysical investigation, an investigation was conducted by SNC Lavallin (SNC) and AEM in December 2015 at station CD-595, and between CD-810 and CD-850. Highly altered and fractured bedrock was encountered and high hydraulic conductivity was measured from Packer testing. Instrumentation of the four boreholes with piezometers and thermistors was done at the same time.

- A study has been completed in 2017 to update the seepage modelling and stability assessment with a seepage flow through the bedrock. In the summer of 2017 an investigation and instrumentation campaign was performed by Golder to confirm the results of the seepage modelling. The results from this investigation support the hypothesis that the seepage pathway occur in the bedrock. During this investigation a potential void in the till layer was encountered during drilling. A complementary investigation was thus performed and was not able to confirm the presence of the void.

3.2.7 Stormwater Dike – TSF Divider Dike

Stormwater Dike is an internal structure that subdivides the TSF into the North Cell and the South Cell within the dewatered northwestern arm of Second Portage Lake. The North Cell side is referred as upstream and the South Cell side as downstream.

Stormwater Dike is a rockfill embankment structure founded on lakebed soils. The upstream slope is approximately 3H:1V and the downstream slope is about 1.3H:1V. A bituminous geomembrane liner has been installed above the graded filters on the upstream face of the dike. Low permeability till was placed and compacted along the upstream toe of the dike, above the liner. Stormwater Dike was initially designed as a temporary structure that would be encapsulated in tailings to equal elevation on both side. With the change in tailings deposition strategy there is a 5 m difference in tailings elevation between the upstream and downstream area and this structure cannot be considered as a temporary one anymore.

Stormwater dike was raised in 3 stages using the downstream raise method. Stage 1 was constructed in 2009 to a height of 10 m (crest elevation of 140 m) and a length of 860 m. Stage 2 was primarily constructed in 2010 to an overall height of 18 m (crest elevation of 148 m) and length of about 1,060 m. A horizontal bench is present along the upstream face of the structure due to the connection of the 2009 and 2010 portions of the structure. The junction between the bituminous liner of Stormwater Dike and the LLDPE liner of Saddle Dam 2 was completed in 2011 and the crest of Stormwater Dike was raised to 150 m in 2013 (Stage 3). A stabilisation buttress as added in some area at the downstream toe of the structure in 2016.

The majority of the dike is seated on dense till from the former lakebed within the talik while the abutments are generally founded on bedrock. The foundation preparation of Stage 2 was completed in winter conditions. It was generally done above water except in an area where water ponding was present (between Sta.10+500 and 10+750 approximately). This pond was located where the topography suggests that the soft lakebed sediment thickness may be greater than at other locations along the dike. Due to the presence of water, the ice crust was cracked with the excavator and only minimal foundation preparation was possible. As a result, most of the lakebed sediment probably remained in place in this area.

Movement and deformation were observed on Stormwater Dike in the past, as detailed below which triggered an increase in the TARP level of the structure. The movement are stable since 2019 and the dike TARP level is back to normal operating condition.

The main highlights of the dike operation are summarized below:

- At the end of August 2016, during a routine inspection, AEM noticed tension cracks and signs of settlements on the crest of Stormwater Dike between Sta. 10+500 to 10+750 approximatively. The crack system that suddenly developed in this area had a lateral and vertical component according to the monitoring equipment. To mitigate against a possible foundation failure, a rockfill buttress support was constructed at the downstream toe of Stormwater Dike in the South Cell (from Sta. 10+300 to Sta. 10+700 approximatively). After the completion of this buttress the displacement at Stormwater Dike stabilized and then stopped. Cracks have since been filled with bentonite.
- In July 2017, during a routine inspection, AEM noticed new tension cracks and signs of settlements on the crest of Stormwater Dike around Sta. 10+425, between Sta. 10+550 and Sta. 10+650, between Sta. 10+800 and Sta. 10+950, and around Sta. 11+050 approximatively. Settling of about 300 mm was observed between Sta. 10+800 and Sta. 10+950, approximately. Cracks appear to be oblique tension fractures, extending over the entire width of the dike crest. Some cracks were up to 5 cm wide but most of them did not progress after they were first observed. The area affected by these cracks is consistent with the limits of the South Cell water ponding against Stormwater Dike, which probably thawed the frozen soft soil foundation.
- In April 2018, new cracks were observed by AEM in between Sta. 10+950 and Sta. 11+010. The widest crack was about 4 cm wide but the cracks did not progress significantly after they were first noted. New crack were observed later in July in between S114 and S115 but no elongation was noted after.
- The current understanding of the situation is that the soft sediment foundation was frozen in the winter of 2010 while additional rockfill material continued to be placed over it until July 2010. The foundation freezing explains why no adverse settlement or soil failure was observed until the South Cell water level started reaching the toe of the structure in July 2016, which probably thawed the frozen soft soil foundation. The mechanism that caused the observed movement could be due to a foundation soil failure, the thawing of ice lenses or a combination of both.
- No further movement has occurred in Stormwater Dike since 2018. There is tailings at the toe of the structure on both side.

A small pump is installed as required on the Eastern edge of the dike to collect water trapped between the capping and the dike and pump it back to the North Cell. This will prevent pooling of water against the toe of the dike.

References to key documents for the design and construction of Stormwater Dike are presented in Table 3-17. Table 3-18 summarizes the main highlights of Stormwater Dike.

Table 3-17: Reference Documents for Stormwater Dike Design and Construction

Dike	Type of Information	Reference Document	Link to retrieve document
Stormwater Dike	Design Report	Detailed Design of Tailings Storage Facility Dike (Golder, 2008) Doc 784 Rev 0 (08-1428-0029) Buttress Design	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\1- Saddle Dam 1\1- Engineering\3- Deliverable\1-Design Report\Doc 784 1217_08 RPT-Detailed Design of Tailings Storage Facility Dike-Meadowbank Ver 0.pdf \\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\7-Stormwater Dike\Buttress\Buttress Design
	Drawings	Drawings in Detailed Design of Tailings Storage Facility Dike (Golder, 2008) Doc 784 Rev 0 (08-1428-0029)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\1- Saddle Dam 1\1- Engineering\3- Deliverable\1-Design Report\Doc 784 1217_08 RPT-Detailed Design of Tailings Storage Facility Dike-Meadowbank Ver 0.pdf
	Technical Specifications	Specifications for TSF Dike Construction (Golder, 2009) Doc 795 Rev 0 (08-1428-0029/6000)	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\1- Saddle Dam 1\1- Engineering\3- Deliverable\3-Specifications\Doc 795 1020_09 Specification-TSF Dike Construction Meadowbank Rev 0.pdf
	As-Built	Construction Report TSF 2009-2011 (AEM 2013) Construction Report Buttress (AEM 2016)	**2009-2011** \\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\7-Stormwater Dike\AS-BUILT\2010 **2016:** \\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\7-Stormwater Dike\AS-BUILT\2016

Table 3-18 : Stormwater Dike Structure Summary

Stormwater Dike
Designer : Golder **Construction Period :** 2009-2013 **Operation Period :** 2009 - 2026 **Planned Closure Period :** 2026-2042
Design Criteria : Significant CDA classification (refer to table 3-3 for other parameter)
Divider dike separating the TSF North Cell and the South Cell. Zoned rockfill dike with an upstream low-permeability element (bituminous liner) with an upstream toe liner tie-in. The structure is in operation.
Operation Highlight • Deformation and movement observed yearly from 2016 to 2018. Stable since 2019 • South Cell and North Cell inactive since 2019.
No risk assessment performed on this structure yet, planned for 2021. Design Factor of Safety in Appendix B

Figure 3-15 : Aerial View of Stormwater Dike (2019)

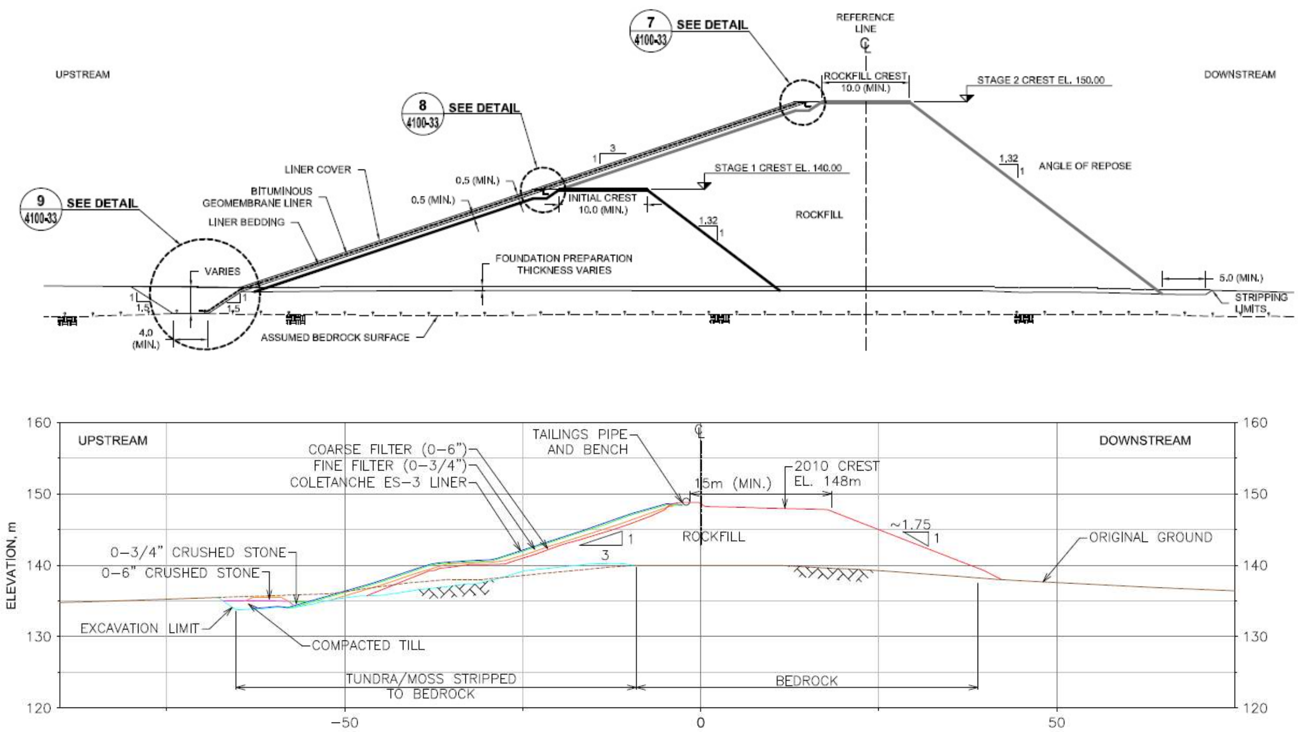


Figure 3-16: Typical Cross-section of Stormwater Dike (top). As-built section of Phase 2 (bottom)

3.2.8 Diversion Ditches – North Cell

The diversion ditches (West and East), located around the perimeter of the North Cell TSF and the Portage RSF, are designed to collect the non-contact water runoff from the surrounding watershed before they reach the TSF area. The ditches are composed of the west section that divert water to the western interception sump and then Portage Lake and the east sections that divert water to NP2 Lake and then from another section to NP1-N Lake. These ditches were constructed in 2012 and are 2622 m long. In the summer of 2014 and 2015 sloughing damage and erosion damage were observed in the channel slopes. These events were corrected by reprofiling the channel slope and adding additional material. Since then the North Cell diversion has been performing adequately.

In 2013, a till plug was installed on ST-16 when seepage was observed reporting into Lake NP2 from this location. The till plug was constructed in the summer of 2013. Its construction consisted in profiling the upstream slope and placing a 0.5-m-thick layer of compacted crusher reject, and then installing a geotextile membrane covered by 0.5 m of fine ultramafic rockfill and material reject from till sieving. Both granular layers were compacted with an excavator bucket.

On the west end of the diversion ditches, an Interception Sump was constructed in 2014-2015. The objective of the interception sump is to collect runoff water from the west section of the diversion ditches and to retain it until the total suspended solids in the water have reached the criteria allowing discharge to the environment. When the TSS level in the interception sump is considered too high water from that sump is pumped back into the North Cell of the TSF.

After flowing through the AWAR culvert the water discharges across the tundra into Third Portage Lake. WEP1 and WEP2 sumps were constructed in September 2015 to manage water around the northeast side of the RSF and to ensure that all water ponding behind the RSF is transferred back to the North Cell TSF. Water collected at WEP1 is pumped to WEP2 which in turn is pumped to ST-16 (RSF seepage pumping system). Water collected at the latter is pumped back into the North Cell TSF. These infrastructures are shown in Figure 3-17.

References to key documents for the design and construction of the North Cell diversion ditches system are presented in Table 3-19 **Error! Reference source not found.**. Table 3-20Table 3-20 summarizes the main design criteria for the North Cell diversion.

Table 3-19 : Reference Documents for North Cell Diversion Ditches Design and Construction

Channel	Type of Information	Document Reference	Link to Retrieve Document
North Cell Diversion	Design Basis	Design Basis for NC water diversions (Golder, 2012) Doc 1352 12-1221-0010 V0	\\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\1 -North Cell\20 -NC Diversion Ditches\1-Engineering\Design\1- Report
	Design Report	Detailed Design Memorandum for water diversion NC (Golder, 2012) Doc 1370 12-1221-0010 V0	\\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\1 -North Cell\20 -NC Diversion Ditches\1-Engineering\Design\1- Report
	Drawings	Technical Specifications from Design Report for IVR Diversion (Golder, 2012) Doc 1359 12-1221-0010 0724_12	\\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\1 -North Cell\20 -NC Diversion Ditches\1-Engineering\Design\2- Drawings
	As-Built	North Cell Diversion Ditches As-built (AEM, 2013) Wester Diversion Ditch Interception Sump Construction Summary Report (AEM 2015)	\\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\1 -North Cell\20 -NC Diversion Ditches\2-Construction\1- NC Diversion\4-Deliverable\1- As-Built Report \\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\1 -North Cell\20 -NC Diversion Ditches\2-Construction\2- Western Interception Sump\3- Deliverable

Table 3-20: Design Criteria for North Cell Diversion Infrastructure

North Cell Diversion			
Designer : Golder **Construction Period :** 2012 (ditch) / 2014-2015 (Western Interception Sump) **Operation Period :** 2020 - 2026 **Planned Closure Period :** 2026-2042			
Design Criteria			
Use	**Water type**	**Inflow Design Flood**	**Base width (m)**
Water Conveyance	Non-contact	1:100	0.5m to 3 m
Built to convey non-contact water to Third Portage, Lake NP2 and Lake NP1-N The West and East diversion required maintenance work in 2014 and 2015 to correct slope sloughing and erosion			
No risk assessment performed on this structure Note 1: PMF means Probable Maximum Flood			

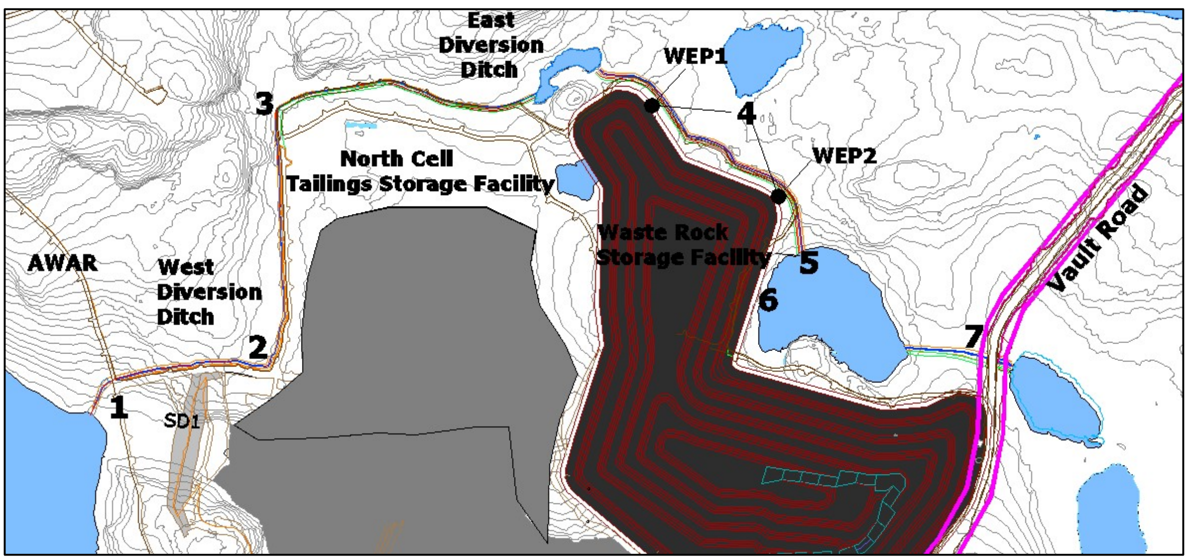


Figure 3-17 – Diversion Ditches and related infrastructure

3.3 IN-PIT TAILINGS DEPOSITION

Some of the mined-out pits at Meadowbank are approved for the use for management of water and tailings. The components of the in-pit tailings deposition system are:

- Goose Pit
- Portage Pit E
- Portage Pit A
- Reclaim water system from Pit A to the Process Plant
- Water transfer system from Goose Pit to Portage Pit A

In-Pit tailings deposition has started in the summer of 2019 with the deposition of tailings in Goose Pit. Deposition of tailings has switched to Portage Pit E in the fall of 2020. Water is reclaimed to the mill from Pit A. Water is transferred from Goose Pit to Pit A as required.

Reference to the design and construction document for the in-pit tailings management system are presented in Table 3-21.

Figure 3-18: In-Pit Area for Tailings Management (Summer 2020)

Table 3-21: Reference Documents for the In-Pit Deposition

	Type of Information	Reference Document	Link to retrieve document
In-Pit Deposition	Design Report	In-pit tailings deposition design report, SNC (2018) Ref. 651196-9000-40ER-0001 Short-Term In-Pit Reclaim System Upgrade Report (booster Pit A), (SNC 2021). Ref. 678925-3000-40ER-0001 Medium term In-Pit Reclaim System Upgrade Report (Pit E reclaim (SNC 2021).	\\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\3- In-Pit Deposition\1- Engineering Study\2 – Detailled Engineering\4-Deliverable\1- Design Report\Final\651196-9000-40ER-0001-00 In Pit Tailings Disposal – Detailed Engineering Report.pdf \\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\3- In-Pit Deposition\1- Engineering Study\5- Reclaim System Increase\3- Deliverable\1-Report\Short Term Increase (booster) Report to be provided
	Drawings	In-pit tailings deposition construction drawings, SNC (2018) Short-Term In-Pit Reclaim System Upgrade Construction Drawings (2021) Medium term In-Pit Reclaim System Construction Drawings (SNC 2021).	\\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\3- In-Pit Deposition\1- Engineering Study\2 - Detailled Engineering\4-Deliverable\2-Drawings\Meadowbank In-Pit Deposition Layouts Revision R2 \\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\3- In-Pit Deposition\1- Engineering Study\5- Reclaim System Increase\3- Deliverable\2-Drawings\1- Short Term System (Booster) Drawings to be provided
	Technical Specifications	In-pit tailings deposition technical specifications (SNC, 2018) Ref. 6118-E-132-001-SPT-001_R0	\\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\3-In-Pit Deposition\1- Engineering Study\2 - Detailled Engineering\4-Deliverable\3-Specification\6118-E-132-001-SPT-001_R0 (signed).pdf
	As-Built	AEM (2020) As-built drawings (as-built report in progress)	\\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\3-In-Pit Deposition\3 - Construction\1-Infra Construction 2019-2021\4-Deliverable\1- As-Built Report\Drawing

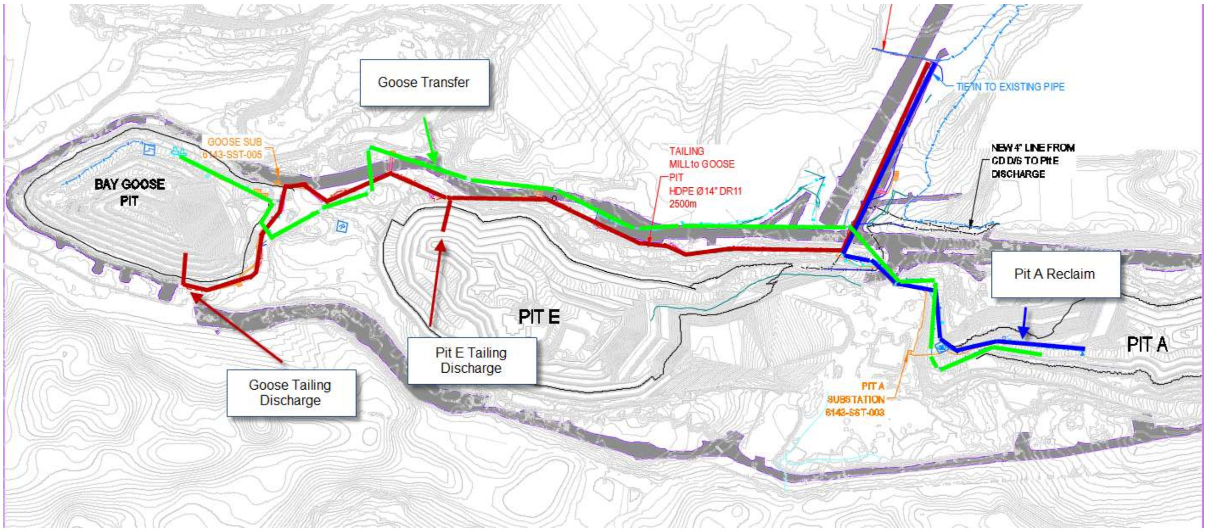


Figure 3-19: Plan view of In-Pit Area and Related Infrastructure (as of Fall 2020)

3.3.1 Pits

Goose Pit is located at the South end of Meadowbank site, in the dewatered section of the Third Portage Lake. It was mined out between the years 2012 to 2015. The crest is at an elevation of 130.0 masl and the bottom is at an elevation of -10.0 masl which provides a total volume of retention for tailings of 5,471,353 m^3 – for tailings and water: 6,321,146 m^3. The walls are mainly composed of Iron formation, intermediate volcanic and ultramafic volcanic rocks and can contain quartzite on the upper west pit wall. Sheared and fractured rocks were observed at the contact zone between rock units. Water bearing fractures are predominantly associated with the contact between quartzite and the ultramafic formations.

Portage Pit A within the dewatered portion of the Second Portage Lake. It was mined out between the years 2010 and 2018 by creating 5 benches of 21 meters each. The crest is at an elevation of 130 masl and the bottom is at -3 masl, which provides a total volume of retention for tailings of 11,416,587 m^3 – for tailings and water: of 12,965,099 m^3 (130.0masl) and 14,719,893 m^3 (133.6masl).

Portage Pit E is located between Portage Pit A and Goose Pit, within the dewatered portion of the Third Portage Lake. It was mined out between the years 2010 and 2019 by creating 7 benches of 21 meters each. The crest is at an elevation of 130 masl and the bottom is at -20 masl, which provides a total volume of retention for tailings of 19,141,935 m^3 – for tailings and water: of 20,891,735 m^3 (130.0masl) and 23,695,162 m^3 (133.6masl).

Table 3-22: Design Criteria for In-Pit Deposition (from design report)

In-Pit Tailings Deposition (Goose Pit, Portage Pit A, Portage Pit E)	
Designer :SNC **Construction Period (infra) :** 2019-2021 **Operation Period :** 2019 - 2026 **Planned Closure Period :** 2026-2042	
Design Criteria	
Maximum tailings elevation	El. 125.6 - 8m below Third Portage lake level (133.6 m)

3.4 TAILINGS CONVEYANCE INFRASTRUCTURE

Tailings are produced as a slurry in the process plant. OMS component related to the tailings circuit at the process plant is out of scope of this document. These components include grind circuit, intensive cyanidation unit (ICU), pre-generation tanks, leach tanks, carbon in pulp (CIP) tanks, cyanide recovery, thickener, cyanide destruction circuit, tailings pump box and reclaim water tank. AEM is a member of the ICMC and comply with the cyanide transportation and operation protocol. By complying with these protocols it ensures that tailings are managed adequately at the process plant and in conveyance to the process plant.

From the tailings pumpbox tailings are pumped to designed tailings management area using the process plant tailings slurry pumps. A simplified flow sheet of the process plant flow diagram is included in Appendix C. A schematization of the tailings pumpbox system is included in **Error! Reference source not found.**.

Tailings slurry is conveyed in HDPE pipe (16’’ DR11 or 14’’ DR17). Tailings deposition at Meadowbank is done using the end of pipe technique with only one active tailings deposition point at a given time. Appendix C includes a layout of the current tailings deposition line and the designed deposition points.

A booster pump station is required to be able to pump the tailings into the North Cell due to the pumping distance and difference in elevation. The booster pump station includes two electrical pumps that are controlled by the mill.

When tailings deposition occurs from a dike, the tailings deposition points are constructed in a way to prevent damaging the structure (also call deposition finger). The protection usually includes placement of aggregate over the structure as well as the placement of geomembrane or used conveyor belt.

Table 3-23 Key References for Tailings Conveyance Infrastructure

	Type of Information	**Link to retrieve document**
Process Plant	General Layout Plan	\\CANUFS01\public\ICMC\2021\Mill\9. Engineering plans
	Drawings	P:\Construction\2008 MEAD-Construction\400 ENGINEERING\10 HATCH\10 DRAWINGS
North Cell Booster Pump	Design & Construction document	\\CANUFS01\public\ICMC\2021\Mill\9. Engineering plans\Tailing booster pump
Pig Launcher Station	Design & Construction document	\\CANUFS01\public\ICMC\2021\Mill\9. Engineering plans\Pig Launcher Station
South Cell Pump	Design & Construction document	\\CANUFS01\public\ICMC\2021\Mill\9. Engineering plans\South cell pump

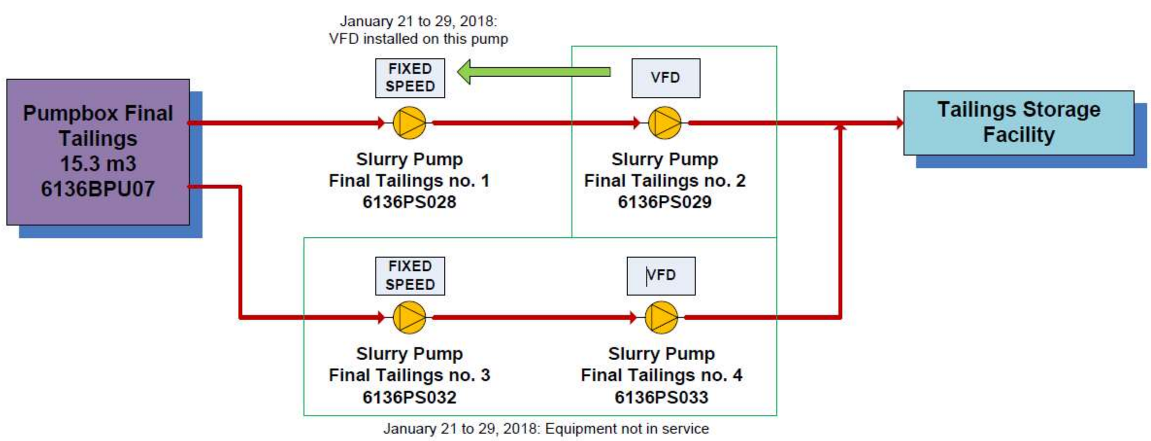


Figure 3-20: Schematic Diagram of the Final Tailings Installation System at the Process Plant

3.5 RECLAIM INFRASTRUCTURE

The following pumping infrastructure are required to reclaim water from the in-pit system

- Transfer system from Goose Pit to Portage Pit A. Includes two submersible pumps (Model S8C1) connected to an electrical substation (Goose Sub). This system uses 14’’ DR17 pipe.
- Reclaim system from Pit A to the reclaim tank in the process plant. Includes two submersible pumps (Model S8C1) with two containerized mechanical booster pump station in series. This setup also includes one electrical station container with variable frequency drive per booster pump each connected to an electrical station (Pit A sub and Pit E sub). Pipe use for this system is 10’’ DR11 HDPE from Pit A to the West Road and then 1’’ DR17 pipe to the mill.

Reference to the design and construction document for the reclaim infrastructure are included as part of the documentation of the in-pit tailings management system presented in Table 3-21. Information on the design parameters of these systems is included in Table 3-24.

Table 3-24 Design Criteria for In-Pit Deposition Reclaim and Transfer System (from design report)

In-Pit Reclaim System (Pit A) Design Criteria	
Desired reclaim flowrate	400 m^3/h with 4 S8C1 pumps operating (2 submersible and 2 boosters in a series configuration)
Water level in Pit A	El. 64 to 84 m
Booster pump inlet pressure	20 to 50 psig
Velocity in HDPE pipe	< 4.5 m/s
In-Pit Goose Transfer System Design Criteria	
Desired transfer flowrate	400 to 800 m^3/h
Water level in Goose Pit	El. 110 to 129

3.6 WATER MANAGEMENT PUMPING INFRASTRUCTURE

Appendix C shows the pumping flowchart for the Meadowbank Site as well as the location of the pumping infrastructure.

The water management strategy for the TSF is to pump the runoff and seepage from the North area (Western Interception sump, ST-16) in the North Cell. Water seeping out of the dike TSF is captured in sump and pumped back as required on the upstream side of the dike. Most sumps do not have a permanent pumping system and water is pumped out as required during freshet using a mobile pump. These sumps are located at SD1, SD3 and SD4, and around North Cell Internal Structure. Central Dike has a permanent pumping system comprised of an electrical pump and a diesel pump. Pumping of the downstream pond is required on a year-round basis as to maintain a target EL. at 115 m. Water from Central Dike seepage is sent back into the South Cell.

Water from the North Cell and from Stormwater Management Pond is transferred to the South Cell to ensure the respect of water level criteria. Water from the South Cell, Central Dike seepage, East Dike seepage and Stormwater Pond will be directed to Portage Pit A.

Water accumulating in the surface area around Goose Pit (Bay Goose Dike ring road, NPAG stockpile, Goose sump) is pumped to Goose Pit as required.

3.7 INSTRUMENTATION

The tailings management area and infrastructures are instrumented to continuously monitor performance. In-situ instruments are installed within the structures and their foundations to monitor stability and within the tailings (piezometers, thermistors) to monitor freeze back.

Water levels in the ponds are monitored by piezometers whose reading are confirmed with periodic water survey.

The telemetry instruments to monitor the tailings conveyance system and the water reclaim system (flow meters, pressure sensors) are accessible through the communication interface (HMI) but are out of scope of this document as they are operated and maintained by the process plant.

Groundwater quality is monitored around the tailings management area by 5 groundwater wells, 4 of which are around the in-pit areas. More details on the groundwater well system can be found in the groundwater monitoring plan.

Reference documents for the instrumentation installed on the tailings management infrastructures is summarized in Table 3-25. The summary of the instruments installed is summarized in Table 3-26.

Table 3-25 : Reference Documents for Instrumentation

Type of Information	Reference Document	Link to Retrieve Document
Instruments Database	AEM	\\Cambfs01\groups\Engineering\05-Geotechnic\11-Instrumentation\1- Instruments\ALL Instruments Databases Global database in progress to centralize the information
Instrument Map and Cross-Section	AEM (latest summarized in MDRB 28 presentations)	South Cell: \\Cambfs01\groups\Engineering\05-Geotechnic\13-MDRB\MDRB 28\Presentations\Final\P5 - Tailings Management - Dike Performance and Instrumentation - South Cell 2020.pptx North Cell: \\Cambfs01\groups\Engineering\05-Geotechnic\13-MDRB\MDRB 28\Presentations\Final\P4 - Tailings Management - Dike Performance and Instrumentation - North Cell-SWD 2020.pdf
Groundwater monitoring plan	AEM (V11, March 2020)	\\Cambfs01\groups\Environment\MANAGEMENT PLANS\Management plans\Groundwater monitoring plan\Meadowbank\Version 11
Process plant communication interface (reclaim water system, tailings circuit)	HMI Interface	Through Wonderware interface

Table 3-26 : Instrumentation Summary for the Tailings Management Area and Infrastructure

Structure	Piezometers	Thermistors
Central Dike	53	21
Stormwater Dike	2	2
Saddle Dam 1	-	4
Saddle Dam 2	-	4
Saddle Dam 3	-	3
Saddle Dam 4	-	3
Saddle Dam 5	-	3
RF1-RF2	-	5
North Cell Internal Structure	-	4
North Cell Tailings	-	10

SECTION 4 • OPERATIONS

The following section outlines the key operational procedures that need to be observed and followed during operation of the Meadowbank tailings management infrastructures in accordance with their performance objective.

4.1 REFERENCES

References to key documents for the operation of the Meadowbank tailings management infrastructure are presented in Table 4-1.

Table 4-1 : Key Reference Documents for Operation of Meadowbank Tailings Management Infrastructure

Type of information	Reference	Link to Retrieve Document
Tailings Deposition Plan	2021 R1	\\Cambfs01\groups\Engineering\12- Annual Report\2020\1- Annual Report 2020\5- Waste rock and tailings management plan (in-pit update)\Meadowbank\Appendix B- 2021 Deposition Plan.pdf
Tailings Management Monthly Compliance Report		\\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\3- In-Pit Deposition\4 - Operation\3-Inspection
Meadowbank Annual Water Balance	2021	\\Cambfs01\groups\Engineering\12- Annual Report\2020\1- Annual Report 2020\6- Water Management Plan Update\Appendix A Water Balance Table.pdf
Meadowbank Water Management Plan	V9 AEM 2021	\\Cambfs01\groups\Engineering\12- Annual Report\2020\1- Annual Report 2020\6- Water Management Plan Update\Meadowbank\2020 AEM MBK Water Management Report Plan.pdf
Meadowbank Waste Management Plan	V11 AEM 2021	\\Cambfs01\groups\Engineering\12- Annual Report\2020\1- Annual Report 2020\5- Waste rock and tailings management plan (in-pit update)\Meadowbank\MBK Waste Rock-Tailings mgt plan 2020.pdf
ICMC Documentation	2021	\\CANUFS01\public\ICMC\2021\Mill\9. Engineering plans
360 Cyanide Destruction Control Plan	V7 AEM 2018	\\CANUFS01\public\ICMC\2021\Mill\3. Process Plan control Room
Control logic for Process Plant Tailings Pumps to In-Pit	Evaluation of existing tailings pump for in-pit deposition 651196-4000-49CX-01 (SNC 2018)	\\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\3- In-Pit Deposition\1- Engineering Study\2 - Detailled Engineering\3-Technical\4-Infrastructures\11 - Tailings Pumps Analysis
Reclaim System Control Logic (Pit A reclaim)	Short-Term In-Pit Reclaim System Upgrade Report 678925-3000-40ER-01 (SNC, 2021)	\\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\3- In-Pit Deposition\1- Engineering Study\5- Reclaim System Increase\3- Deliverable\1- Report\1- Short Term Increase (booster)
General Alarm Emergency Evacuation	MBK-MILL-HS-PRO	Intelex
Process Plant Power Outage	MVK-MIL-OP-0044	Intelex
Process Plant Loss of Tailings	MBK-MIL-OP-0049	Intelex
Process Plant Shutdown	MBK-MIL-OP-0029	Intelex
Send Slurry Pig	MBK-MILL-OP-PRO Send Slurry Pig	Intelex

4.2 SUMMARY OF PERFORMANCE OBJECTIVES AND OPERATIONAL CONTROL

The performance objectives with respect to the failure modes are summarized in Table 4-2. The operational control for the Meadowbank tailings management system during operation are summarized in Table 4-3 and described further in this Section.

Table 4-2: Performance Objectives in Terms of Failure Modes of the Meadowbank Tailings Management System

Type of structure	Failure mode	Inferred mechanism	Causes	Consequences	Performance objective and indicator
Tailings containment facility (Dikes and in-pit)	Loss of containment by overtopping	Water or tailings level exceeds containment elevation of the facility	• Poor management of tailings and water level • Subsidence of low-permeability element	• Uncontrolled outflow • Material damage • Loss of access • Potential for loss of life • Environmental exceedance / damage • Loss of reputation	• Adequate freeboard level (monitoring by survey and PZ) • Water management compliance to water balance • Tailings deposition plan compliance • No subsidence of the crest (visual inspections & drone survey)
	Internal erosion (dike)	• Erosion of engineered fill leading to deformation of liner • Damage in liner (hole or tear) • Erosion of foundation soils	• Excessive hydraulic gradient • Pre-existing seepage channels • Inadequate construction materials or foundation soils (unlikely due to appropriate design and QA/QC) • Damage to liner due to operations around the dike (unlikely because liner is protected)	• Loss of tailings containment • Degradation of structure increasing risk of failure • Increased risk of uncontrolled release of contaminant	• Stable condition of fill and toe area (visual inspections) • Adequate tailings beach along dike and no water ponding or channeling against the liner (visual inspection) • Stable, manageable seepage (visual inspections, flowmeter monitoring) • Stable thermal and piezometric regime in foundation (piezometers and thermistors monitoring, refer to TARP in Section 4.8)
	Foundation failure (dike)	Failure of foundation soils against shear stress	• Inadequate foundation shear strength	• Uncontrolled outflow • Material damage	• Good, stable condition of foundation at the toe (visual inspections)

Type of structure	Failure mode	Inferred mechanism	Causes	Consequences	Performance objective and indicator
			• Excessive pore-water pressure • Erosion of soils (refer to previous failure mode)	• Loss of access • Potential for loss of life • Environmental exceedance / damage	• Stable thermal and piezometric regime in foundation, acceptable pore-pressure levels (piezometers and thermistors monitoring refer to TARP in Section 4.8)
	Dike slope failure	Failure of construction material against shear stress	• Excessive deformation of engineering fill or liner • Erosion of soils (refer to previous failure mode)	• Uncontrolled outflow • Material damage • Loss of access • Potential for loss of life • Environmental exceedance / damage • Loss of reputation	• Good, stable condition of all elements of the dike (visual inspections) • Acceptable levels of deformation (movement monitoring, refer to TARP in Section 4.8)
	Uncontrolled release of deleterious substance to Env from the tailing's containment facility	• Unmanageable seepage • Groundwater contamination • Windblown contamination	• Excessive hydraulic gradient • Pre-existing seepage channels • Inadequate seepage collection system • Damage to liner • Permafrost degradation • Water not meeting discharge quality criteria is released in Env	• Environmental exceedance / damage • Loss of reputation	• Manageable seepage (visual inspections, flowmeter monitoring, pumping capacity) • Water Quality monitoring & forecast (surface / groundwater) • Visual observation of tailings dust outside of site • Stable thermal and piezometric regime in foundation (piezometers and thermistors monitoring refer to TARP in Section 4.8)
	Overtopping of channel slopes	Insufficient capacity to convey water through the channel	• Blockage by debris • Erosion of slope materials	• Uncontrolled outflow	• Good condition (unobstructed) of the channels, inlets and

Type of structure	Failure mode	Inferred mechanism	Causes	Consequences	Performance objective and indicator
Channels			• Ice / snow blockage	• Environmental exceedance / damage • Loss of reputation	outlets (visual inspections) • Normal water levels in channels and upstream area (refer to TARP in Section 4.8) • Proper snow removal strategy prior to freshet
	Excessive turbidity in water discharge into environment	Erosion of materials or foundation	• Inadequate materials • Exposed foundation • Failure of turbidity control systems (turbidity barriers)	• Environmental exceedance / damage • Loss of reputation	Good condition (no erosion) of the channel materials (visual inspections)
Tailings Conveyance Infrastructure	Tailings line leakage	Physical damage to the piping and pumping systems	• Poor maintenance of piping and pumps • Infrastructure are damaged by mobile equipment	• Uncontrolled outflow • Environmental exceedance / damage • Interruption of milling activity	• Good condition of piping and pumping infrastructure (visual inspection, thickness measurement and maintenance) • Infrastructure are well identified in the field and in status map
	Tailings conveyance failure	Impossibility to pump tailings from the mill to the containment area	• Freezing of tailings line • Blockage in tailings line (tailings build up) • Mechanical and Electrical Infra failure	• Interruption of milling activity	• Good condition of piping and pumping infrastructure (visual inspection and maintenance) • Frequency of pig cleaning of the line • Pressure in the line • Discharge rate
Reclaim water infrastructure	Reclaim system failure	Impossibility to reclaim water from containment area	• Freezing of line • Infrastructure are damaged by mobile equipment • Mechanical and Electrical Infra failure • Flooding of infra • High turbidity to the mill	• Increase freshwater consumption (impact on closure cost)	• Good condition of piping and pumping infrastructure (visual inspection and maintenance) • Frequency of pig cleaning of the line • Pressure in the line • Reclaim rate • TSS level of reclaim water

Table 4-3 : Operational Control of the Meadowbank tailings management infrastructure

Tailings Transportation and Placement
• Tailings deposition is compliant to the tailings deposition plan (respect of deposition duration and location) • Tailings delivery systems are operated and maintained as per the control plan (Table 4-3). Low flow alarm at 350 m3/h and Low Low flow alarm at 0 m^3/h. High pressure alarm set at 1200 kPa in tailings line • Procedure are in place to stop tailings transportation in case of major issue with tailings management system (Table 4-3).
Tailings Containment
• All tailings must be stored within the TSF or the selected Pits • Tailings freeboard must be respected at all time (refer to Section 4.6) • Tailings beaches need to be promoted along the peripheral structures (except SD3) • The construction schedule for the raise of the tailings containment structures is aligned with the deposition plan.
Water Management
• A sufficient water volume must be maintained in the TSF ponds or the Pits to allow recirculation to the mill (reclaim). The volume of water to be kept in the TSF should not exceed that value • The freshwater limit of the Water License must be respected. • The mill requires a minimum freshwater consumption of 50 m^3/h (based on historical observation) • The reclaim water in the reclaim tank must have NTU between 145 and 245 (approximately 10 to 40 ppm) • The location of the water pond in the TSF must comply with the deposition plan and a minimum water head should pond against the peripheral structure (except SD3) • A 3 m water cover must be maintained in the pit in operation to minimise tailings re-suspension. • Ice is not allowed to pond against the liner of the tailings retention structures. A 20 m tailings beach need to be maintained in winter • Operational freeboard of each tailings retention structure must be respected during operation (refer to section 4.6). • Water movement are tracked and recorded on a monthly basis (volume, origin, destination) • The water management systems (pump, pipes) are operated and maintained as per the planning logic. • Pumping unit must be collected to alarm and interlock system to be able to react quickly to any deficiency (avoid freezing or damaging system due to a component shutdown) • The water level in each of the tailings containment facilities must be compliant with the water balance model and be compatible with the pumping infra elevation. Difference must be explained to forecast the impact on the available containment and closure strategy • Any seepage must be captured by a sump and pumped back to allowed location (or naturally report to an approved location). Seepage control and collection (Section 4.7). • Water quality is monitored (surface & groundwater) and this information inform the water quality forecast at closure and closure strategy
Surveillance
• Surveillance requirements for operational performance indicator (Section 4.8) • Threshold for performance criteria to trigger pre-defined action (Section 4.8)

4.3 TAILINGS MANAGEMENT STRATEGY

The TSF was commissioned in conjunction with the mill start-up in February 2010, with tailings being deposited within the North Cell of the facility. Tailings deposition was transferred from the North Cell to the South Cell at the end of 2014. Tailings deposition occurred during the summer of 2015 within the North Cell and resumed in the South Cell in October 2015. Progressive closure of the North Cell started in the winter of 2015 with the construction of a non-acid generating rockfill capping over the tailings and continued in the winter of 2016. In the summer of 2018 the North Cell internal structure was built and deposition was resumed in the North Cell. In the beginning of July 2019, In-Pit Deposition started in Goose Pit. Since August 2020, tailings is distributed from the mill to Pit E by pumping it as a slurry.

Tailings deposition is done using the end of pipe technique with only one active tailings deposition point at a given time. From the pig launcher the tailings pipe is then positioned to reach the current deposition point (Pit E). The location of the tailings deposition points is determined during the tailings deposition plan exercise.

Changing between deposition points on a given line consist of stopping the flow of tailings in the line, redirecting it through the pig launcher bypass, flushing the line, relocating the deposition point pipe and then switching tailings from the by-pass to the newly installed deposition line.

The tailings transport and reclaim system to the mill is managed by a control loop in HMI link to a series of sensors and alarm in these systems. Reference to the control plan and operational document is included in Table 4-1.

The tailings deposition strategy in the South Cell is to push the pond of water against SD3 and Stormwater Dike while maintaining tailings beach against the other peripheral structure (SD4, SD5, Central Dike). The objective is to keep the pond as far as possible from these structures with a minimum beach length target of 20 m. The tailings deposition strategy in the North Cell is to promote closure landform as much as possible. This is done by depositing tailings from the North Cell Internal Structure located in the northern section of the North Cell. Due to the length of the beach in the North Cell the deposition strategy is to only perform deposition form May to October to limit aerial deposition in the winter which is typically associated with high ice entrapment. The tailings deposition strategy in the in-pit is to maintain the tailings deposition point in Pit E.

4.4 WATER MANAGEMENT

The water management strategy for the Tailings Management Infrastructures can be found in the water balance and in the water management plan. A schematic version of the water movement strategy for the Tailings Management Infrastructures as well as the operational guideline is summarised in Appendix C.

All water accumulation from the North Cell (from tailings deposition, NCIS sumps, seepage and transfer from the Western Ditch interception sump) is transferred into the South Cell to maintain a minimum water level in the North Cell.

The water management strategy is documented in the site wide water balance. The water balance is updated monthly with the realised information of the previous month and is used to look at any deviation from the plan and the impact it might have on water & tailings management.

The water management strategy in the South Cell is to keep the water level as low as possible by transferring the water into Portage Pit A.The in-pit deposition water management strategy can best be explained by separating into the 3 main portage pits (Goose, Pit A and Pit E).

- Goose Pit: Water transfers from Goose Pit to Pit A or Pit E will occur as required.
- Pit E: Will be the only site of tailings deposition from August 2020 until end-of-life in 2026. Pit E will also be the site of primary water reclaim starting in September 2021 until 2026. Water reclaim from the ramp will be done using a pumping system located in the Pit E3 ramp.
- Pit A: Is the location of reclaim from August 2020 to September 2021. Submersible pumps (2) and booster pumps (2) system are used to optimize reclaim from this pit during 2020-2021. From September 2021 onwards the Pit A system will be used as a backup system.

4.5 DEPOSITION PLANNING

Deposition of tailings must be done according to the approved deposition plan developed by the Environment Department. The process of preparing or updating a deposition includes defining the parameter analysis & objectives, preparing the deposition plan, having the deposition plan approved and distribution of the deposition plan.

Deposition plans are schedule to be updated twice a year following update to the LOM and Budget. The deposition planning is done by the Environment Department (water & tailings engineer) using the software Muck 3D. The deposition planning update must also include an update of the water balance. Unplanned update to the deposition plan and water balance might be required if compliance to the deposition plan can no longer be reconciled (i.e change in deposition strategy, change in deposition parameter) or at the request of the RP or the EoR. The deposition plan usually presents the deposition strategy for each month for the coming year, on a quarterly basis for the second year and on a yearly basis after that.

While defining the deposition strategy it is important to refer to Table 4-4 to ensure that the strategy of the deposition plan met the performance objective and operational criteria. Any proposed deviation to the performance objective must be submitted for approval to the RP and EoR.

Twice a year a bathymetry and scan of the TSF and the active tailings deposition Pits will be completed (one in July and one in September). Bathymetric analyse in inactive tailings management area will be done once a year. The latest information is to be used to calculate some of the parameters used in the deposition planning.

Table 4-4 presents the information required prior updating a deposition plan and the way to obtain it. Input parameter needs to be approved prior to beginning working on the deposition plan.

Table 4-5 presents the outputs of a deposition plan for each timestep modeled. Once the deposition plan has been reviewed against the criteria of Table 4-3 to

Table 4-5 by the Water Management & Geotechnical Engineering Coordinator it is ready to be approved by the Water & Tailings General Supervisor. An approved deposition plan is an essential tool to be used to plan water management strategy, raise of tailings dike, reclaim vs freshwater ratio and deposition points constructions.

Table 4-7 summarise the main parameter impacting tailings deposition, how they are measured, the frequency at which they are reviewed and their impact on tailings management.

Table 4-4: Input Parameters of a Deposition Plan

Deposition Sequence Objective
• Tailings transportation and placement must happen continuously while the mill is operating • Limit switching between tailings deposition point so to ease operation (maximize duration at a given deposition point) • Tailings deposition needs to limit ice-entrapment by limiting sub-aerial deposition in the winter • Respect tailings and water freeboard requirement
Information obtained from the approved mining schedule (approved LOM or Budget)

• Tonnage profile to be stored until the end of life of the mining operation • Nominal processing rate at the mill on a monthly basis
Information obtained from bathymetric analysis
• Review of storage curve and initial surface • Tailings dry density in t/m^3 (generally in the historical range from 1.2 to 1.4 t/m^3) • Deposition slope angle (sub-aerial and sub-aqueous) for each tailings storage location • Storage capacity curve
Information obtained from the water balance
• Volume of water in the pond • Water transfer information (required volume) • Water and Ice entrapment by volume
Property from the mill
• Reclaim water rate (to be compared with pump capacity and considering mechanical availability) • Minimum freshwater use limit of the mill • Slurry solid concentration from mill % w/w

Table 4-5: Output of a Deposition Plan

Active deposition point
• List of the active deposition point and the order of deposition • Duration (days) and tonnage (tons) of deposition at each point • Tailings elevation at each point at the end of deposition (ensure that freeboard is respected) • Total tonnages modelled and difference with Mine Plan (ensure compliance with milling schedule)
Pond Property
• Total water volume (ensure compliance with water balance) • Free water volume (ensure compliance with reclaim objective) • Pond elevation (ensure that freeboard is respected) • Ice volume, ice thickness, ice ratio (%) • Water entrapment (%)
Figure of deposition area at the end of deposition
• Pond location is shown (ensure that the pond is at desired location)

• Tailings location is shown (ensure that tailings beach requirements are met) • Location of pumping infrastructure for reclaim to be identified
Recommendations
• Verify if a change in water management strategy is required (i.e water transfer, change in reclaim volume vs freshwater) • Verify if tailings dike raise is required for capacity and the timeline associated • Verify if new deposition point creations are required • Planification of required infrastructure move (reclaim infra, water transfer infra) • Verify if action is required to maintain reclaim capability (i.e construction of internal structure to prevent tailings from reaching reclaim area)

4.5.1 Deposition Planning Compliance

At the end of each month the compliance to the deposition performed must be validated against the performance indicator of Table 4-6 to verify if the deposition is on track. This compliance analysis is documented in the Tailings Management Monthly Inspection Report. Work is also ongoing to add a tailings management dashboard to the Power BI application.

Table 4-6: KPI for Tailings Deposition to be Tracked Monthly

Key Performance Indicator
• Mill output (TPD) vs plan • Achieved reclaim rate (m^3/h) vs plan • Mill freshwater consumption rate (m^3/h) vs plan • Water level in active area (reclaim, tailings deposition, transfer) vs plan • Tailings beach from scan vs simulated output (for subaerial deposition only) • Tailings freeboard vs plan • Slurry solid concentration from mill % (w/w) (total water used at the mill / mill throughput • Slurry density pumped from mill (t/m^3)

Table 4-7: Summary of Parameter Impacting Tailings Deposition

Tailings Management Parameters	Source of Information	Frequency for Parameter Collection and Compliance Review	Impact of Parameter on Tailings Management
Water level in active area (reclaim, deposition, transfer)	Piezometer and water level survey	Weekly check and Monthly Compliance Report during subaerial depostion	Main KPI to evaluate the remaining volume for in-pit deposition and assess freeboard compliance (Very Important)
Tailings level in active deposition area	Visual observation, tailings beach scan, drone survey	Weekly check and Monthly Compliance Report	To ensure tailings freeboard compliance (Very Important)
Mill throughput rate per day (dry solid) (TPD)	SQL Mill Production Report	Monthly Compliance Report	Explain possible deviation to compliance
Mill reclaim water rate (m^3/h)	HMI - In Pit KPI tool & Water Balance monthly update	Weekly check and Monthly Compliance Report	Has direct impact on total volume of water stored in the pit (Very Important). A regular follow up is required to ensure the system is running at maximum reclaim capacity
Mill freshwater consumption (m^3/h)	HMI - In Pit KPI tool & Water Balance monthly update	Weekly check and Monthly (Compliance Report)	Direct impacts on total volume of water added into inpit storage
Tons deposited per deposition point per month / Tailings Surface	Tailings scan beach and conciliaction modelling using Muck 3D	Monthly (Compliance Report) during subaerial deposition	To validate compliance to desired tailings surface (ensure proper tailings beach)
Slurry solid concentration from mill % w/w	Mill Water consumption (Total water used at the mill / Mill Throughput) - (m3/t). Calculated during Water Balance monthly update using info from HMI	Monthly (Compliance Report)	This parameter impacts volume of water planned to reclaim. Impacts on volume of water discharge into the pit (Important)
Slurry density pumped from the mill (t/m^3)	Tailings density from the mill (mill throughput (t) / mill throughput flow (m3))	Monthly (Compliance Report)	Does not impact tailings storage but can explain variation in other parameter
Moisture content in Ore (%)	Water Balance monthly update, data provided in Mill daily report	Monthly (Water Balance Update)	Very minimal impact on Water Balance. Between 1-2% of total water from Ore treatment process
Tailings production tonnage profile	BUD and/or LOM Mill Thoughtput profile. Part of bi-annual IPD update	At each official update to production profile (LOM and Budget)	This parameter impacts total quantity of tailing discharged in-pit. Contributing factor on water level and storage capacity.
Slurry density in the tailings storage area (t/m^3)	Parameter analysis using bathymetric survey and scan of tailings beach	At each official update to production profile (LOM and Budget)	Impact volume that the tailings occupy in the storage area after consolidation
Tailings slope (%)	Parameter analysis using bathymetric survey and scan of tailings beach.	At each official update to production profile (LOM and Budget)	IMPORTANT for TSF deposition. Minimal impact for InPit deposition plan.
Water cover depth (m)	Parameter analysis using bathymetric survey and scan of tailings beach.	At each official update to production profile (LOM and Budget)	To ensure compliance to the 3 m water cover in operation and 8m water cover at closure
Ice Entrapment and water entrapment	Parameter analysis using bathymetric survey and water balance	At each official update to production profile (LOM and Budget)	Important to be able to well estimate free water volume during deposition
Surface Used - Storage Curve	EOM mining data for in-pit Topography data before tailings deposition for TSF Bathymetric survey and scan and drone survey	At each official update to production profile (LOM and Budget)	Using proper surface and storage curve will directly impact the results of the tailings deposition simulation
Tailings settlement / consolidation curve	Laboratory testing (SNC Report: 643541-5000-4GCA-0001 Tailings Consolidation Assessment Rev0 Appendix A)	Once for each ore deposit	Determine if we should expect settlement issue causing high TSS in reclaim water. Can also benchmark slurry density after deposition (however less precise than actual field measurement)
Tailings solid specific gravity	Laboratory teting (SNC Report: 643541-5000-4GCA-0001 Tailings Consolidation Assessment Rev0 Appendix A)	Once for each ore deposit	Will impact transportation calculation and milling process. Not an important parameter to tailings management
Tailings solid particle size	Laboratory testing (SNC Report: 643541-5000-4GCA-0001 Tailings Consolidation Assessment Rev0 Appendix A)	Once for each ore deposit	Will impact transportation calculation and milling process. Not an important parameter for tailings management as tailings are not used as a construction material
Ice thickness (m)	Historical Information Ice Survey Thickness	Once for each deposition area (if safe to do so)	The Ice thickness represented dead volume for water and impact water balance.
Pit infiltration	Hydrological Analysis - SNC Report: 651196-9000-40ER-0001-00 In Pit Tailings Disposal - Detailed Engineering Report	Once for each deposition area	Significant impact at Goose. Minimal impact expected at Pit A & E
Precipitation/evaporation values (mm)	Hydrological Analysis - SNC Report: 651196-9000-40ER-0001-00 In Pit Tailings Disposal - Detailed Engineering Report . See table 5-4	Once for each deposition area	Minimal impact on water balance

4.6 OPERATING LEVEL & FREEBOARD

Operating level and freeboard are monitored by water level survey and piezometric monitoring. The design criteria for minimum freeboard and operational criteria for the relevant tailings and water management infrastructure are presented in Table 4-8. Refer to Section 4.9 for communication protocol related to TARP levels and Appendix C for the list of Specific action to take (Operational Guideline). The freeboard may change due to fluctuations in supernatant water levels or due to settlement of the dikes. Maintenance may be required to restore loss of freeboard due to settlement.

Table 4-8 : Freeboard and Operational levels

Structure	Freeboard to crest (m)		Maximum tailings elevation (m)	Operation Water level (m)		Critical water level (m)	Emergency Water Level
	Tailings	Water		Normal	Maximum		
North Cell	0.5	2.0	149.5	<148	148-149	149-150	>150
NCIS	0.5	N/A	151.5 to 153.4	N/A	N/A	N/A	N/A
Stormwater Dike	0.5	2.0	149.5	<148	148-149	149-150	>150
South Cell	N/A	2.0	N/A	<143	143-144	144-145	>145
Central Dike D/S	-	-	-	114.8 to 115.1	115.1 to 115.5	115.5 to 116	>116
In-Pit MDBK	8 m below El. of Lake at closure	2 m below El. of West Road	125.6	<128* (<124.4 now)	128-129* (124.4 - 125.4 now)	129-130 * (125.4-126.4 now)	>130* (126.4 now)
TARP Level	N/A			Green	Yellow	Orange (risk of overtopping)	Red (overtopping and uncontrolled inflow)
Response	N/A			Standard operations	Inform stakeholders (Section 4.9) Refer to Appendix C for specific action	Immediately take action to stop increase. Inform stakeholders (Section 4.9) Refer to Appendix C for specific action	Trigger ERP (Section 4.9)

* This consider that the West Road has been raised to El. 130 m. The current elevation of the low point of the West Road is at El. 126.4

4.7 SEEPAGE MANAGEMENT

The strategy to deal with seepage and runoff is to capture it within sump at the downstream of the structure and to pump it back in the TSF. The quantity and quality of each seepage out of the TSF is monitored. Historically seepage mixed with runoff water has been pumped back into the TSF at freshet from the RSF (ST 16).

The quantity and quality of seepage from a tailings and water management infrastructure has to be monitored as per the requirements outlined in Section 6.

There is one operational seepage collection system around the TSF, located at the downstream toe of Central Dike. It is collecting seepage water composed of a mix of tailings supernatant water and groundwater. Seepage has been stable for the past two years. Seepage from Central Dike is pump back on a continuous basis into Portage Pit A.

The amount of seepage that can be tolerated is dependent on the structure design intent and the capacity collection system in place. These values are considered to determine the seepage indicator in the TARP levels presented in Section 4.8.

Table 4-9: Summary of Seepage Management

Structure	Seepage Expected From Design	Performance Indicator	Status	Water Collection System	Seepage Quality
Central Dike	Yes, talik. (40 to 100 m^3/h from design report)	Seepage rate measured from seepage collection system flowmeter	Relatively stable, fluctuating from 50 m^3/h in winter to 200 m^3/h at freshet	Downstream collection sump and pumping system, pumping back to Portage Pit A. Winter system in 4'' pipe with max capacity of 45 m^3/h Freshet system in 8'' pipe with max capacity of 470 m^3/h	Generally clear, with seasonal orange coloration due to biochemical processes.

4.8 OPERATING PROCEDURE DURING OPERATION OF THE MEADOWBANK TAILINGS MANAGEMENT INFRASTRUCTURE

Table 4-10 to Table 4-12 below present performance indicators for each of the Meadowbank tailings management infrastructures and the Trigger Action Response Plan (TARP) if the associated performance criteria deviate from the defined range.

Table 4-10: Threshold Criteria and Pre-Defined Action During Operation of Tailings Containment Facility (TSF or In-Pit)

	Failure mode	Observation	Threshold Criteria During Operation			
			Green Normal Operating Range	Yellow Areas of Concern	Orange High Risk Situation	Red Emergency Situation
Criteria	Loss of containment by overtopping leading to uncontrolled outflow (tailings and/or contaminated water)	Water Freeboard	Refer to Table 4-8	Refer to Table 4-8	Refer to Table 4-8	Refer to Table 4-8
		Tailings Freeboard	> 0.5 m to top of containment	>0.5 to <0.2 m to top of containment and active deposition occurring in vicinity	>0.2 m to top of containment and active deposition occurring in vicinity	> top of containment
	Internal erosion of dike or foundation, leading to partial loss of containment (seepage through wall or foundation)	Sinkhole on crest	None visible / inactive	Localised depression > 5 m outside from centreline	Sinkhole identified	Development of sinkhole Dike stability or liner integrity is compromised
		Temperature variation along centreline (based on thermistors and piezometers)	Temperature measurement stable, seasonal trend observed from previous years	Increasing trend in temperature below the active layer (permafrost degradation)	Thawing of the dike keytrench (if applicable)	-
	Unmanageable seepage to site (can also be indicative of internal erosion failure mode depending on seepage flowpath)	Seepage through containment area (structure other than CD)	No seepage observed (except runoff water at freshet)	Inflow < 300 m^3/day and managed by pumping (FOS >2) turbidity in the water (not related to freshet)	Inflow > 300 m^3/day and managed by pumping (FOS >2) turbidity in the water (not related to freshet)	Inflow is unmanageable with pumping capacity (FOS < 1)
		Seepage through containment area (CD)	< 200 m^3/h and managed by pumping (FOS >2)	> 200 and < 300 m^3/h but managed by pumping (FOS >1.5) or Sudden or cumulative increase > 25 % in over 3 days (not related to freshet) turbidity in the water (not related to freshet)	> 300 and < 450 m^3/h but managed by pumping (FOS >1) or turbidity in the water (not related to freshet or known phenomenon)	Inflow is unmanageable with pumping capacity (FOS < 1)
	Instability due to foundation failure, leading to dam breach and total or partial loss of containment	Downstream toe displacement, sloughing or bulging	None visible / inactive	Visible displacement or bulging	Toe displacement related to a sloughing slide from near downstream crest to 5 m from centreline Bulging > 1 m in height	Toe displacement related to a sloughing slide reaching 5 m from centreline Bulging greater than 4m in height. Continued event.
		Pore water pressure (based on PZ at CD) Refer to Doc 1562 CD seepage modeling	P1 in till < 121.5 (FoS >1.5) P2 in till < 115.5 (FoS > 1.5)	P1 in till 121.6-126.2 (FoS 1.3-1.5) P2 in till 115.5-117.8 (FoS 1.3-1.5)	P1 in till 126.3-127.4 (1.1-1.3) P2 in till >117.9 (FoS < 1.3)	N/A
	Instability due to deformation and slope failure, leading to dam breach and total or partial loss of containment	Tension crack observed at the crest	< 0.1 m deep and < 3 m length along the dike Or cracks inactive more than 1 year	> 0.1 m and < 1.0 m deep >3 to < 5 m in length < 0.1 m wide Or cracks inactive more than 6 months	> 0.1 m and < 0.2 m wide & > 5 m and < 10 m length along the dike > 1.0 m deep	0.2 m wide > 10 m length along the dike > 2.0 m deep
		Cumulative vertical crest movement	< 0.2 m Or inactive settlement for more than 1 years	> 0.2 and < 1 m or Or inactive settlement for more than 6 months	> 1 m with increasing rate of settlement	> 2 m with increasing rate of settlement
		Embankment lateral cumulative deformation (rate of deformation to be examined as well)	No deformation observed	< 0.1 m	> 0.1 m and <0.25 m	> 0.25 m
	Loss of tailings containment	Observation of tailings out of the containment facility	Tailings within authorised containment facility	-	-	Tailing slurry observed out of containment area
Action Required			• Continue operation, maintenance, surveillance and monitoring as per standard operating procedure	• If event is related to water level refer to Appendix C • If event is referring to seepage rate increase pumping capacity or repair system • Document location, photograph, survey, and increase inspection and instrument monitoring in area of concern (refer to Section 6) • Implement engineering review. • Implement communication plan (section 4.9)	• Continue measure of Yellow Level • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• Implement Emergency Response Plan (Section 4.9) • Evacuation of personnel and equipment from downstream area. • Close access to dike crest • Stop tailings deposition if event is happening in active deposition area or involve slurry containment loss

Table 4-11 : Threshold Criteria and Pre-Defined Action During Operation of Tailings Containment Facility Diversion Ditches

	Failure mode	Observation	Threshold Criteria During Operation			
			Green Normal Operating Range	Yellow Areas of concern	Orange High Risk Situation	Red Emergency Situation
Criteria	Overtopping of ditches slopes	Sloughing along ditch slopes	None visible / inactive	Visible displacement or bulging	displacement related to a sloughing slide Bulging > 1 m in height	displacement related to a sloughing slide Bulging greater than 4m in height. Continued event
		Cumulative vertical crest movement	< 0.2 m	> 0.2 and < 1 m or Stable trend	> 1 m with increasing rate of settlement	> 2 m with increasing rate of settlement
		Blockage of the ditch	None visible	Accumulation of debris or ice blockage in the ditch during open water season, water still flowing well	Accumulation of debris or ice blockage in the ditch during open water season, water still flowing through but reduced flow and elevated water level behind the blockage compare to historical level, uncontrolled release to site	Accumulation of debris or ice blockage in the ditch during open water season, no water flowing through, observation of uncontrolled release to Environment
	Excessive turbidity or poor water quality in water discharge into environment	Ditch water quality (turbidity)	No observation of turbidity in ditch	Turbidity observed in ditch water (single TSS event of 30 mg/L)	Sustained high turbidity over 30 mg/L in ditch water	Turbidity is linked with erosion of ditch or outlet
		Water quality in the receiving environment and at outlet	Water quality at outlet met receiving environment criteria and Water quality of the receiving environment follows water quality forecast	Water quality at outlet met receiving environment criteria And Water quality of the receiving environment shows a trend that water quality is deteriorating	Water quality at outlet does not met receiving environment criteria	-
Action Required			• Continue operation, maintenance, surveillance and monitoring as per standard operating procedure	• If event is related to turbidity install turbidity control measure • Document location, photograph, survey, and increase inspection and instrument monitoring in area of concern (refer to Section 6) • Implement engineering review. • Implement communication plan (section 4.9)	• Continue measure of Yellow Level • If event is link to snow blockage remove obstruction or install pumping system to help transfer • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• Implement Emergency Response Plan (Section 4.9) • Stop tailings deposition if event involve loss of tailings slurry out of containment area

Table 4-12: Threshold Criteria and Pre-Defined Action During Operation of Tailings Management Pumping Infrastructure

	Failure mode	Observation	Threshold Criteria During Operation			
			Green **Normal Operating Range**	**Yellow** **Areas of concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria	Release of tailings or contaminated water from containment area	Physical damage to the piping and pumping systems (leaks)	None visible	Minor leakage of water at one location. No environmental spill report required. Repairs can be easily done without interrupting the deposition operations.	Significant leakage of water at several locations (environmental spill report required). Significant repairs but can be done without shutting down the deposition operations	Loss of slurry outside containment area
	Overflowing of the containment area because of excessive inflow	Water movement and inflow	Inflow are as expected or can be managed without modifying water management strategy and Elevation of each pumping point is within the predicted range of the water balance	Unexpected inflow that are manageable by modifying the water management strategy	Inflow that are manageable for the moment but cannot be sustained	Water cannot be stored / discharged from the site.
	Uncontrolled release of deleterious substance to Env from Tailings containment facility	Water quality in the receiving environment	Water quality of the receiving environment follows water quality forecast	Water quality of the receiving environment shows a trend that water quality is deteriorating higher than the forecast	-	Water quality of the receiving environment exceed allowable limit
Action Required			• Continue operation, maintenance, surveillance and monitoring as per standard operating procedure	• If event is related to inflow review the site wide water balance • Document location, photograph, survey, and increase inspection and instrument monitoring in area of concern (refer to Section 6) • Implement engineering review. • Implement communication plan (section 4.9)	• Continue measure of Yellow Level • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• Implement Emergency Response Plan (Section 4.9)

4.9 COMMUNICATION AND DECISION MAKING

Error! Reference source not found. indicates the communication and decision processes when the threshold criteria are met and when pre-defined action need to be implemented. Table 4-13 indicates the communication procedure to follow when changing the TARP level.

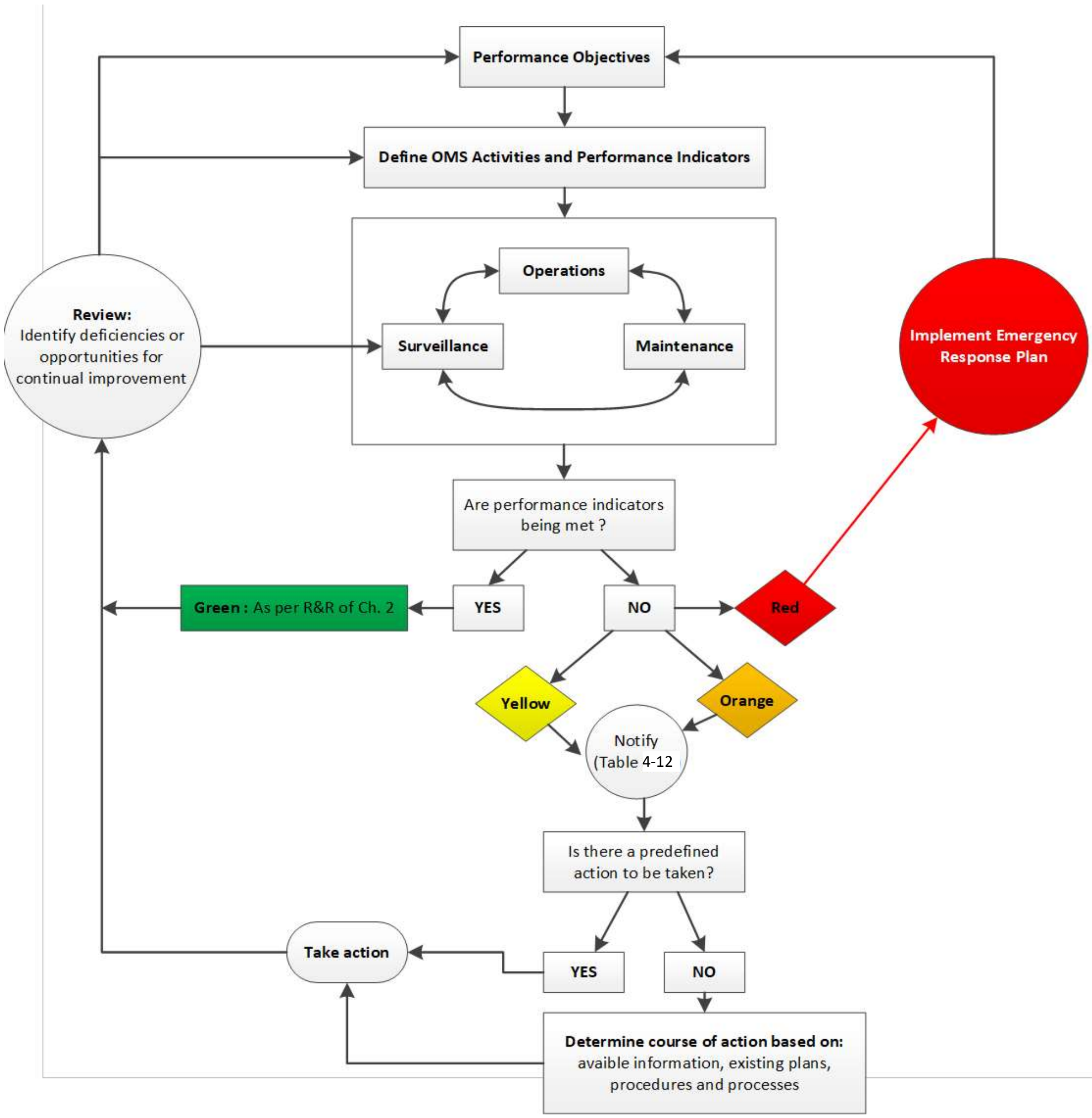


Figure 4-1: Communication and Decision Process for Water Management Infrastructure TARP

Table 4-13 : Communication Procedure to Change TARP Level

Category	Notify	Timeline	Method of Communication
Green	On-Site team → Responsible person → • Independent Review Board • Designer • General Manager • EOR • AEO	The trigger are back to green for more than 2 weeks	Phone Call and E-mail to inform on status change. RP and EOR must agree to change status Brief memo sent by e-mail to officialise TARP change
Yellow	On-Site team → Responsible person → • Water & Tailings G.S • EOR	Within 24 hours of the TARP level condition being met	Phone Call and E-mail to inform on status change. RP and EOR must agree to change status. If RP can't be joined the on-site team will try to contact these people in this order : Water & Tailings GS, EOR, AEO
	Responsible person → • Independent Review Board • Designer • General Manager • EOR • Process Plant Superintendent	Within 72 hours of the TARP level change	Brief memo sent by e-mail to officialise TARP change Meeting to be set to explain situation if required
	EOR → • AEO	Within 1 week of TARP level change	Left to the EOR discretion
Orange	On-Site team → Responsible person → • Water & Tailings GS • EOR	Immediately upon discovering TARP level triggers change	Phone Call, E-mail and meeting to inform on status change. If RP can't be joined the on-site team will try to contact these people in this order : Water & Tailings GS, EOR, AEO
	Responsible person → • Independent Review Board • Water & Tailings GS • Designer • General Manager • EOR • AEO • Health & Safety Superintendent • Process Plant Superintendent	Within 24 hours of the TARP level change	Brief memo sent by e-mail to officialise TARP change Meeting to be set to explain situation
RED	On-Site team → Emergencies Response Team Once an emergency is declared refer to the ERP. Emergency response is out of scope of this document	Immediately when the emergency is discovered. If there is currently a risk to Env or Health and Safety	Code 1 – Code 1 – Code 1 in all pit operation and road channel Or at Emergencies 460-6911
		Immediately when the emergency is discovered. If there is imminent risk to Env or Health and Safety	Phone call to Emergency Measure Counselor (460-6809) & Health and Safety Superintendent

SECTION 5 • MAINTENANCE

This section identifies all infrastructures within the scope of this manual that have maintenance requirements and identifies all preventative, predictive and corrective maintenance activities.

5.1 PREVENTATIVE, PREDICTIVE AND CORRECTIVE MAINTENANCE

Maintenance is divided into preventative (planned), predictive and corrective.

Preventative maintenances are planned, recurring maintenance activities conducted at a fixed or approximate frequency and not typically arising from results of surveillance activities. Examples of such maintenance includes calibration and maintenance of surveillance equipment or regularly changing oil on a pump as per the manufacturer's requirement.

Predictive maintenances are pre-defined maintenances conducted in response to results of surveillance activities that measure the condition of a specific component against performance criteria.

Corrective maintenance of a component of the tailings management system is to prevent further deterioration and ensure their performance in conformance with performance objectives. The need for corrective maintenances is based on surveillance activities, with surveillance results identifying the need and urgency of maintenance.

5.2 REFERENCES

References to key documents for the maintenance of the Meadowbank tailings management infrastructure are presented in Table 5-1.

Table 5-1: Reference Documents for Maintenance of the Meadowbank Tailings Management Infrastructure

Type of information	Link to Retrieve Information
Maintenance log of tailings management infrastructure (to come)	In progress
Maintenance log of pumping equipment	I:\MAINTENANCE\G dore\PWA-COM-LGT hrs reading.xlsx P:\EnergyInfra\08-PowerHouse\2 EQUIPMENT\2 GENERATORS
Maintenance log of geotechnical instrumentation (to come)	..\..\..\..\..\05-Geotechnic\11-Instrumentation\12-Instrumentation_Analysis
Pump allocation tool	..\..\..\04- Water Management\4- Water Management Infrastucture\3- 2019\1 - Planning\9-Procurement\Pump Allocation\AMQ Pump Allocation 2019-2020.pptx
Godwin pump parts and schematics site	https://xylem.sysonline.com/Login.aspx Username: 6184 Password: Parts2019
Geotechnical instrument & Data logger inventory	..\..\..\..\..\05-Geotechnic\11-Instrumentation\1-Instruments\ALL Instruments DatabasesIn progress
Send Slurry Pig MBK-MILL-OP-PRO Send Slurry Pig	Intellex
Tailings Line Thickness Inspection MBK-MIL-MT-PRO-6143TAI01	Intellex

5.3 COMPONENTS OF THE TAILINGS MANAGEMENT INFRASTRUCTURES REQUIRING MAINTENANCE

Table 5-2 indicates all the components of the Meadowbank tailings management infrastructure that require maintenance.

Table 5-2: Components of the Tailings Management Infrastructure Requiring Maintenance

Tailings and Water Management Infrastructure
• Dike embankment (i.e repair erosion) • Dike crest (i.e fill inactive tension cracks) • Pit wall crest (i.e. fill inactive tension cracks and repair erosion) • Seepage collection sump (i.e, reprofile slope, increase sump volume) • Ditches and diversions (i.e snow removal, repair erosion)
Pumping infrastructure
• Pumps (mechanical and electrical maintenance) • Pipes (steaming, repair leak) • Tailings Pipe (wall thickness)

• Flush pipes of tailings and water prior to periods of non-use (pigging)
Surveillance
• Geotechnical instruments (thermistors, piezometers, inclinometers, survey monument) • Data acquisition system • Flowmeter
Other
• Dike crest access road • Pit ramps • Peripheral pit roads • Access to sump

5.3.1 Maintenance Components Outside the Scope of this OMS Manual

The following component maintenance activities are outside of the scope of this OMS manual. For more information, the superintendent of the department responsible for this maintenance can be contacted

- Infrastructures located within the process plant and tailings pumps – Process Plant
- Electrical systems and supply – E&I
- Maintenance of heavy equipment and light vehicles – Maintenance
- Communication infrastructures - IT
- Road used to access the infrastructures – Mine

5.4 DESCRIPTION OF MAINTENANCE ACTIVITIES

Table 5-3 summarizes the description of maintenance activities for each component of the Meadowbank tailings management infrastructure. Each component has activities as well as a trigger for that maintenance and a person in charge of this activity. It is the duty of the person responsible for the maintenance activity to ensure that the person doing the maintenance has the qualifications and competencies required to conduct the maintenance and is following the proper safety procedure. The person in charge of the activity must also ensure that the proper documentation and reporting requirements are followed.

Table 5-3 : Description of Maintenance Activities for Components of Tailings Management Infrastructure

Component	Type of Maintenance	Nature of the Activity	Frequency of Maintenance (preventative) OR Trigger of Maintenance (predictive and corrective)	Accountable for the activity→ Responsible for the Activity	Documentation Required	Reporting Requirement
Tailings Management Infrastructure						
Dike embankment – repair erosion	Corrective	Gullies and depressions to be filled with rockfill and re-sloped	Following a visual inspection showing erosion	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo & survey of corrective work	Water & Geotechnical Coordinator to update the maintenance log of the structure. Survey of work to be added to structure layout
Dike crest – fill inactive tension cracks	Corrective	Inactive tension cracks to be filled with bentonite to prevent widening due to water infiltration	Following consecutive visual inspection showing inactive tension cracks (more than 1 month)	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo & survey of corrective work	Water & Geotechnical Coordinator to update the maintenance log of the structure. Survey of work to be added to structure layout
Dike crest – compensate settlement	Corrective	Add rockfill to increase the height of the dike following observation of settlement	Following a visual inspection showing settlement that need to be compensated (i.e loss of freeboard)	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo & survey of corrective work	Water & Geotechnical Coordinator to update the maintenance log of the structure. Survey of work to be added to structure layout
Seepage collection sump – increase volume	Predictive	Excavate an additional sump or increase the capacity of an existing sump	Following a re-assessment of the required sump capacity	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo & surveying of predictive work	Water & Geotechnical Coordinator to ask for update of status map. Survey of work to be added to structure layout
Seepage collection sump – Broken Culvert / Frozen sump	Corrective	Unfreeze culvert, repair culvert, or install a new sump	Following a visual inspection showing problem with the collection culvert	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo of corrective work	Water & Geotechnical Coordinator to update the maintenance log of the structure.
Seepage collection sump – reprofile sump	Corrective	Excavate flatter slope for the sump or add material against the slope to reprofile them	Following a visual inspection showing instable sump slope	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo of corrective work	Water & Geotechnical Coordinator to update the maintenance log of the structure.
Ditches – snow removal	Predictive	Use an excavator to remove snow in the ditch	Every year prior to freshet to ensure that ditch is clear of snow obstruction. Refer to Freshet Action Plan	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo of predictive work	Water Eng to track the work in freshet readiness meeting. Information to be add to weekly freshet inspection report
Ditches – clean debris and sediment accumulation	Corrective	Remove any debris and accumulation of sediment that can hinder flow	Following a visual inspection showing accumulation of debris and sediment that can hinder flow	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo of corrective work	Water & Geotechnical Coordinator to update the maintenance log of the structure.
Ditches – repair erosion of granular layer	Corrective	Add granular material to repair erosion of the ditches	Following a visual inspection showing erosion of the ditches	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo of corrective work	Water & Geotechnical Coordinator to update the maintenance log of the structure
Ditches – release of TSS from the ditches	Corrective	Corrective action to mitigate release of TSS from ditches. Can include placement of sill curtain or temporary by-passing of the ditches using pump	Following sampling of a high turbidity event from the diches	Environment Superintendent → Environment Coordinator	Water sample results Photo of remediation work	Documented in Freshet Action Plan
Pumping Infrastructure						
Pumps and Genset – maintenance as per manufacturer specification (i.e change oil, look for wear and tear, calibration)	Preventative	Do PM on the pumping unit as per manufacturer recommendation	As per manufacturer specification	Maintenance Superintendent → Pump mechanics	Equipment log Maintenance record	Maintenance to update the pump maintenance log or Genset maintenance log
Pumps and Genset – maintenance when deficiency are observed (cavitation, breakdown, electrical trouble)	Corrective	Troubleshoot the pump problem so that it is once again operational	Following a visual inspection of deficiency	Maintenance Superintendent → Pump mechanics	Equipment log Maintenance record	Maintenance to update the pump maintenance log or Genset maintenance log
Pumps – winterization of unit used in winter	Preventative	Ensure that pumps used in winter have been winterized	Once new pump is received on site that will be used in winter. During initial reception of pump	Maintenance Superintendent → Pump mechanics	Maintenance record	Maintenance to update the pump maintenance log
Tailings Pipe – Measure wall thickness	Preventative	Use ultrasound measurement to confirm pipe wall thickness is sufficient	Once a year at 4 determined control point	Process Plant Superintendent → Process Plant G.S	PM checklist	PM Documentation (JDE)
Pipe – drain the line	Preventative	Ensure that the line is empty of water when it is stopped in winter	Every time pumping is interrupted in winter	E&I Superintendent → E&I Operation G.S	Pigging radius notice	-
Tailings Pipe – Pass pig	Preventative	Ensure that tailings does not build up in the line	Every 2 weeks or when pressure is building up in the line	E&I Superintendent → E&I Operation G.S	Pigging radius notice	-
Pipe – unfreezing a line	Corrective	Steaming the line to unfreeze it in winter	Following visual inspection of a frozen line	E&I Superintendent → E&I Operation G.S	-	-

Component	Type of Maintenance	Nature of the Activity	Frequency of Maintenance (preventative) OR Trigger of Maintenance (predictive and corrective)	Accountable for the activity→ Responsible for the Activity	Documentation Required	Reporting Requirement
Pipe – maintenance when deficiency are observed (leak, pipe burst)	Corrective	Replacing a deficient part of a line with new pipe	Following visual inspection of pipe deficiency	E&I Superintendent → E&I Operation G.S	How much pipe was replaced, what was installed and where it come from	CM documentation (JDE)
Surveillance						
Geotechnical instrument – loss of reading	Corrective	Investigate the status of an instrument that no longer gave data	When an instrument no longer gave data for an unknown reason	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Update status in instrument database	Update of the geotechnical instrument database by the Project Tech
Geotechnical instrument – unusual reading	Corrective	Investigate the status of an instrument that gave unusual data	When an instrument gave unusual data	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Update status in instrument database	Update of the geotechnical instrument database by the Project Tech
Geotechnical instrument – replacement	Corrective	Replace an instrument that no longer works	Following an assessment that an instrument need to be replaced to ensure proper coverage of the surveillance system	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Instrument installation as-built report Update spare inventory Calibration sheet Initial instrument reading	Update of the geotechnical instrument database by the Project Tech
Survey Instrument – Repair of equipment (drone, survey rod, scanner)	Corrective	Fix a problem with the survey equipment (could require to send it for repair)	Following an assessment that there is an issue with the equipment	Engineering Superintendent → Survey Leader	-	-
Survey Instrument – Calibration of drone data	Preventative	Confirm the accuracy of the drone survey with rod or scan survey	Once a year per structure	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Survey data and drone data	Both data in the survey file
Data acquisition system – maintenance	Preventative	Do maintenance of datalogger (i.e battery, solar panel, shack)	Yearly	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	list of items maintained	Update of the geotechnical instrument maintenance log by the Project Tech
Datalogger – battery change	Predictive	Change battery when the battery level alarm gets triggered	When the battery alarm is triggered in VDV	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Update status in instrument database	Update of the geotechnical instrument maintenance log by the Project Tech
Datalogger – troubleshooting	Corrective	Repair of a datalogger deficiency	When a datalogger is suspected of being deficient	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Update status in instrument database	Update of the geotechnical instrument maintenance log by the geotechnical technician
Flowmeter – calibration	Preventative	Calibrate the flowmeter as per License requirement	Yearly	E&I Superintendent → E&I Operation G.S	Calibration sheet	Update of the geotechnical instrument maintenance log by the Project Tech
Flowmeter – deficient reading	Corrective	Repair of a flowmeter deficiency	When a flowmeter is suspected on providing anomalous data	E&I Superintendent → E&I Operation G.S	Maintenance report	Update of the geotechnical instrument database by the Project Tech
Other						
Dike crest access, pit access, sump access, access road	Predictive	Snow clearing, maintaining roadway, grading access as per snow management map	As required to maintain access	E&I Superintendent → E&I Operation G.S	-	-

SECTION 6 • SURVEILLANCE

Surveillance involves the inspection and monitoring (i.e. collection of qualitative and quantitative observations and data) of the Tailings Management Infrastructure. Surveillance also includes the timely documentation, analysis and communication of surveillance results, to inform decision making and verify whether performance objectives including critical controls are being met.

There are two type of surveillance activities which are further discussed in this section:

- Site observation and inspection
- Instrument monitoring

6.1 REFERENCE

References to key documents for site observation & inspection of the Meadowbank tailings management infrastructure are presented in Table 6-1. References to key documents for instrument monitoring are presented in Table 6-2.

Table 6-1: Key Reference Documents for Inspection of Tailings Management Infrastructure

Type of information	Document #	Document Title and link
Integrated inspection form template	-	OMS manual – Appendix D
Detailed visual inspection form template	-	OMS manual – Appendix D
Saddle Dam 1	SD1-VIR	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\1- Saddle Dam 1\3- Operation\1-Inspection
Saddle Dam 2	SD2-VIR	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\2- Saddle Dam 2\3- Operation\1-Inspection
Saddle Dam 3	SD3-VIR	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\3- Saddle Dam 3\3- Operation\1-Inspection
Saddle Dam 4	SD4-VIR	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\4- Saddle Dam 4\3- Operation\1-Inspection
Saddle Dam 5 / Central Dike	CD-VIR	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\8- Central Dike\Inspection
NCIS	NCIS-VIR	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\9- North Cell Internal Structure (NCIS)\3- Operation\2-Inspection
Stormwater Dike	SWD-VIR	\\Cambfs01\groups\Engineering\05-Geotechnic\03-TailingsDams\7- Stormwater Dike\Inspection
RF1	RF1-VIR	\\Cambfs01\groups\Engineering\05-Geotechnic\08-RockStorageFacility\Inspections\RF1
RF2	RF2-VIR	\\Cambfs01\groups\Engineering\05-Geotechnic\08-RockStorageFacility\Inspections\RF2
Tailings Management North Cell area	NC-IR	\\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\1 - North Cell\14- Inspection
Tailings Management South Cell area	SC-IR	\\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\2 - South Cell\5- Inspection
Tailings Management In-Pit	IPD-IR	\\Cambfs01\groups\Engineering\05-Geotechnic\06-TailingsManagement\3- In-Pit Deposition\4 -Operation\3- Inspection
Annual dike safety inspection (annual geotechnical inspection)	-	\\Cambfs01\groups\Engineering\05-Geotechnic\10-Inspection\Annual Geotechnical Inspection
Minute of MDRB Meeting	MDRB #28 (most recent)	\\CAMBFS01\Groups\Engineering\05-Geotechnic\13-MDRB
Surveillance Recommendation Tracking Tool	-	\\Cambfs01\groups\Engineering\05-Geotechnic\10-Inspection\Inspection Recommendation Implementation Plan

Table 6-2: Reference Documents for Instrument Monitoring of the Meadowbank Tailings Management Infrastructure

Type of Information	Link to Retrieve Information
Surveillance Signoff Log	\\Cambfs01\groups\Engineering\05-Geotechnic\10-Inspection\Surveillance Log (Inspection Signoff)
Geotechnical Instruments Map	Work in progress
Access to Instrument Data	VDV (http://cambeng2:8080/)
Instrumentation analysis	\\Cambfs01\groups\Engineering\05-Geotechnic\11-Instrumentation\12- Instrumentation_Analysis
Quarterly Instrumentation Report	\\Cambfs01\groups\Engineering\05-Geotechnic\17-Report\Quarterly Reports
Water Quality Result Database	EQuiS
Blast Vibration Log	..\..\..\..\05-Geotechnic\99-Archive\Blast Monitoring\Events
Morning Management Meeting Water Level Tab	\\CAMBFS01\Public\Morning Meeting Minutes
Water Level Survey File	\\CAMBFS01\Groups\Engineering\06-Surveying\15-Dewatering
Tailings Pump Flow & Pressure Alarm	HMI, Wonderware

6.2 PRIORITY LISTING

Any recommendation or action to be taken following a surveillance activity must be assigned a priority and an Owner and be followed on depending on its priority. The priority scale of Table 6-3 must be used for this. These recommendations must also be tracked using the Surveillance Recommendation Implementation Tracking File.

Table 6-3: Surveillance Activity Recommendation Priority Listing

Priority #	Description	Timeline to Address
P-1	A high priority or actual structure safety issue considered immediately dangerous to life, health, or the environment; or a significant risk of regulatory enforcement	Immediately to 1 week
P-2	If not corrected could likely result in structure safety issues leading to injury, environmental impact, or significant regulatory enforcement ; or a repetitive deficiency that demonstrates a systematic breakdown of procedures	1 week to 3 months
P-3	Single occurrences or deficiencies or non-conformance that alone would not be expected to result in structure safety issues	3 months to 6 months
P-4	Best Management Practice – further improvements are necessary to meet industry best practices or reduce potential risks	>6 months

6.3 SITE OBSERVATIONS AND INSPECTIONS

The purpose of site observations and inspections is to identify warning signs of the development of potentially adverse conditions that could lead to a failure or some other form of loss of control. Site observations and inspections include the direct observations by personnel on or adjacent to the Tailings Management Infrastructure and may also include observations from helicopter or photos taken from unmanned airborne vehicle (UAV, satellites).

Site observations and inspections are used to identify and track visible changes in the condition of the tailings management infrastructure. Changes that may be observed throughout site observations and inspections are included in Table 6-4.

Table 6-4 : Changes Possibly Observed through Site Observation and Inspection of the Meadowbank tailings management infrastructure

Changes related to physical risk of dike, pit wall, road, ramp
• Change in freeboard • Deformation or change in condition at the crest, slopes, and toes (i.e. bulges, cracks, sinkholes, sloughing, settlement) • Newly formed or expanding areas of erosion • Evidence of piping or unexpected water movement through water containment structures • Changes in the seepage quantity (pumping rate) and quality (turbidity) • Rock falls and other movements in pit walls • New seepage observed in pit walls
Changes related to chemical risks
• Evidence of newly formed seepage, or changes in seepage and evidence of any changes in seepage characteristics (i.e. coloration, turbidity, TSS)
Changes related to physical risk of ditch
• Newly formed or expanding areas of erosion • Newly formed obstructions to flow (i.e. boulder, sediments, snow) • Newly formed slope instability
Changes related to water storage and transport
• Change in sump level • Discovering using a staff gauge (when applicable) that the pond is not being operated within its normal operating condition • Changes in the seepage quantity (pumping rate) and quality (turbidity) • Change in the condition of the piping for water or tailings transport • Sign of leaks from water or tailings line • Change in the condition of pumps
Changes related to surveillance instrumentation
• Change in the condition of surveillance instruments and associated protection around instruments (i.e. cover, barriers to prevent vehicle damage) • Change in condition of power supplies for instruments (i.e. solar panel) • Change in condition of communication infrastructures associated with instruments (i.e. antenna, datalogger)

6.3.1 Site Observation

Site observation is conducted by personnel working on or adjacent to the tailings management infrastructure as part of their daily activities, maintaining awareness of the facility while performing their duties. Trained personnel such as geotechnical technicians and the dewatering crew should be on the lookout for signs of changing conditions as indicated in Table 6-4 since adverse conditions can develop rapidly between inspections. A simplified visual observation form can be used to document such observations, but they do not need to be documented unless a new condition has been observed. Any new observation should be documented by photograph and reported to the geotechnical team.

6.3.2 Inspection Program

Inspections are conducted by the Environment department or other personnel with appropriate training and competency and are more rigorous than site observations.

The inspection program consists of several types of inspections such as routine and special visual inspections, dike safety inspections and dam safety reviews. The following sub-sections describe in more detail the scope, frequency and person responsible for each type of inspection.

6.3.3 Routine Visual Inspection and Reporting

Routine visual inspections are conducted on a pre-defined schedule and may target specific activities. Their objective is to identify any conditions that might indicate change in the Tailings Management Infrastructure performance and therefore require follow-up. The inspections need to cover the aspects described in Table 6-4. Of significance are new occurrences or noted changes in seepage, erosion, sinkholes, boils, slope slumping, settlement, displacement, or cracking of structure components. These inspections are held during dewatering and operation.

There are two approved inspection forms for inspection: a integrated inspection form and a visual inspection form The detailed form is used for monthly inspection while the integrated form is used for weekly inspection during freshet (during period of flow) or when required to document an ad-hoc inspection. These forms can be found in Appendix D. All areas of the form must be filled.

The person responsible for the inspection must:

- Perform the inspection as per the OMS frequency. The performance of all component of the structure must be accessed on foot and visually assessed (access, earthwork, sump, pumping system, instrument).
- Take pictures to supplement the inspection. As much as possible, these are to be taken from the same vantage points during each inspection so that changes in conditions can be readily identified. All area having abnormal condition (active or inactive or no longer visible) must be photographed. Photos must be annotated or captioned and must include a date stamp.
- Store electronically all photos and the inspection form (even those not included in the report)
- Fill all information on the proper inspection form (integrated or visual inspection form). A proper inspection form includes:

  - Summary of visual observation during the inspection (including inactive feature)
  - Discussion on the progress of former inspection observation
  - Documentation of the performance indicator versus the threshold criteria (water level, seepage rate, visual observation)
  - Map of where the visual observation are located (including past observation with date)
  - Representative photo that have caption and a clear way of locating where they are taken
  - Action item to be taken following the inspection (operation, maintenance or surveillance) with a Priority listing as well as an Owner.
- Update the surveillance log
- Sign the inspection form as the person having done the inspection and ensure that the reviewer is aware that the document is ready to be reviewed

During the review process, the reviewer must:

- Ensure that all required information is present as per requirement of section above
- Ensure that the indicator does not trigger a change in alert level
- Approve the action item and ensure that they are assigned an Owner.
- Update the inspection recommendation tracking tool accordingly
- Sign the inspection form as a reviewer
- Update the surveillance log
- Distribute the inspection results to the EoR, the Meadowbank Geotechnical Engineering e-mail list and to responsible of action item

The frequency for inspection of a structure will vary based on its TARP level and needs to be updated in the surveillance log if it changes.

Table 6-5 summarizes the routine visual inspection roles and responsibilities, suggested frequency, and scope in function of the alert level of the structure.

Table 6-5 : Summary of Routine Inspection Requirements (frequency, reporting, distribution)

Structure	TARP Level	Person Responsible	Inspection Frequency	Reporting	Inspection Reviewer	Distribution List
SD1, SD2, SD3, SD4, SD5, RF1, RF2, Central Dike, Stormwater Dike, NCIS	Green	Geotechnical Technician	Monthly	Visual inspection form	Geotechnical Coordinator	Meadowbank Geotechnical Eng e-mail list, EOR, recommendation Owner
			Weekly during period of flow (from May to October)	Integrated Inspection form for each component (in-pit, pond, dike, channel)		
	Yellow		Monthly	Visual inspection form		Meadowbank Geotechnical Eng e-mail list, EOR, recommendation Owner, Designer, Independent Review Board, AEO, General Manager
			Weekly	Integrated Inspection form		
	Orange	Water & Geotechnical Coordinator	Weekly	Report on summary of surveillance activity + status of mitigation action	Water & Tailings G.S and/or EOR (left at EOR discretion)	Meadowbank Geotechnical Eng e-mail list, EOR, recommendation Owner
			Monthly	Visual inspection form		
			Daily	Integrated Inspection form		
TSF Pond, Tailings distribution and Pumping Infrastructure – Operation	Green	Water & Tailings Engineer	Monthly	Visual inspection form	Geotechnical Coordinator	Meadowbank Geotechnical Eng e-mail list, EOR, recommendation Owner
			Weekly during period of flow (from May to October)	Integrated Inspection form for each component (in-pit, pond, dike, channel)		
	Yellow		Monthly	Visual inspection form		Meadowbank Geotechnical Eng e-mail list, EOR, recommendation Owner, Designer, Independent Review Board, AEO, General Manager
			Weekly	Integrated Inspection form		
	Orange		Weekly	Report on summary of surveillance activity + status of mitigation action	Water & Tailings G.S and/or EOR (left at EOR discretion)	Meadowbank Geotechnical Eng e-mail list, EOR, recommendation Owner
			Monthly	Visual inspection form		
			Daily	Integrated Inspection form		

6.3.3.1 Special Visual Inspection

Special inspections are conducted during and after unusual or extreme events that may impact the facility. Special inspections are conducted by the Geotechnical Technician and the Geotechnical Coordinator. The Engineer of Record or the Independent Review Board or the Designer could be asked to join these inspections based on the circumstance of the event (left at the RP and EOR discretion). This inspection will be recorded using the visual inspection form using the same procedure for review and documentation. A memo might also accompany these inspections based on the circumstances of the event (left at the EOR and RP discretion)

Special visual inspections must be done on each structure after each of these events:

- At the end of dewatering once the downstream toe is exposed
- Following a blast that exceeds the vibration limits of the structure
- After an earthquake
- After a high intensity rainfall event (higher than a 1:2 years recurrence)
- Immediately after a site observation notices a change in condition
- Prior or immediately after increasing or decreasing the TARP level of a structure

6.3.3.2 Annual Geotechnical Inspection

The Annual Geotechnical Inspection is a requirement of the Water License. It is a more comprehensive technical inspection, integrating inspections and results of monitoring instruments. This inspection is conducted annually by an external geotechnical engineer to have a more complete understanding of the facility performance and to identify deficiencies in performance or opportunity for improvement. This will also provide information to be used to revise the OMS manual.

For the Meadowbank tailings and water management infrastructure, such inspection must occur on an annual basis by the end of the flow period (July to September). The following components need to be inspected during this review:

- Saddle Dam 1, Saddle Dam 2, Saddle Dam 3, Saddle Dam 4, Saddle Dam 5, North Cell Internal Structure, Stormwater Dike, Central Dike, RF1, RF2
- North Cell and South Cell pond and reclaim infrastructure
- Tailings deposition infrastructure
- Ditches and channels

In addition to field inspection performed as part of the safety review the following points should be addressed during the review:

- Review of inspection reports performed since the last review
- Review of instruments data
- Identify deficiencies in performance or opportunity for improvement
- Review performance indicator, operational control and operational threshold criteria

- Review and provide recommendations regarding the OMS for the following year.

After each annual inspection, a report must be submitted to the Responsible Person which includes the results of the inspection and addresses all points above. These reports will be stored electronically. The recommendation must respect the priority nomenclature. The Responsible Person will ensure that an action plan is developed to address the recommendation and will transmit the report and the action plan to the EoR.

6.3.3.3 EOR Inspection

As per AEM Governance on Critical Infrastructure, on an annual basis the EOR will perform a site visit to inspect the infrastructure and review the various component of the water & tailings management system. The results of this inspection will be summarized in an annual report transmitted to the RP and the AEO. The Water & Tailings Superintendent will ensure that an action plan is developed to address the recommendation of the EOR inspection.

6.3.3.4 Independent Review Board Meeting (MDRB)

The name of the Independent Review Board for the Meadowbank Complex is the Meadowbank Dike Review Board (MDRB).

An annual MDRB meeting will be held every year. The following topic are part of the annual MDRB scope of work:

- Site visit (during period of flow) of all infrastructure covered by the scope of the MDRB
- Review of mine waste management strategy (including tailings and waste rock storage facilities);
- Review tailings management infrastructure designs and performance (including water retaining infrastructures);
- Review of on-going construction works and monitoring data;
- Comment on implementation progress of proposed mine waste management improvement measures;
- Provide opinions and guidance to the operation on the physical integrity, safety, behavior, and performance of the confinement systems for mine waste and water retaining infrastructures; and
- Comment on management systems, emergency preparedness and overall management approach of the different mine waste management facilities and water retaining infrastructures.

Other events that could trigger a MDRB meeting are:

- Presentation of design of new critical infrastructure
- Major modifications to the design or design criteria
- Discovery of unusual conditions that can compromise the integrity of the Tailings Dikes
- After extreme hydrological or seismic events
- Decommissioning

The MDRB will submit a report following their observation and recommendation following each meeting. The Water & Tailings Superintendent will ensure that an action plan is developed to address the recommendation and will transmit the report and the action plan to the EOR.

6.3.3.5 Independent Dike Safety Review (DSR)

Independent dike safety reviews (DSR) are carried out by an independent third party with the EOR, if possible, to review all aspects of the design, construction, operation, maintenance, processes, and other systems affecting the dike safety, including the dike safety management system. The DSR defines and encompasses all components of the "dike system" under evaluation including the dike, foundations, abutments, instrumentation, and seepage collection works.

A DSR will be organized every 5 years by the Responsible Person and will be done according to the Dam Safety Guideline (CDA, 2013). No DSR have been performed so far for the Meadowbank tailings management infrastructure. The next DSR should be done in 2021.

6.3.3.6 Tailings Management Working Group (TMWG)

Tailings working group is a mechanism to facilitate the communication between the different key stakeholder involved in tailings management. Meeting of the TMWG will be held on a quarterly basis and minutes will be distributed to the attendee. The following topics are part of the TMWG :

- Discuss change at the process plan that could impact tailings management
- Review deposition plan, water balance and operational compliance
- Review facility performance
- Discuss IRB recommendation and develop implementation plan

6.4 INSTRUMENT MONITORING PROGRAM – DATA ACQUISTION

Instrument monitoring provides information on parameters or characteristics that cannot be detected through site observation or inspections, cannot be observed with sufficient precision and accuracy, or need to be monitored at high frequency or continuously.

The objective of instrument monitoring is to collect data to be used to assess the performance of the infrastructures against the performance objectives and indicators and the critical controls (refer to Table 4-2). Instrument monitoring and inspections work together as a comprehensive data set to enable assessment of the tailings management infrastructure performance and to provide a basis for informed decision making. All are essential, and none of these forms of surveillance can be neglected if performance objectives are to be met and risks are to be managed.

More information on the type of in-situ instruments installed on each structure, how they were installed, and their location can be found in Section 3.7 of this OMS manual.

Table 6-6 indicates the type of information collected through instrument monitoring and how it is collected. Table 6-7 summarizes the data acquisition programs related to instrument monitoring. Table 6-7 also goes over the required water level surveys at Meadowbank; this information is used by the Water & Tailings Engineer to update the water movement log and water balance and is vital information for ensuring the freeboard of the Tailings Dikes is respected.

Table 6-6 : Information Collected Using Instrument Monitoring

Direct collection of information
• In-situ thermistors to measure temperature profile within the structure and its foundation • In-situ piezometer to measure pore-water pressure providing information about flow of water through the structure and foundation stability • Airborne survey to monitor vertical settlement and deformation • Survey of dike crest to provide validation on settlement and deformation • Blast monitor to inform on potential impact of blasting vibration on the structure • Flow meters and seepage monitoring stations to inform on volume of water movement • Surveys conducted to measure ice cover, water level, and update height and slope of containment structure
Collection of information from remote sensing
• Data acquired from airborne survey to generate detailed topographic map
Collection of information based on laboratory analyses
• Water quality analysis of seepage and surface runoff reporting to sump • Water quality analysis in groundwater wells in pits • Water quality analysis of water discharged through diffuser to inform on Environmental compliance • Water quality analysis of water stored in the various ponds on site to inform on water movement decisions
Collection of information related to the conduct of OMS activities
• Automatic data collection and transmission system for in-situ instruments (datalogger, solar panel, antenna, battery)

Table 6-7 : Summaries of Data Acquisition Programs Related to Instrument Monitoring of the Meadowbank tailings management infrastructure

Instrument Monitoring	Location of Monitoring (1)	Parameter Measured	Acquisition Methodology	Standard Acquisition Frequency	Acquisition Responsible	Documentation Methodology	Documentation Responsible
Thermistors	SD1, SD2, SD3,SD4,SD5, RF1, RF2, SWD, CD, NCIS, North Cell pond	Temperature (C^0) point for each bead on the chain	In-situ instrument connected to automatic data acquisition and transmission system	New data are acquired and transmitted to VDV every 3 hrs	Environment Superintendent → Water & Geotechnical Coordinator	Data are documented in VDV	Water & Geotechnical Coordinator
Piezometer	Central Dike, Stormwater Dike	Pressure (kpa) point for each instrument	In-situ instrument connected to automatic data acquisition and transmission system	New data are acquired and transmitted to VDV every 3 hrs	Environment Superintendent → Water & Geotechnical Coordinator	Data are documented in VDV	Water & Geotechnical Coordinator
Blast Monitor	SD1, SD2, SD3,SD4,SD5, RF1, RF2, SWD, CD, NCIS, North Cell pond	Peak particle velocity (PPV) measured by the blast monitor (mm/s)	Placement of blast monitor at a predetermined area on the dike	Before each blast in the blast radius of the dike	Environment Superintendent → Water & Geotechnical Coordinator	Update the blast vibration log.	Water & Geotechnical Coordinator
Flow Meter	Central Dike D/S	Volume of water pumped (m^3)	Flowmeter connected to HMI system (remote data acquisition)	Daily when pump is operating Or Continuously if connected to HMI	E&I Superintendent→ E&I Operation G.S	Pumpsheet reading entered in water balance Or Historian (if connected to HMI)	Water & Geotechnical Coordinator
Survey Shot	All TSF ponds	Elevation of the water level (minimum precision of 3 mm required)	Take a water/ice level at a predetermined area	From May to September; once per week for all water bodies, From October to April: monthly to confirm PZ reading	Engineering Superintendent → Surveyor Leader	Water Level Survey file	Survey Leader
Bathymetry / Scan of tailings beach	North Cell / South Cell	Aerial and sub-aerial topography	Surveyor will take a scan and a bathymetry with a boat	At beginning and end of freshet in active tailings area. Once per summer in inactive tailings deposition area	Environment Superintendent → Contractor	Integrated in the tailings deposition plan	Water & Tailings engineer
Airborne Survey	All tailings management infrastructure	Topographic aerial survey made using drone. Measurement of structure settlement	Surveyor will take a drone survey	Once per month from May to October	Engineering Superintendent → Surveyor Leader	Within survey database	Surveyor Leader
Water Quality(2)	Refer to Water Management Plan	Parameters indicated within water management plan	Water quality sample taken and sent for laboratory analyses	Acquisition frequency within water management plan	Environment General Supervisor	Within Env water quality database	Environment General Supervisor
Groundwater Well	Refer to Groundwater Management Plan	Parameters indicated within groundwater management plan	Water quality sample taken and sent for laboratory analyses	Acquisition frequency within groundwater management plan	Environment General Supervisor	Within Env water quality database	Environment General Supervisor

(1) Refer to section 6.4 for more information on reporting methodology and the frequency of reporting
(2) Refer to section 6.7 on how to present instrumentation data from VDV in a report
(3) Exact location of each instrument can be found in the instrumentation database
(4) Location of water quality sampling point can be found in water management plan

6.5 ADDING INSTRUMENTS TO THE MONITORING PROGRAM

Any addition of instruments to the monitoring program must be validated by the Acquisition Responsible in Table 6-7. The addition of a new type of monitoring needs to be validated by the structure owner Superintendent. In-situ instrument installation must be recorded in an as-built report and added to the instrumentation database and map. After each installation of instrumentation, the following must be done:

- Document the calibration sheet and initial data reading
- Document instrument specification (manufacturer sheet)
- Document information to which datalogger the instrument is connected
- Survey instrument coordinates (x,y,z)
- If the instrument is drilled, a schematic view of the depth of the instrument versus the stratigraphy must be produced
- Photo of installation must be documented
- Update the structure layout with the location of the new instruments
- Update the instrument database of the structure

6.6 ANALYSIS OF SURVEILLANCE RESULTS

For the effective use of surveillance results in decision making, results must be collated, examined, analysed and reported in a timely and effective manner.

For visual inspections, the process of analyzing the data and communicating the results is described in Sections 6.6.1 and 6.6.2 and happens while the inspection is done, and the report is sent. The information gained from the analysis of these results is then compared during the inspection and review to the TARP criteria which will then indicate the action to take if performance indicators are not met.

For the instrumentation monitoring to be effective, the data must be reviewed, analysed and reported at the proper frequency. Table 6-8 summarizes the requirements for review, analyses and reporting of instrumentation data.

The person responsible for instrumentation data review needs to update the surveillance log each time an instrument result has been reviewed and analysed. The person responsible for review of reporting and distribution needs to update the surveillance log once the report has been reviewed and distributed.

6.6.1 Procedure to review PZ and TH data

While the use of an automatic data acquisition system eases the collection and review of instruments data there are certain pitfalls that need to be avoided to ensure a proper analysis. When doing a formal instrument review according to Table 6-8 it is important to fill the instrumentation analysis tool and to ensure the following:

<u>Piezometer:</u>

- When reviewing PZ data it is important to look at the associated temperature of the instrument. A PZ which ever recorded data below 0 degree should be considered unreliable. A frozen piezometer data should not be relied upon.
- When reviewing PZ data it is important to understand the piezometric regime of the instrument and what is the expected pressure profile. A PZ data should be analyzed in context of where the instruments is installed and on the expected reading. It is not recommended to only look at the variation of the reading and all piezometers should have reading associated to a trigger. If there is no trigger for the instrument and only a differential reading is examined (fall and rise) then the following must be taken into account in the review and analysis :
    - Ensure that the vertical scale is adequate. The scale use must allow to notice change at the scale of decimeter. A 1 m change rise or fall is a very significant event that must be examined. If the vertical scale is too big a significant increase can easily be masked
    - Ensure that the data are reviewed at various timescale. When reviewing an instrument data the data should be looked at a multi-year scale (to see cyclical trend), a monthly scale and a weekly scale.
    - Try to correlate increase and decrease in piezometric reading with change in the environment (change in water level, change in pumping activity, freezing of the ground, nearby blasting, progression of a nearby excavation).

<u>Thermistor:</u>

To effectively review a TH data it is important to understand what the purpose is. Displacement graph showing a TH profile at set time in function of the elevation should not solely be used for such review. It is important to also graph thermal profile (colour map).

- When reviewing a TH installed in a structure that must maintain a foundation in permafrost to perform (all Saddle Dam, NCIS) the objective of the TH is to ensure that the design intent is met. The TH review need to focus on the active layer depth, behaviour of the permafrost (aggradation, degradation, stable). It is especially important to look at the thermal profile located in the low permeability element of the design (foundation). If a permafrost degradation trend beyond the active layer is observed progressing toward the foundation it must be raised. To review the performance of these structures, thermal graphs are really effective and displacement graphs should not be relied upon alone.
- When reviewing a TH installed in talik or in a structure that does not require permafrost condition to perform (Central Dike, Stormwater Dike) the objective of the TH is to identify potential seepage pathway (correlation between water temperature and TH reading) as well as to monitor the evolution of the thermal condition (as some PZ behaviour can be explained by change in thermal profile). The review of the instrument must focus on the link between the lake temperature and the TH temperature (as well as the delay in correlation) as well as the

general progression of the thermal profile over multiple year. To do this review a combination of displacement graph and thermal profile should be used. Trend of permafrost aggradation should be looked for while reviewing such instruments.

Table 6-8: Requirements for Review, Analysis, and Reporting of Instrument Data

Instrumentation	TARP Level	Expected Range of Observation	Responsible for Review & Analysis	Frequency of Review	Responsible for Reporting	Reporting Frequency	Responsible for Review and Distribution	Distribution List
Piezometer, Thermistor	Green	Defined in TARP of each structure	Water & Geotechnical Coordinator	Bi-Weekly, or following any anomalous visual inspection	Water & Geotechnical Coordinator	Quarterly instrumentation report	Water & Geotechnical Coordinator	Engineering Geotechnical Team, EOR
	Yellow	Defined in TARP of each structure	Water & Geotechnical Coordinator	Weekly (for instrument related to the TARP increase failure mode)	Water & Geotechnical Coordinator	Discussion of instrument behaviour related to the TARP increase failure mode in the inspection report	Water & Geotechnical Coordinator	Engineering Geotechnical Team, EOR
	Orange	Defined in TARP of each structure	Water & Geotechnical Coordinator (can't be delegated)	Daily (for instrument related to the TARP increase failure mode)	Water & Geotechnical Coordinator (can't be delegated)	Discussion of instrument behaviour related to the TARP increase failure mode in the inspection report in the weekly update report	Water & Tailings General Supervisor and/or EOR (left at EOR discretion)	Engineering Geotechnical Team, Designer, EOR, MDRB
Water level	Any	Defined in TARP of each structure	Water & Geotechnical Coordinator	Daily	Water & Geotechnical Coordinator	Daily water level update in the E&I management meeting minute file	Water & Geotechnical Coordinator	Management Meeting Minute
Blast Monitor	Any	PPV> 50 mm/s	Water & Geotechnical Coordinator	After retrieving a blast monitor on a tailings management structure	Water & Geotechnical Coordinator	Quarterly instrumentation report. To summarize event of the period	Water & Geotechnical Coordinator	Engineering Geotechnical Team, EOR
Flow Meter / Seepage Monitoring	Green	Defined in TARP of each structure	Water & Geotechnical Coordinator	Weekly	Water & Geotechnical Coordinator	Documented in each inspection form and in quarterly instrumentation report	Water & Geotechnical Coordinator	Engineering Geotechnical Team, EOR
	Yellow	Defined in TARP of each structure	Water & Geotechnical Coordinator	Weekly	Water & Geotechnical Coordinator	Documented in each inspection form and in quarterly instrumentation report	Water & Geotechnical Coordinator	Engineering Geotechnical Team, EOR
	Orange	Defined in TARP of each structure	Water & Geotechnical Coordinator (can't be delegated)	Daily	Water & Geotechnical Coordinator (can't be delegated)	Included within weekly update report	Water & Tailings General Supervisor and/or EOR (left at EOR discretion)	Engineering Geotechnical Team, Designer, EOR, MDRB
Water Quality	Any	Defined in Water Management Plan	Environment Coordinator	As per water management plan	Environment General Supervisor	As per water management plan	Environment General Supervisor	Engineering Geotechnical Team
Groundwater Quality	Any	Defined in Groundwater Management Plan	Environment Coordinator	As per groundwater management plan	Environment General Supervisor	As per groundwater management plan	Environment General Supervisor	Engineering Geotechnical Team

6.6.2 Procedure If Data Exceeds Expected Range of Observation

If data exceeding the expected range of observation or anomalous data readings are observed, the following actions need to be taken by the person reviewing the instrument:

Anomalous instrumentation data examples are presented in Table 6-9. These anomalies could happen without triggering a TARP level change and need to be investigated and recorded in the instrumentation analysis tool:

- Re-read to check the reading (if the reading is from VDV, take a manual reading in the field)
- If the instrument is connected to a datalogger ask the Project technician to check readout equipment to verify that it is functioning correctly and to verify calibration
- If instrument has stopped functioning, notify the Geotechnical Coordinator immediately. If considered critical, a replacement instrument should be installed
- If an anomalous reading is confirmed, a detailed review of the effects of the reading should be carried out and design or remedial actions should be implemented if determined necessary by the Geotechnical Coordinator. Any malfunctioning instrument or frozen piezometer must be documented
- In the case of valid data that would exceed the TARP level perform a special inspection if possible

Before modifying the TARP level due to in-situ instrumentation or readings that cannot be confirmed by visual observation, the EOR must be consulted for further guidance.

Table 6-9 : Examples of Anomalous Data and Some Common Causes

Thermistors
• Increase or decrease in measurements (over two or more readings) that cannot be explained by seasonal temperature variations • Progressive loss of data (starting from the bottom and progressing). This is usually a sign of water infiltration • Observation of a spike in temperature in one bead. This is usually due to a capacitive effect • Loss of data (could be a transmission error, faulty hardware or a sheared cable)
Piezometer
• Increase or decrease in pore water pressure measurements that cannot be explained by seasonal lake level variations (verify that the instrument has not been installed in a casing). Also verify if the trend is seasonal. This sometime can be observed in the winter in instrument installed in former talik area that are freezing back • Sharp increase in reading. Verify that the instrument is not frozen. If multiple instruments are impacted at the same time verify the barometer reading • Loss of data (could be a transmission error, faulty hardware, a sheared cable or no more battery power). Especially true if several instruments are lost at the same time or if it is the winter

Blast Monitor
• Vibrations during a blast are not observed (the blast was cancelled, the blast monitor was not properly installed or vibrations were too weak to be recorded)
Flowmeter, Survey Shot
• Increase or decrease of a flowmeter reading that are inconsistent with pumping rate or rainfall or observed water level • Survey elevation that has a sharp fluctuation from last reading. This can be caused by the reading not being taken at the right location, wave actions or daily variances in GPS signal

6.6.2.1 Blast Monitoring

If a reading exceeding the PPV limit for a tailings management structure (50 mm/s) is observed, this event must be communicated to the drill and blast engineer who will need to ensure that the blasting pattern is modified to avoid re-occurrence of this event. Afterward a special inspection will need to be done on the structure to look for changes in condition.

If more than one occurrence of blast vibration exceeding the limit is observed within a 2 weeks period, the Environment Superintendent needs to be notified of the situation.

6.7 INSTRUMENTATION MONITORING DOCUMENTATION AND REPORTING

An instrumentation report needs to be prepared at a predetermined frequency to present the analyse of all instrumentation monitoring data as described in Table 6-8. The goal of this report is to present a summary of the instrument monitoring done for the period as well as the item of interest for the performance of the structure. is not required in an instrumentation report to present all instrumentation graph in a structure but the summary of the instrumentation analysis tool need to be presented and all type of monitoring trend for the period need to be summarised. Graph should only be presented if they are there to support the analysis (show cyclical trend, show trend being closely followed, show example of a type of trend that can be observed in several instrument. Table 6-10 describes how instrumentation graph should be reported when they are included in the report.

Instrumentation reports need to include the following information:

- Layout of each structure covered by the report showing all the instruments installed on the structure
- Table presenting all the instruments installed on each structure, their status and pertinent installation information
- Summary of the monitoring done on the structure for the period and if surveillance objective were met for the period.
- Indicator on the instrumentation system on the structure (how many instruments installed and how many are operational). The report must include a discussion on whether the coverage is sufficient or whether it is recommended to replace instruments to maintain coverage in some area.
- Analysis of each type of instruments trend (PZ, TH, inclinometer, water level, seepage) and how the data relate to the performance objective and indicator of the structure.
- Discussion on anomalous trends and their potential cause.
- Graph relevant to the analysis. The graph needs to be presented in a way that allows for data interpretation without referring to other documents. The Graph also need to follow guideline of Table 6-10. In general it is expected to present one graph per type of trend observed for operational instruments. Non-operational instrument graphs should not be presented.
- Actionable recommendation having priority, owner and due date
- The graph needs to present data for a minimum period of 1 year. Higher recurrence should be presented if clarity of the presented information allows it.

For the structures that have a yellow TARP level, the monitoring data relevant to the cause of the alert needs to be included. A summary of this monitoring data also needs to be included in the inspection report.

For the structures that have an orange TARP level, the monitoring data relevant to the alert level needs to be included with each inspection report. In addition, the weekly update report needs to be written with the following information:

- Context on why the structure is at the orange level
- Change in condition since the last weekly report
- Description of the mitigation plan and what actions have been taken since the last update report
- Discussion on the results of the instrumentation data

Table 6-10 : Data Presentation for Instrumentation Monitoring Report

Thermistor
• Temperature vs. depth plots over time presented as colour map should be the main way to present thermal data if the goal is to present general thermal trend • The plot needs to indicate relevant stratigraphy and their depth • In vertical displacement plot the thermistor string reference number and date of each measurements presented should be included. The number of reading presented need to be minimised so that it is easy to understand why this plot is presented. Otherwise use a colour map plot. This plot is best use when looking at sudden thermal change over a small period of time • Historical plot needs to be presented with a cross-section of the installation (if on a structure) as well as a plan view showing the instrument location. These plots are best use to present the potential seepage location and should be accompanied with the lake temperature data
Piezometer
• Plots of total head as elevation versus time. These plots are very scale sensitive and are generally not the best to show several instruments having different scale of reading • When presenting PZ reading to assess the effectiveness of a liner it is important to present the various PZ reading for a horizontal cross-section through the liner. • Plot needs to be presented with a cross-section of the installation showing lithology with depth as well as a plan view showing the instrument location • The plot needs to indicate the instrument number, the dates of each measurement and mention if the temperature read by the instrument is less than 0 degrees
Inclinometer
• Cumulative displacement plots (to view total displacement) • Incremental displacement plots (to present increasing or accelerating movements between readings) • Cumulative displacement at crest versus time • Time plots at zones of identified displacement • Both elevations and depths should be presented together with the lithology • A plan view needs to be included showing the instruments locations
Settlement Map

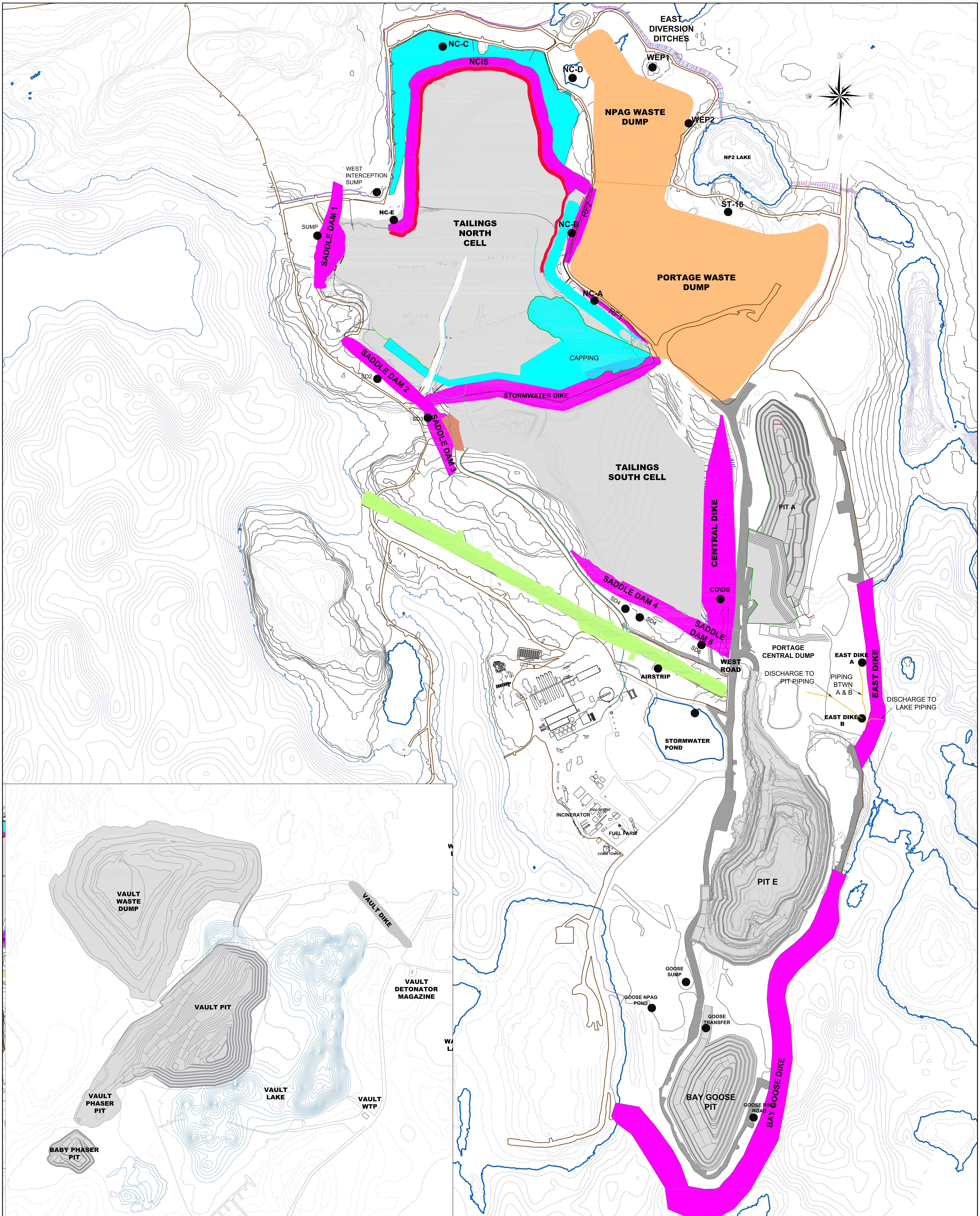
• It is recommended to provide plan view colour map of the settlement made using calibrated drone survey.
• If presenting settlement monument survey the following info must be included
  o Total net movement plots (to present total displacement)
  o Vertical displacement plots
  o Lateral displacement plots parallel and perpendicular to the dike axis
  o The plot needs to indicate the survey monument number, what is considered positive and negative displacement and the dates of each measurement
  o A plan view needs to be included showing the instruments locations

6.8 DATA MANAGEMENT

An electronic library or database, which is easily accessible, shall be set up to catalogue and store inspection documents, maintenance reports, and instrumentation measurements. The following will be stored in electronic format. Section 6.1 indicates where each of these items must be stored.

Appendix A

SITE LAYOUT



GENERAL NOTES

TITLE	# DWG	REV	DESCRIPTION	DATE	BY
REFERENCE DRAWINGS		REVISIONS			

AGNICO EAGLE MEADOWBANK

DRAWN BY: P.Gagnon — DATE: 01/06/2017
CHECKED BY:
APPROVED BY:
PROJECT NO.:
DATE:

TITLE: AGNICO–EAGLE – MEADOWBANK DIVISION

SITE MAP UPDATED Q4 2014

SCALE: N.T.S. — FILE: .DWG

DRAWING NO. — REVISION — SHEET 1 / 1

Appendix B

DESIGN CRITERIA AND ANNUAL PROBABILITY OF FAILURE

Table B-1 : Tailings Management Earthwork Design Criteria

Structures	Classification (CDA 2007/2013)	Side slope	Crest elevation (m)	Length (m)	Construction period
Saddle Dam 1	High	US 3H:1V DS 1.3H:1V	150	~ 400	2009 (El. 141 m) 2010 (El. 150 m)
Saddle Dam 2	High	US 3H:1V DS 1.5H:1V	150	~460	2011 (El.150 m)
Saddle Dam 3	High	US 3H:1V DS 1.5H:1V	150	~245	2015 (El.140 m) 2016 (El.143 m) 2017-2018 (El.145 m)
Saddle Dam 4	High	US 3H:1V DS 1.5H:1V	143	~365	2015 (El.140 m) 2016 (El.143 m) 2017 (El.145 m)
Saddle Dam 5	High	US 3H:1V DS 1.5H:1V	143	~255	2016 (El.143 m) 2017 (El.145 m)
RF1	-	US 1.5H:1V DS 1.5H:1V	150	~400	2009 2013 (Till Plug)
RF2	-	US 1.5H:1V US 1.5H:1V	150	~281	2009
Central Dike	High	US 2 H:1V El.130 US 3H:1V El. 130 DS 1.5H:1V	150	~900	2012 (El.110 m) 2013 (El. 115 m) 2014 (El.132 m) 2016 (El.143 m) 2017-2018(El.145 m)
Strormwater Dike	High	US 3H:1V DS 1.3H:1V	150	~1000	2009 (El.140 m) 2010 (El.148 m) 2013 (El.150 m)
North Cell Internal Structure	Significant	US 3H:1V DS 1.5H:1V	Variable El.152-154	~2160	2018 (Variable El.152-154)
South Cell Internal Structure (reclaim)	-	US 1.3H:1V DS 1.3H:1V	El 142.5	-	2017 (El. 137.2) 2019 (El. 142.5)

Table B-2: Design Factors of Safety for the TSF Dikes (extract from Golder, 2008)

TABLE 2.3: Factors of Safety for Slope Stability, Static Assessment (CDA 2007, Section 6.6, p. 70)

Loading Conditions	Minimum Factor-of-Safety	Slope
End of construction before reservoir filling	1.3	Downstream and Upstream
Long-term (steady-state seepage, normal reservoir level)	1.5	Downstream
Full or partial rapid drawdown	1.2 to 1.3	Upstream

TABLE 2.4: Factors of Safety for Slope Stability, Seismic Assessment (CDA 2007, Section 6.6, p. 70)

Loading Conditions	Minimum Factor-of-Safety
Pseudo-static	1.0
Post-earthquake	1.2-1.3

TABLE 5.6: Stability Analysis Results Summary – Central Dike

Phase	Crest Elevation (masl)	FoS for Drained Conditions static (pseudostatic)	
		Upstream Failure Mode	Downstream Failure Mode
Stage 1 Construction	135	2.1 (1.8)	2.1 (1.9)
Stage 1 Operation	135	>5	2.1 (1.9)
Stage 2 Operation	145	>5	2.0 (1.8)
Stage 3 Operation	150	>5	2.0 (1.8)
Post Closure	150	>5	1.9 (1.5)
Stage 3 Operation on steep downstream foundation slope	150	>5	1.7 (1.5)
Post Closure on steep downstream foundation slope	150	>5	1.7 (1.5)

Station 3+275 represents highest dike section with steep foundation (sloping down in upstream direction), Station 2+950 represents steep downstream foundation slope (sloping down in downstream direction).

TABLE 5.18: Stability Analysis Results Summary – Divider Dike

Crest El. (masl)	FoS for Drained Conditions	
	Upstream Failure Mode Static (pseudostatic)	Downstream Failure Mode static (pseudostatic)
140	2.5 (2.2)	2.2 (1.9)
150	>5	1.7 (1.6)

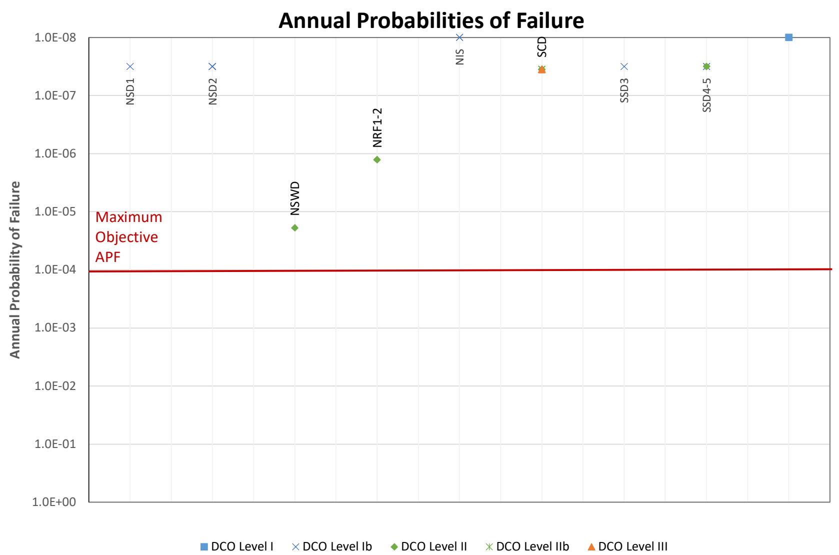
TABLE 5.20: Stability Analysis Results Summary – Saddle Dams

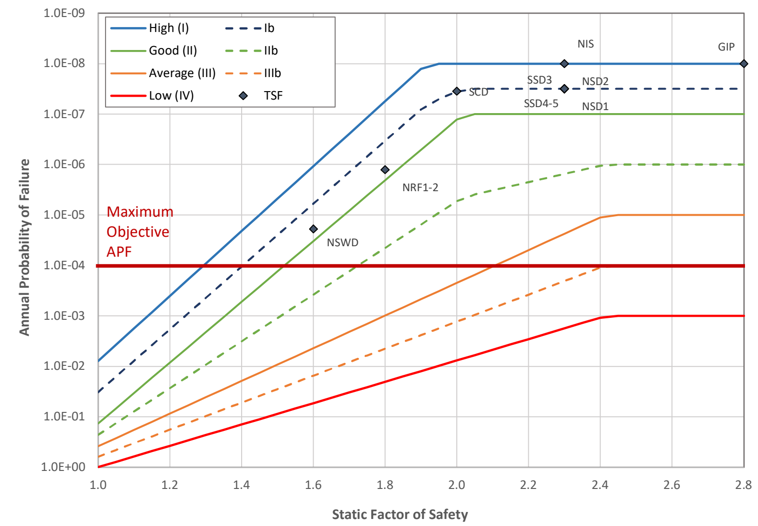
Phase	Crest El. (masl)	FoS for Drained Conditions static (pseudostatic)	
		Upstream Failure Mode	Downstream Failure Mode
Construction	141	2.4 (2.1)	3.1 (2.6)
Stage 1	141	>5	3.1 (2.6)
Stage 2	150	>5	2.3 (2.0)
Closure	--	>5	2.3 (2.0)

Meadowbank Comparisons on TSFs

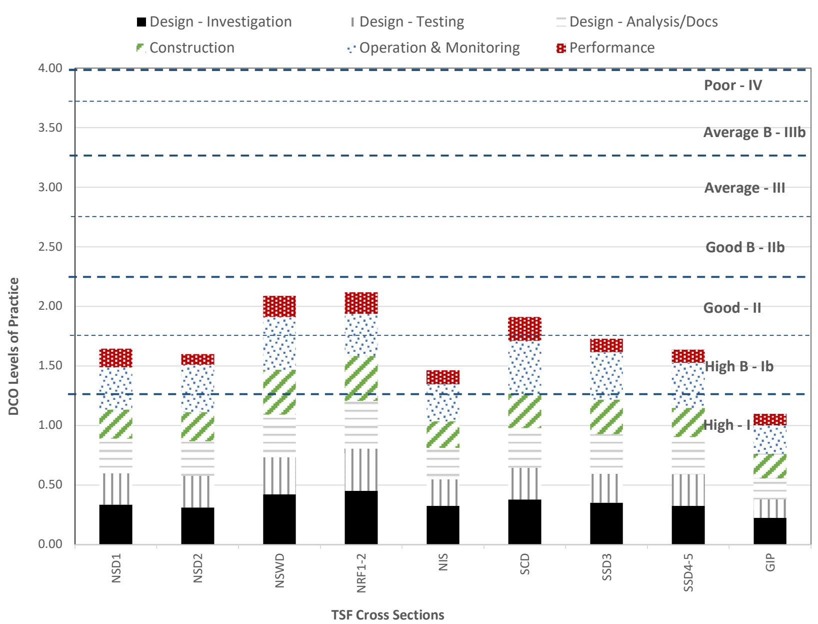
	North Cell TSF					South Cell TSF			Goose Pit
Infrastructures	**NSD1**	**NSD2**	**NSWD**	**NRF1-2**	**NIS**	**SCD**	**SSD3**	**SSD4-5**	**GIP**
FOS Static (Average conditions)	2.30	2.30	1.60	1.80	2.30	2.00	2.30	2.30	2.80
Design - Investigation	0.33	0.31	0.42	0.45	0.33	0.38	0.35	0.33	0.23
Design - Testing	0.27	0.27	0.31	0.36	0.22	0.27	0.24	0.27	0.16
Design - Analysis/Docs	0.29	0.29	0.36	0.40	0.27	0.33	0.33	0.31	0.18
Construction	0.24	0.24	0.38	0.38	0.22	0.29	0.29	0.24	0.20
Operation & Monitoring	0.36	0.40	0.44	0.36	0.31	0.44	0.40	0.38	0.25
Performance	0.16	0.09	0.18	0.18	0.11	0.20	0.11	0.11	0.09
DCO Level	**1.64**	**1.60**	**2.09**	**2.12**	**1.46**	**1.91**	**1.73**	**1.64**	**1.09**
PoF	**3.16E-08**	**3.16E-08**	**1.90E-05**	**1.27E-06**	**1.00E-08**	**3.55E-08**	**3.16E-08**	**3.16E-08**	**1.00E-08**
Low PoF	3.16E-08	3.16E-08	1.40E-05	7.71E-07	1.00E-08	3.05E-08	3.16E-08	3.16E-08	1.00E-08
High PoF	3.16E-08	3.16E-08	2.40E-05	1.77E-06	1.00E-08	4.05E-08	3.16E-08	3.16E-08	1.00E-08
Health & Safety Consequence Rating	4	4	3	4	3	4	4	4	4
Material Damage Consequence Rating	4	4	3	2	4	4	4	4	4
Environment Consequence Rating	4	4	2	4	4	4	5	4	4
Community Consequence Rating	4	4	3	4	3	4	4	4	4
Consequence Rating	**4**	**4**	**3**	**4**	**4**	**4**	**5**	**4**	**4**

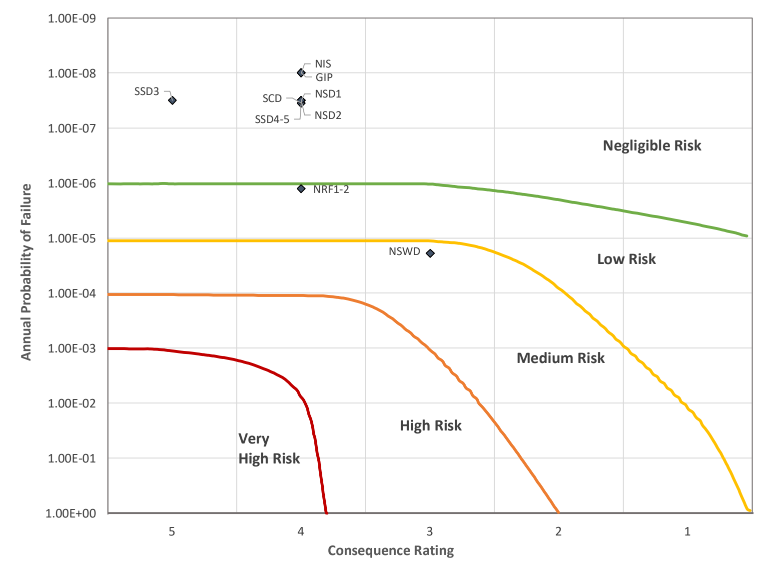
Items 1 and 2	Items 1 and 2	Item 9	Item 10		Item 1	Item 3	Item 4	Item 5		Item 7	Item 8	Item 11		Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20
Mine Site	**Facility Names**	**Current tailings volume (m^3)**	**Tailings volume (m^3) in 5 years (2023)**	**Type of tailings**	**Infrastructure identifier**	**Ownership**	**Status**	**Year(s) of construction**	**Type of Construction**	**Type of Raise Construction (if applicable)**	**Current Max Dam/Dyke Height (m)**	**External Review Process in place (see note 1)**	**Engineer of Record (see note 2)**	**Latest External Inspection (See note 3)**	**Relevant engineering records (see note 4)**	**Potential consequence level after a failure (see note 5)**	**Guidelines used (see note 6)**	**Have remedial actions been carried out over time (see note 7)**	**Internal and external engineering support (see note 8)**	**Formal analysis of the downstream impacts (see note 9)**	**Closure plan and long term monitoring (see note 10)**	**Impact of climate change considered (see note 11)**	**Additional notes**
Meadowbank NU, Canada 65°01'25''N 96°04'28''W (Meadowbank manages the taillings from Amaruq)	**South Cell TSF - Max Capacity = 16.3 Mm^3**	10,420,000	10,800,000	Slurry	Saddle Dam 1	Owned and operated by AEM	Active	2009/2010	Tailings retaining infrastructure: Rockfill shell with liner tie-in key trench with transition	Downstream Raise	15.0	Yes	Yes	2018 (Golder)	Yes	Moderate to high	CDA	Yes	Both	On-going	Yes	Yes - being considered	
					Saddle Dam 2	Owned and operated by AEM	Active	2010/	Tailings retaining infrastructure: Rockfill shell with liner tie-in key trench with transition	Downstream Raise	10.0	Yes	Yes	2018 (Golder)	Yes	Moderate to high	CDA	No	Both	On-going	Yes	Yes - being considered	
					Stormwater Dyke	Owned and operated by AEM	Active	2010	Tailings retaining infrastructure: Rockfill shell with liner tie-in key trench with transition	Downstream Raise	31.0	Yes	Yes	2018 (Golder)	Yes	Moderate to high	CDA	Yes	Both	On-going	Yes	Yes - being considered	
					RF1	Owned and operated by AEM	Active	2010	Tailings retaining infrastructure: Rockfill embankment with transition	Not raised	12.0	Yes	Yes	2018 (Golder)	Yes	Moderate to high	CDA	No	Both	On-going	Yes	Yes - being considered	
					RF2	Owned and operated by AEM	Active	2010	Tailings retaining infrastructure: Rockfill embankment with transition	Not raised	9.0	Yes	Yes	2018 (Golder)	Yes	Moderate to high	CDA	No	Both	On-going	Yes	Yes - being considered	
	North Cell TSF - Max Capacity = 14.4 Mm^3	14,400,000	14,400,000	Slurry	Saddle Dam 3	Owned and operated by AEM	Active	2016/2017	Tailings retaining infrastructure: Rockfill shell with liner tie-in key trench with transition	Downstream Raise	10.0	Yes	Yes	2018 (Golder)	Yes	Moderate to high	CDA	No	Both	On-going	Yes	Yes - being considered	
					Saddle Dam 4	Owned and operated by AEM	Active	2016/2017	Tailings retaining infrastructure: Rockfill shell with liner tie-in key trench with transition	Downstream Raise	8.0	Yes	Yes	2018 (Golder)	Yes	Moderate to high	CDA	No	Both	On-going	Yes	Yes - being considered	
					Saddle Dam 5	Owned and operated by AEM	Active	2016/2017	Tailings retaining infrastructure: Rockfill shell with liner tie-in key trench with transition	Downstream Raise	10.0	Yes	Yes	2018 (Golder)	Yes	Moderate to high	CDA	No	Both	On-going	Yes	Yes - being considered	
					Central Dyke	Owned and operated by AEM	Active	2012/2013/2014/2015/2016/2017/2018	Tailings retaining infrastructure: Rockfill shell with liner tie-in key trench with transition	Downstream Raise	49.0	Yes	Yes	2018 (Golder)	Yes	Moderate to high	CDA	Yes	Both	On-going	Yes	Yes - being considered	
					North Cell Internal Structure	Owned and operated by AEM	Active	2018	Tailings retaining infrastructure: Rockfill embankment with transition	Upstream raise	4.0	Yes	Yes	2018 (Golder)	Yes	Moderate to high	CDA	No	Both	On-going	Yes	Yes - being considered	
	Tailings in pit disposal	0	12,500,000	Slurry	Goose and Portage Pit	Owned and operated by AEM	Active	2009 to 2019	Tailings deposited in an open pit	N/A	N/A	Yes	Yes	N/A	Yes	Low to moderate	N/A	No	Both	On-going	Yes	Yes - being considered	
	Dewatering dike	N/A	N/A	N/A	East Dyke	Owned and operated by AEM	Active	2008/2009	Water retaining infrastructure: Rockfill shell with SB and CSB Cut-off wall and transition	Not raised	10.0	Yes	Yes	2018 (Golder)	Yes	Moderate to high	CDA	Yes	Both	On-going	Yes	N/A	
	Dewatering dike				Bay Goose Dyke	Owned and operated by AEM	Active	2009/2010/2011	Water retaining infrastructure: Rockfill shell with SB and CSB Cut-off wall and transition	Not raised	15.0	Yes	Yes	2018 (Golder)	Yes	Moderate to high	CDA	No	Both	On-going	Yes	N/A	
	Dewatering dike				Vault Dyke	Owned and operated by AEM	Active	2013	Water retaining infrastructure: Rockfill shell with liner tie-in key trench with transition	Not raised	3.0	Yes	Yes	2018 (Golder)	Yes	Moderate to high	CDA	No	Both	On-going	Yes	N/A	
	Dewatering dike				South Camp Dyke	Owned and operated by AEM	Active	2009	Water retaining infrastructure: Rockfill shell with liner tie-in key trench with transition	Not raised	3.0	Yes	Yes	2018 (Golder)	Yes	Moderate to high	CDA	No	Both	On-going	Yes	N/A	





	NSD1	NSD2	NSWD	NRF1-2	NIS	SCD	SSD3	SSD4-5	GIP			
Level I	1.64	1.60	2.09	2.12	1.46	1.91	1.73	1.64	1.09			
PoF									1.00E-08			
Level Ib	1.64	1.60	2.09	2.12	1.46	1.91	1.73	1.64	1.09			
PoF	3.16E-08	3.16E-08			1.00E-08		3.16E-08	3.16E-08				
Level II	1.64	1.60	2.09	2.12	1.46	1.91	1.73	1.64	1.09			
PoF			1.90E-05	1.27E-06		3.55E-08						
Level IIb	1.64	1.60	2.09	2.12	1.46	1.91	1.73	1.64	1.09			
PoF												
Level III	1.64	1.60	2.09	2.12	1.46	1.91	1.73	1.64	1.09			
PoF												

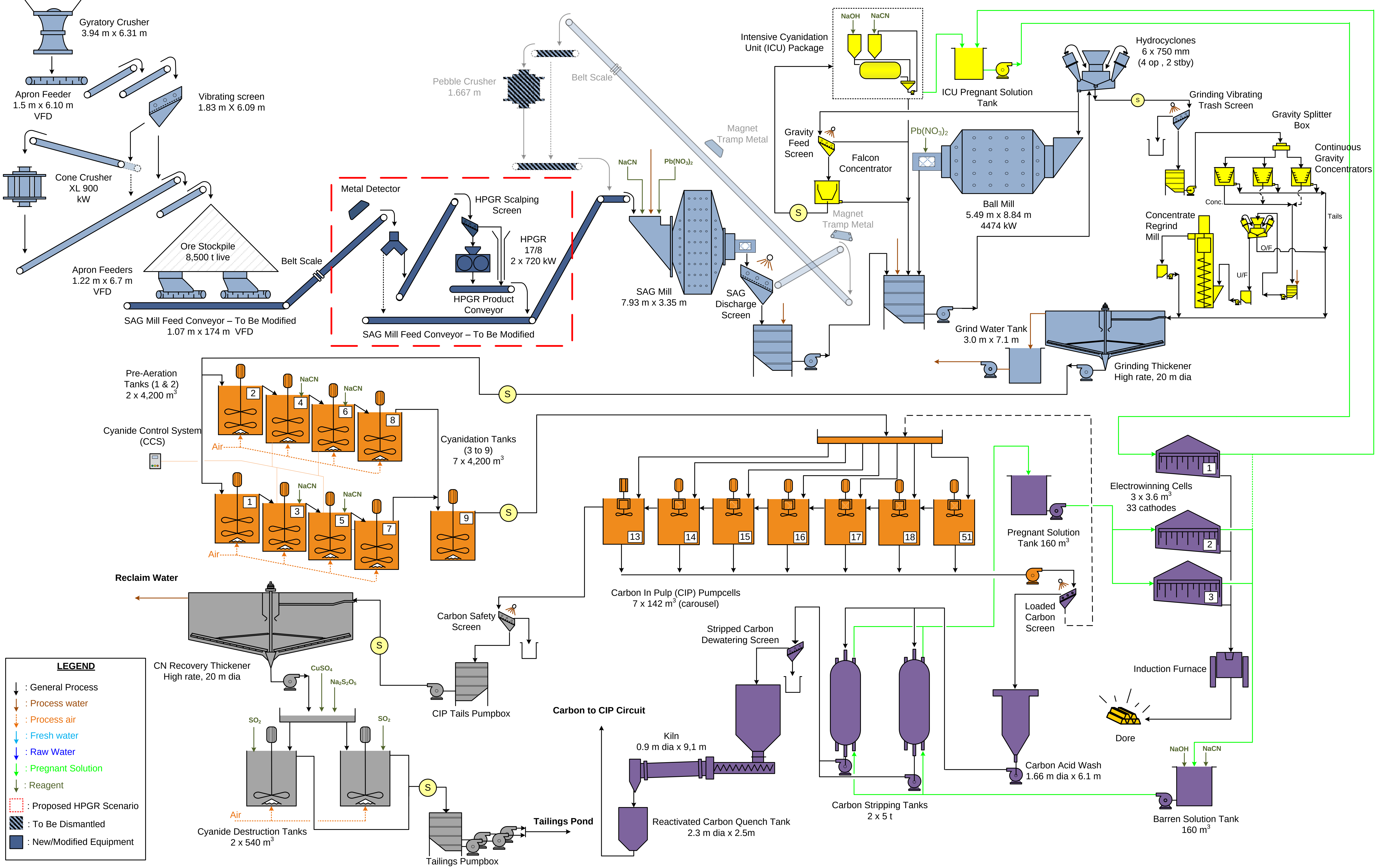




Appendix C

WATER AND TAILINGS MANAGMEENT FLOWCHARTS AND OPERATIONAL GUIDELINES

AGNICO EAGLE MINES LTD - MEADOWBANK MILLING FLOWSHEET – HPGR PROPOSED SCENARIO



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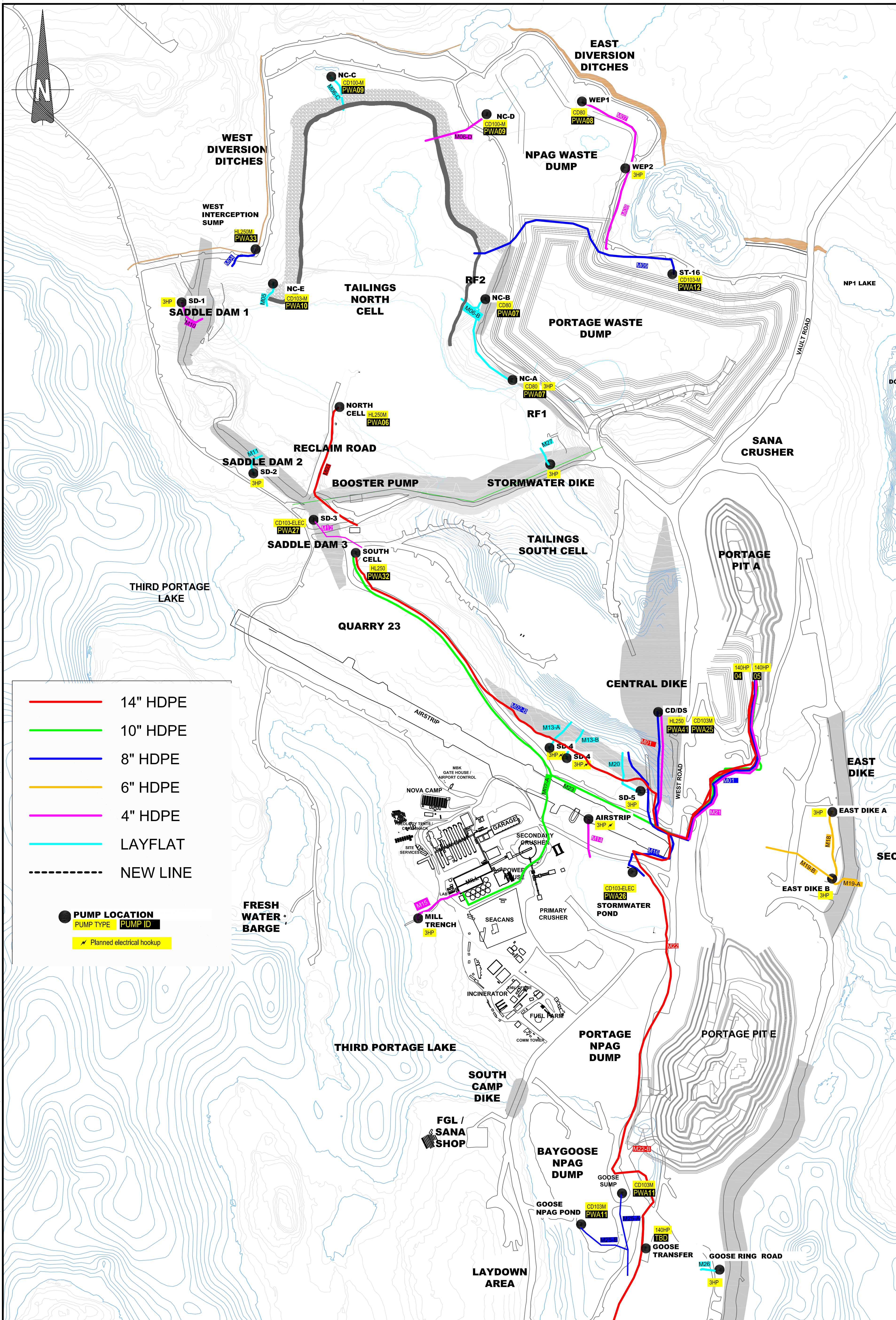

TECHNICAL SPECIFICATION

None

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MEADOWBANK

DRAWN BY	DATE	MODIFIED BY	DATE
SURVEY CHECK	DATE		
GEOLOGY CHECK	DATE		
ENGINEERING CHECK	DATE		

MEADOWBANK DIVISION

ENGINEERING - GEOTECH

MBK DEWATERING MAPS

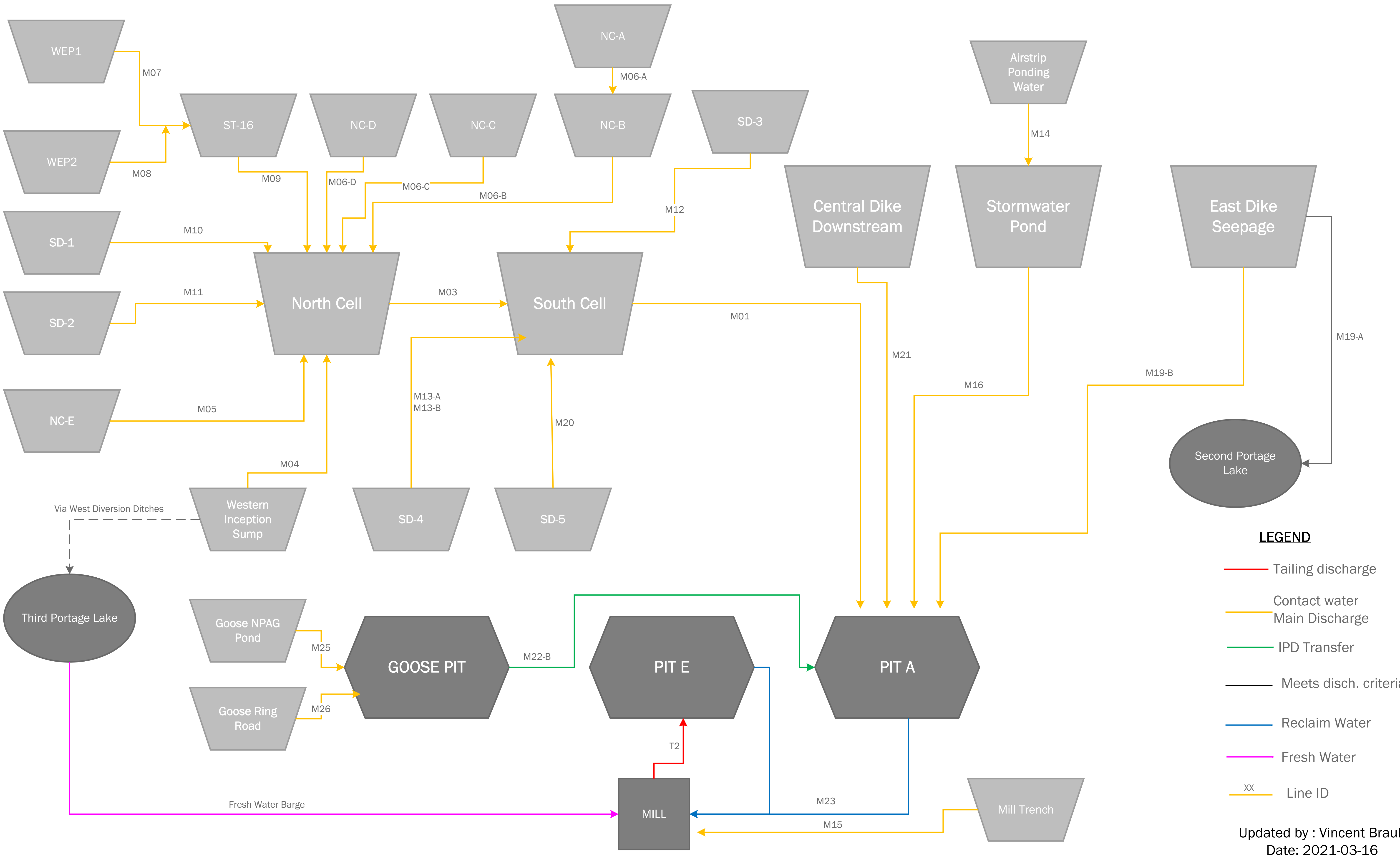
FRESHET 2021

Revision1

SCALE	DATE	FILE
1:12500		.DWG

P:\Engineering\05-Geotechnic\05-WaterManagement\2021\03 – Freshet\1- Technical\Freshet 2021 Meadowbank_R0.dwg, 25 Apr 2021

Meadowbank 2021 Detailed Freshet Flowsheet



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MEADOWBANK DIVISION

ENGINEERING - GEOTECH

Water And Tailings Management

Tailings lines & Dep. points

SCALE	DATE	FILE
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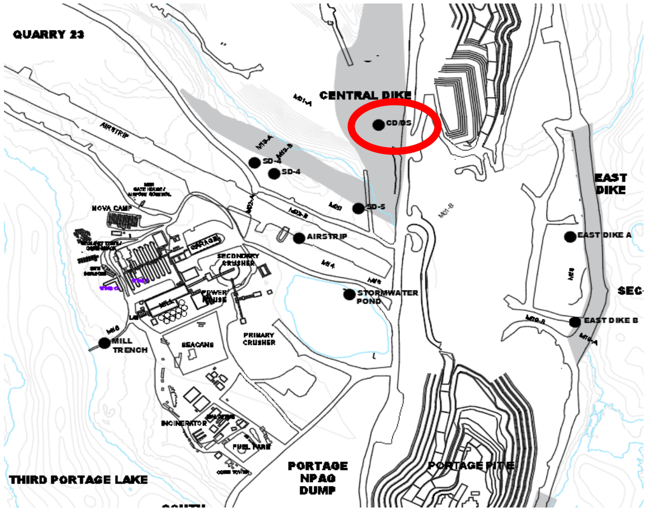
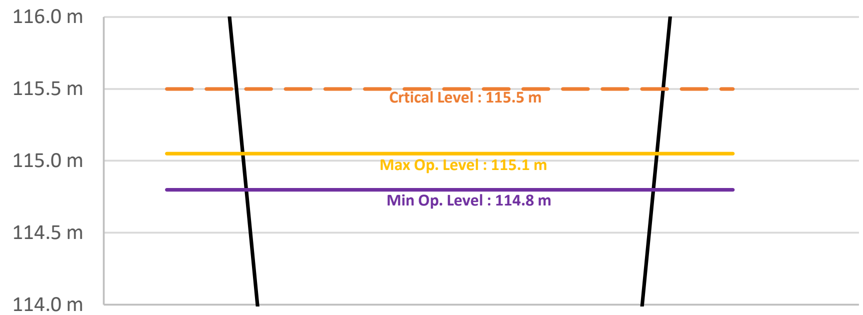
Central Dike D/S Pond - Operational Guidelines





Critical Level :	115.5m
Max Op. Level :	115.1m
Min Op. Level :	114.8m
Approx Bottom :	107.0m

Response

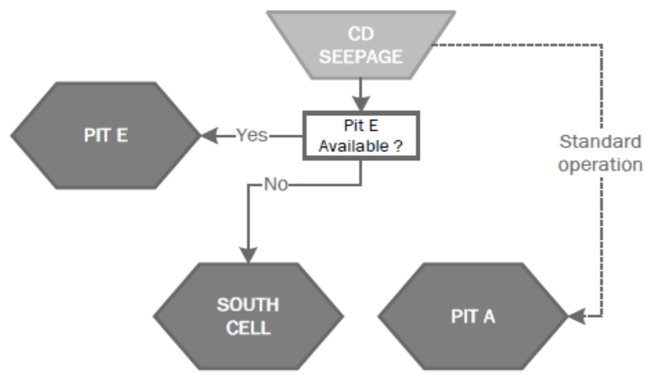
Within Op. Level (114.8m to 115.1m) : Resume or maintain standard operations.

Above Max Op. Level (115.1m to 115.2m) : Lower water level to operational level within 3 days. Increase pumping using current infrastucture or implement mitigation plan. Inform stakeholder as per communication chart. Engineering, E&I and Env to develop path forward with Water & Tailings Superintendent.

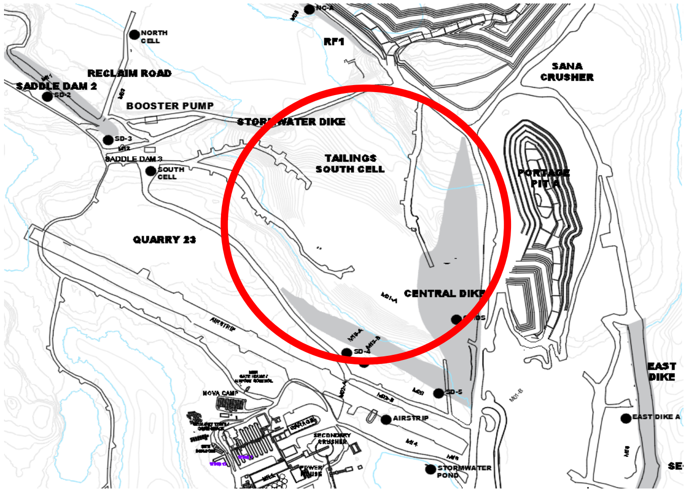
Above Critical Level (>115.5m) : Risk of flooding of the pump pad. Immediately lower water to operational levels. Inform stakeholder as per communication chart. Water & Tailings Superintendent to develop action plan.

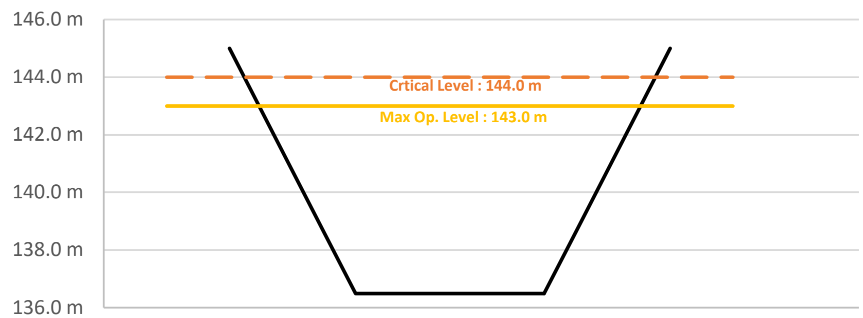
Base of West Road (116 m) : Flooding of pump pad and potential for West Road instability and uncontrolled flow into Portage Pit A. Deploy measure to ensure infrastructure integrity.

Flowchart



South Cell - Operational Guidelines





Critical Level : **144.0m**
Max Op. Level : **143.0m**

Approx Bottom : **136.5m**

Response

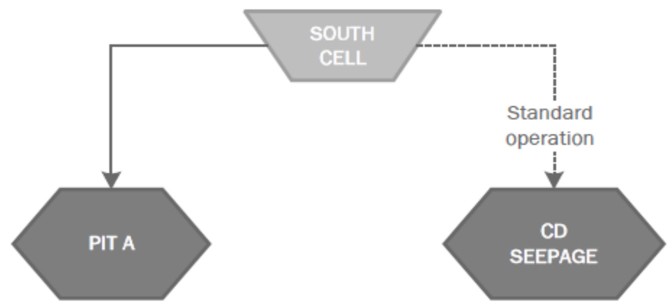
Within Op. Level (up to 143m) : Resume or maintain standard operations.

Above Max Op. Level (143m to 144m) : Lower water level to operational level within 30 days. Increase pumping using current infrastucture or reduce inflows or implement mitigation plan. Inform stakeholder as per communication chart. Engineering, E&I and Env to develop path forward with Water & Tailings Superintendent.

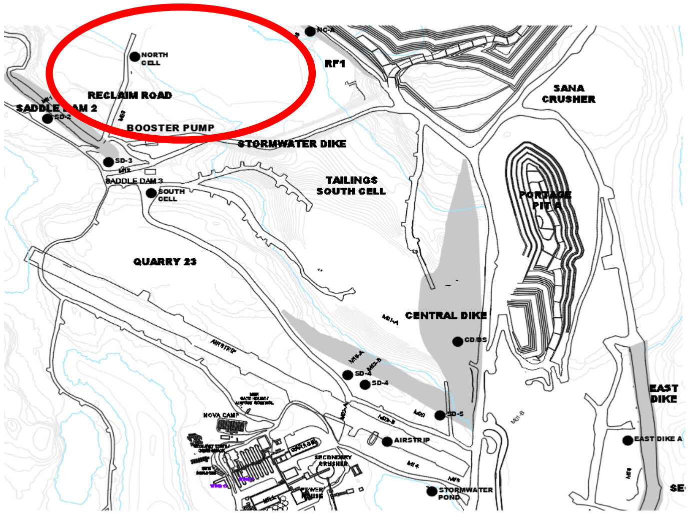
Above Critical Level (>144m) : Non-respect of freeboard with potential for structure overtopping and spill. Immediately lower water to operational levels. Inform stakeholder as per communication chart. Water & Tailings Superintendent to develop action plan.

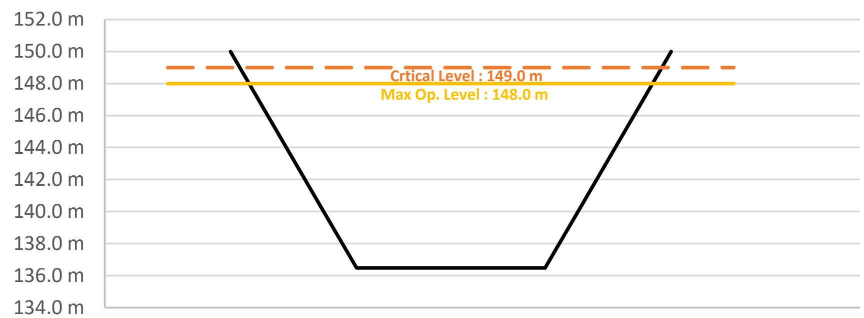
South Cell Dike Liner Elevation (145 m) : Dike crest overtopping, spill into site. Deploy mesure to contain spill, ensure structure integrity and ensure worker safety.

Flowchart



North Cell - Operational Guidelines





Critical Level : 149.0m
Max Op. Level : 148.0m

Approx Bottom : 136.5m

Response

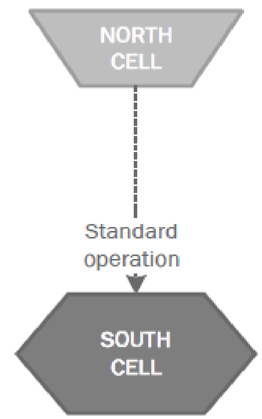
Within Op. Level (up to 148m) : Resume or maintain standard operations.

Above Max Op. Level (148m to 149m) : Lower water level to operational level within 30 days. Increase pumping using current infrastucture or reduce inflows or implement mitigation plan. Inform stakeholder as per communication chart. Engineering, E&I and Env to develop path forward with Water & Tailings Superintendent.

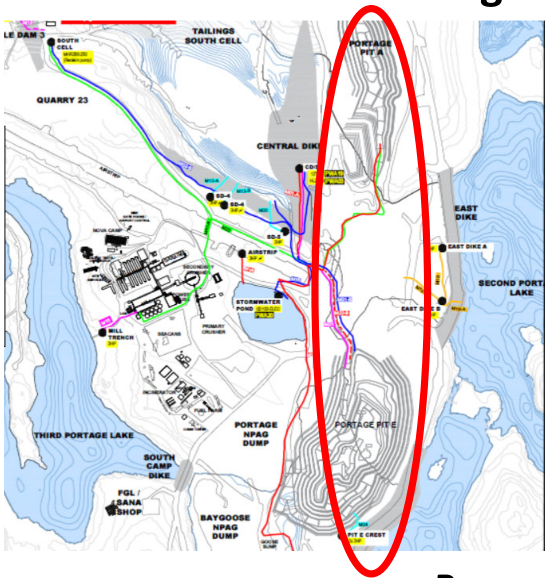
Above Critical Level (>149m) : Non-respect of freeboard with potential for structure overtopping and spill. Immediately lower water to operational levels. Inform stakeholder as per communication chart. Water & Tailings Superintendent to develop action plan.

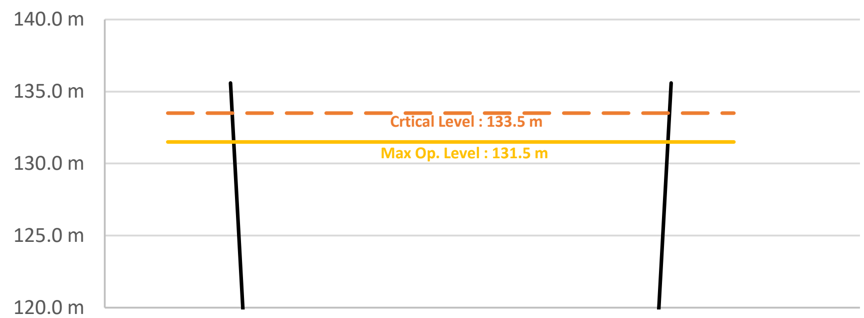
North Cell Dike Liner Elevation (150 m) : Dike crest overtopping, spill into Env and South Cell. Deploy mesure to contain spill, ensure structure integrity and ensure worker safety.

Flowchart



In-Pit Tailings Deposition - Operational Guidelines





Critical Level : 133.5m

Max Op. Level : 131.5m

Approx Bottom : -24.0m

Response

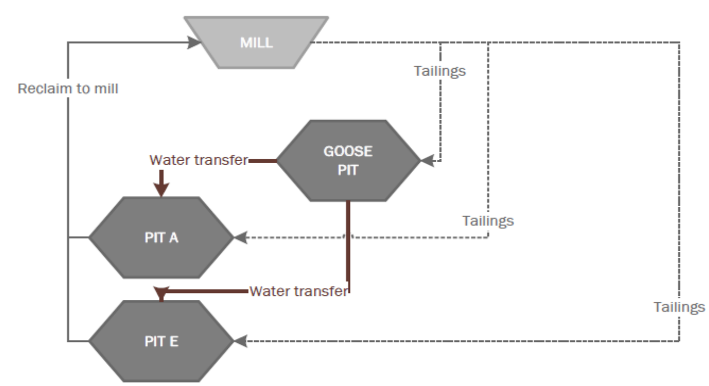
Within Op. Level (up to 131.5m) : Resume or maintain standard operations. West Road needs to be raised to maintain a 4 m freeboard. Lowest point is at El. 126.4 m (needs to be raised prior to El. 122.4 m). Pit A & E connect at El. 87 m. Portage & Goose Pit connect at El. 131 m. Need to raise other accesses prior to reaching El. 131 m. Need to re-assess CD D/S prior to El. 116 m.

Above Max Op. Level (131.5 to 133.2 m) : Lower water level to operational level within 30 days. Increase pumping using current infrastucture or modify deposition strategy. Inform stakeholder as per communication chart. Engineering, E&I and Env to develop path forward with Water & Tailings Superintendent.

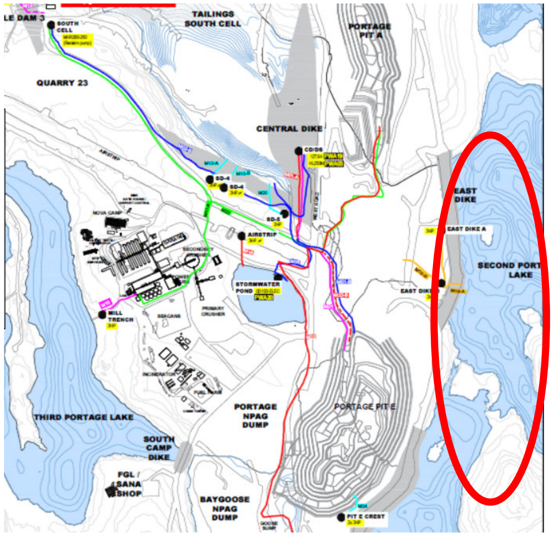
Above Critical Level (>133.5m) : Water ponding at downstream side of East Dike. Immediately lower water to operational levels. Inform stakeholder as per communication chart. Water & Tailings Superintendent to develop action plan.

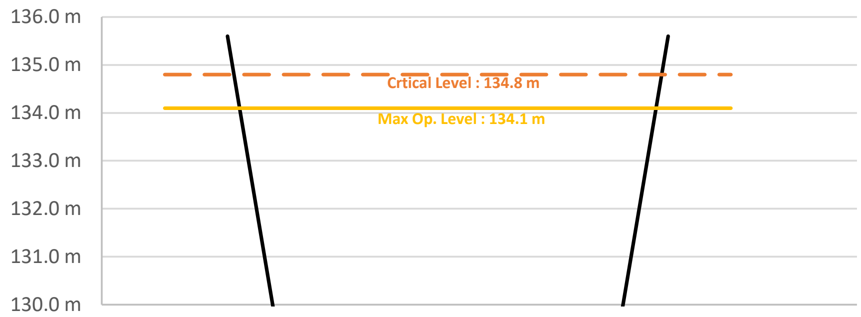
East Dike Core (135.6 m) : Overtopping of dike core. Release of contaminant out of the site. Deploy measure to ensure structure integrity and protect Environment

Flowchart



Second Portage Lake - Operational Guidelines





Critical Level : **134.8m**
Max Op. Level : **134.1m**

Approx Bottom : **120.0m**

Response

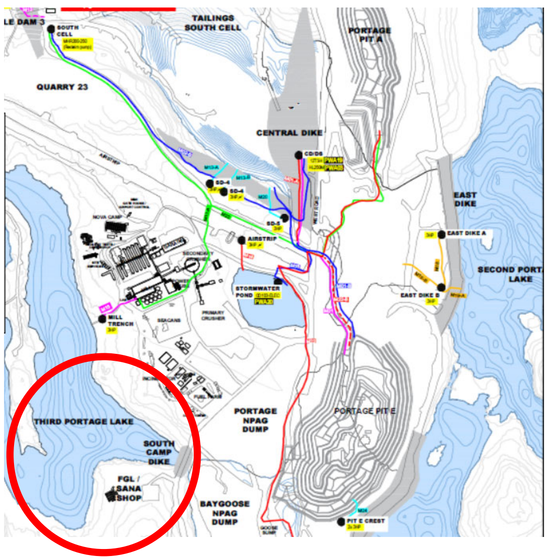
Within Op. Level (up to 134.1m) : Resume or maintain standard operations.

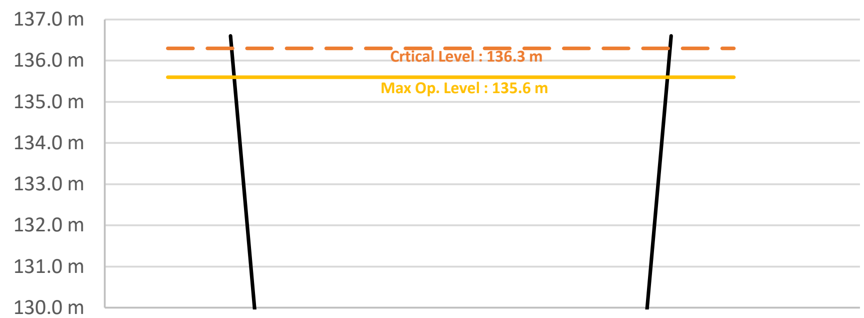
Above Max Op. Level (134.1 to 134.8 m) : Investigate cause. Inform stakeholder as per communication chart. Engineering, E&I and Env to develop path forward with Water & Tailings Superintendent.

Above Critical Level (>134.8m) : Increase risk of East Dike overtopping. Immediately take action to stop increase. Inform stakeholder as per communication chart. Water & Tailings Superintendent to develop action plan.

East Dike Core (135.6 m) : Overtopping of East Dike core. Uncontrolled inflow into site. Deploy measure to ensure structure integrity and protect worker

Third Portage Lake - Operational Guidelines





Critical Level : 136.3m
Max Op. Level : 135.6m

Approx Bottom : 102.0m

Response

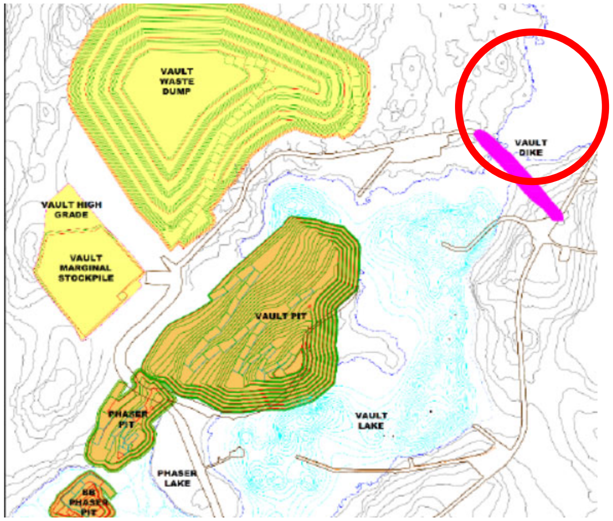
Within Op. Level (up to 135.6m) : Resume or maintain standard operations.

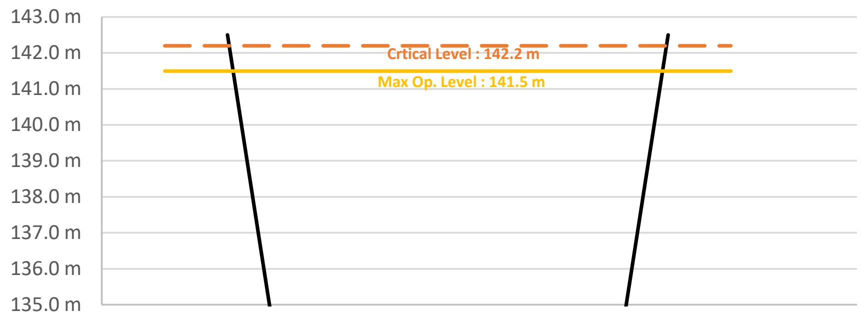
Above Max Op. Level (135.6 to 136.3 m) : Investigate cause. Inform stakeholder as per communication chart. Liner installed at El.136.1 m. Engineering, E&I and Env to develop path forward with Water & Tailings Superintendent.

Above Critical Level (>136.3m) : Increased risk of South Camp Dike overtopping and thawing of thermal cap. Immediately take action to stop increase. Inform stakeholder as per communication chart. Water & Tailings Superintendent to develop action plan.

South Camp Dike Thermal Cap (136.6 m) : Overtopping of thermal cap of South Camp Dike. Uncontrolled inflow into site. Deploy measures to ensure structure integrity and protect workers.

Wally Lake - Operational Guidelines





Critical Level : **142.2m**
Max Op. Level : **141.5m**

Approx Bottom : **120.0m**

Response

Within Op. Level (up to 141.5m) : Resume or maintain standard operations. Liner installed up to El. 141 m.

Above Max Op. Level (141.5 to 142.2 m) : Investigate cause. Inform stakeholder as per communication chart. Liner installed at El.136.1 m. Engineering, E&I and Env to develop path forward with Water & Tailings Superintendent.

Above Critical Level (>142.2m) : Increased risk of Vault Dike overtopping and thawing of thermal cap. Immediately take action to stop increase. Inform stakeholder as per communication chart. Water & Tailings Superintendent to develop action plan.

Vault Dike Thermal Cap (142.5 m) : Overtopping of thermal cap of Vault Dike. Uncontrolled inflow into site. Deploy measures to ensure structure integrity.

Appendix D

INSPECTION FORMS

DIKE VISUAL INSPECTION REPORT

AGNICO EAGLE
MEADOWBANK

The instrumentation data is treated separately in the monthly instrumentation report

Inspecting Officer	Choose an item.
Report No.	DIKE-VIR-#
Inspection Date	

Dike name	

Last Inspection Date											
Weather during the current inspection		Sunny	☐	Overcast	☐	Rain	☐	Snow	☐	Wind	☐
	Comments:										
Main changes since the last inspection											

Water level – Upstream (Date and time)	
Water level – Downstream (Date and time)	
Water Level Prior to Dewatering (Year)	

Tarp level (Based Whale Tail Water Management Infrastructure OMS V2, June 2020)	

General Condition Summary

➢

Inspection Officer:		Inspection Date:	
Reviewing Officer:		Review Date:	

Field Observations

LOCATION	OBSERVATIONS	RECOMMENDATIONS
Downstream slope and berm		
Upstream slope and berm		
Crest and Top platform		

Seepage Report

LOCATION	OBSERVATIONS	RECOMMENDATIONS

AGNICO EAGLE
MEADOWBANK

Observations Related to Water Levels

LOCATION	OBSERVATIONS	RECOMMENDATIONS

Methodology:

For the visual inspection, any anomaly or change since the last inspection must be reported. These anomalies include cracks, erosion, settlements, sink holes, bulging, sloughing, seepage signs, snow/ice, rutting, mud, ponds/puddles, and signs of saturated soil.

***Aerial view of Dike** (Month and Year)*

DIKE VISUAL INSPECTION REPORT

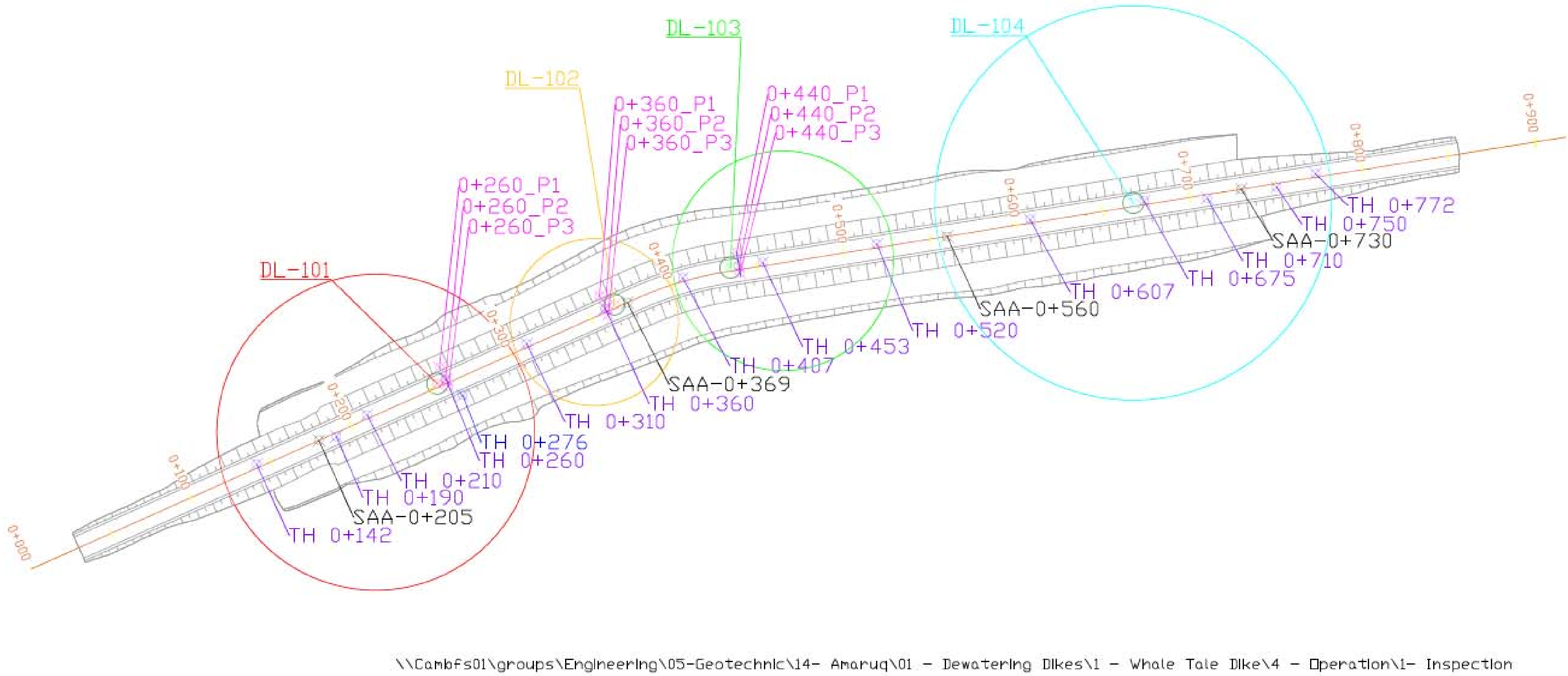


Figure 1 – Dike instruments overview

DIKE VISUAL INSPECTION REPORT

AGNICO EAGLE
MEADOWBANK

Downstream slope and berm

DS1:	Location and orientation of DS1.
DS2:	Location and orientation of DS2.

Upstream slope and berm

US1:	Location and orientation of **US1.**
US2:	Location and orientation of **US2.**

Seepage area

S1:	Location and orientation of S1.
S2:	Location and orientation of S1.

DITCH & CHANNEL INSPECTION FORM

Inspection by:	
DATE:	

CHANNEL/DITCH:

Changing Conditions	Water	Water level	❑ TSS: □ Low □ High
❑ Erosion	❑ Flow	❑ Minimal	Pumping infra
❑ Sliding	❑ Dry	❑ Normal	❑ Pumping required
❑ Obstruction/Debris	❑ Snow	❑ High	❑ Installed
❑ Settlement	❑ Runoff	❑ Critical	❑ Active pumping
❑ Tension cracks	❑ Ponding	❑ Over topping	
	❑ Seepage		

Recommendation

❑ Regular inspection & monitoring
❑ Further investigations
❑ Short term action
❑ Immediate action*

Comments:

CHANNEL/DITCH:

Changing Conditions	Water	Water level	❑ TSS: □ Low □ High
❑ Erosion	❑ Flow	❑ Minimal	Pumping infra
❑ Sliding	❑ Dry	❑ Normal	❑ Pumping required
❑ Obstruction/Debris	❑ Snow	❑ High	❑ Installed
❑ Settlement	❑ Runoff	❑ Critical	❑ Active pumping
❑ Tension cracks	❑ Ponding	❑ Over topping	
	❑ Seepage		

Recommendation

❑ Regular inspection & monitoring
❑ Further investigations
❑ Short term action
❑ Immediate action*

Comments:

CHANNEL/DITCH:

Changing Conditions	Water	Water level	❑ TSS: □ Low □ High
❑ Erosion	❑ Flow	❑ Minimal	Pumping infra
❑ Sliding	❑ Dry	❑ Normal	❑ Pumping required
❑ Obstruction/Debris	❑ Snow	❑ High	❑ Installed
❑ Settlement	❑ Runoff	❑ Critical	❑ Active pumping
❑ Tension cracks	❑ Ponding	❑ Over topping	
	❑ Seepage		

Recommendation

❑ Regular inspection & monitoring
❑ Further investigations
❑ Short term action
❑ Immediate action*

Comments:

CHANNEL/DITCH:

Changing Conditions	Water	Water level	❑ TSS: □ Low □ High
❑ Erosion	❑ Flow	❑ Minimal	Pumping infra
❑ Sliding	❑ Dry	❑ Normal	❑ Pumping required
❑ Obstruction/Debris	❑ Snow	❑ High	❑ Installed
❑ Settlement	❑ Runoff	❑ Critical	❑ Active pumping
❑ Tension cracks	❑ Ponding	❑ Over topping	
	❑ Seepage		

Recommendation

❑ Regular inspection & monitoring
❑ Further investigations
❑ Short term action
❑ Immediate action*

Comments:

*Immediate action: Communicate information to Geotech Coordinator

Attach photos of any relevant observation withis form

INTEGRATED DIKE INSPECTION FORM

Inspection by:

DATE:

DIKE:

UPSTREAM				CREST		DOWNSTREAM				Recommendation
Changing Conditions	Water	Water level	☐ TSS: ☐ Low ☐ High	Changing Conditions	Water	Changing Conditions	Water	Water level	☐ TSS: ☐ Low ☐ High	☐ Regular inspection & monitoring
☐ Erosion	☐ Dry	☐ Minimal	Pumping infra	☐ Erosion	☐ Dry	☐ Erosion	☐ Dry	☐ Minimal	Pumping infra	☐ Further investigations
☐ Sliding	☐ Snow	☐ Normal	☐ Pumping required	☐ Settlement	☐ Snow	☐ Sliding	☐ Snow	☐ Low	☐ Pumping required	☐ Short term action
☐ Sloughing	☐ Runoff	☐ High	☐ Installed	☐ Tension cracks	☐ Runoff	☐ Piping	☐ Runoff	☐ High	☐ Installed	☐ Immediate action*
	☐ Ponding	☐ Critical	☐ Active pumping	☐ Sloughing	☐ Ponding	☐ Sloughing	☐ Ponding	☐ Critical	☐ Active pumping	Comments:
	☐ Lake	☐ Over topping		☐ Sinkhole	☐ Puddles	☐ Obstruction/Debris	☐ Seepage	☐ Over topping		

DIKE:

UPSTREAM				CREST		DOWNSTREAM				Recommendation
Changing Conditions	Water	Water level	☐ TSS: ☐ Low ☐ High	Changing Conditions	Water	Changing Conditions	Water	Water level	☐ TSS: ☐ Low ☐ High	☐ Regular inspection & monitoring
☐ Erosion	☐ Dry	☐ Minimal	Pumping infra	☐ Erosion	☐ Dry	☐ Erosion	☐ Dry	☐ Minimal	Pumping infra	☐ Further investigations
☐ Sliding	☐ Snow	☐ Normal	☐ Pumping required	☐ Settlement	☐ Snow	☐ Sliding	☐ Snow	☐ Low	☐ Pumping required	☐ Short term action
☐ Sloughing	☐ Runoff	☐ High	☐ Installed	☐ Tension cracks	☐ Runoff	☐ Piping	☐ Runoff	☐ High	☐ Installed	☐ Immediate action*
	☐ Ponding	☐ Critical	☐ Active pumping	☐ Sloughing	☐ Ponding	☐ Sloughing	☐ Ponding	☐ Critical	☐ Active pumping	Comments:
	☐ Lake	☐ Over topping		☐ Sinkhole	☐ Puddles	☐ Obstruction/Debris	☐ Seepage	☐ Over topping		

DIKE:

UPSTREAM				CREST		DOWNSTREAM				Recommendation
Changing Conditions	Water	Water level	☐ TSS: ☐ Low ☐ High	Changing Conditions	Water	Changing Conditions	Water	Water level	☐ TSS: ☐ Low ☐ High	☐ Regular inspection & monitoring
☐ Erosion	☐ Dry	☐ Minimal	Pumping infra	☐ Erosion	☐ Dry	☐ Erosion	☐ Dry	☐ Minimal	Pumping infra	☐ Further investigations
☐ Sliding	☐ Snow	☐ Normal	☐ Pumping required	☐ Settlement	☐ Snow	☐ Sliding	☐ Snow	☐ Low	☐ Pumping required	☐ Short term action
☐ Sloughing	☐ Runoff	☐ High	☐ Installed	☐ Tension cracks	☐ Runoff	☐ Piping	☐ Runoff	☐ High	☐ Installed	☐ Immediate action*
	☐ Ponding	☐ Critical	☐ Active pumping	☐ Sloughing	☐ Ponding	☐ Sloughing	☐ Ponding	☐ Critical	☐ Active pumping	Comments:
	☐ Lake	☐ Over topping		☐ Sinkhole	☐ Puddles	☐ Obstruction/Debris	☐ Seepage	☐ Over topping		

DIKE:

UPSTREAM				CREST		DOWNSTREAM				Recommendation
Changing Conditions	Water	Water level	☐ TSS: ☐ Low ☐ High	Changing Conditions	Water	Changing Conditions	Water	Water level	☐ TSS: ☐ Low ☐ High	☐ Regular inspection & monitoring
☐ Erosion	☐ Dry	☐ Minimal	Pumping infra	☐ Erosion	☐ Dry	☐ Erosion	☐ Dry	☐ Minimal	Pumping infra	☐ Further investigations
☐ Sliding	☐ Snow	☐ Normal	☐ Pumping required	☐ Settlement	☐ Snow	☐ Sliding	☐ Snow	☐ Low	☐ Pumping required	☐ Short term action
☐ Sloughing	☐ Runoff	☐ High	☐ Installed	☐ Tension cracks	☐ Runoff	☐ Piping	☐ Runoff	☐ High	☐ Installed	☐ Immediate action*
	☐ Ponding	☐ Critical	☐ Active pumping	☐ Sloughing	☐ Ponding	☐ Sloughing	☐ Ponding	☐ Critical	☐ Active pumping	Comments:
	☐ Lake	☐ Over topping		☐ Sinkhole	☐ Puddles	☐ Obstruction/Debris	☐ Seepage	☐ Over topping		

*Immediate action: Communicate information to Geotech Coordinator
Attach photos of any relevant observation withis form

P:\Engineering\05-Geotechnic\14- Amaruq\04- Water Management\3- Operation\4- Inspection\2- Freshet Inspection\Template Amaruq.xlsx

SUMPS & PONDS INSPECTION FORM

Inspection by:

DATE:

NAME:

Water level	❑ TSS: □ Low □ High	Changing conditions	❑ Seepage	Recommendations	
❑ Minimal	Pumping infra	❑ Dry	❑ Erosion	❑ Regular inspection & monitoring	
❑ Normal	❑ Pumping required	❑ Snow	❑ Sliding - instability	❑ Further investigations	
❑ High	❑ Installed	❑ Runoff	❑ Obstruction/Debris	❑ Short term action	
❑ Critical	❑ Active pumping	❑ Ponding	❑ Settlement	❑ Immediate action*	
❑ Over topping	❑ Pumping to stop	❑ Ice	❑ Instrument damage	Comments:	

NAME:

Water level	❑ TSS: □ Low □ High	Changing conditions	❑ Seepage	Recommendations	
❑ Minimal	Pumping infra	❑ Dry	❑ Erosion	❑ Regular inspection & monitoring	
❑ Normal	❑ Pumping required	❑ Snow	❑ Sliding - instability	❑ Further investigations	
❑ High	❑ Installed	❑ Runoff	❑ Obstruction/Debris	❑ Short term action	
❑ Critical	❑ Active pumping	❑ Ponding	❑ Settlement	❑ Immediate action*	
❑ Over topping	❑ Pumping to stop	❑ Ice	❑ Instrument damage	Comments:	

NAME:

Water level	❑ TSS: □ Low □ High	Changing conditions	❑ Seepage	Recommendations	
❑ Minimal	Pumping infra	❑ Dry	❑ Erosion	❑ Regular inspection & monitoring	
❑ Normal	❑ Pumping required	❑ Snow	❑ Sliding - instability	❑ Further investigations	
❑ High	❑ Installed	❑ Runoff	❑ Obstruction/Debris	❑ Short term action	
❑ Critical	❑ Active pumping	❑ Ponding	❑ Settlement	❑ Immediate action*	
❑ Over topping	❑ Pumping to stop	❑ Ice	❑ Instrument damage	Comments:	

NAME:

Water level	❑ TSS: □ Low □ High	Changing conditions	❑ Seepage	Recommendations	
❑ Minimal	Pumping infra	❑ Dry	❑ Erosion	❑ Regular inspection & monitoring	
❑ Normal	❑ Pumping required	❑ Snow	❑ Sliding - instability	❑ Further investigations	
❑ High	❑ Installed	❑ Runoff	❑ Obstruction/Debris	❑ Short term action	
❑ Critical	❑ Active pumping	❑ Ponding	❑ Settlement	❑ Immediate action*	
❑ Over topping	❑ Pumping to stop	❑ Ice	❑ Instrument damage	Comments:	

NAME:

Water level	❑ TSS: □ Low □ High	Changing conditions	❑ Seepage	Recommendations	
❑ Minimal	Pumping infra	❑ Dry	❑ Erosion	❑ Regular inspection & monitoring	
❑ Normal	❑ Pumping required	❑ Snow	❑ Sliding - instability	❑ Further investigations	
❑ High	❑ Installed	❑ Runoff	❑ Obstruction/Debris	❑ Short term action	
❑ Critical	❑ Active pumping	❑ Ponding	❑ Settlement	❑ Immediate action*	
❑ Over topping	❑ Pumping to stop	❑ Ice	❑ Instrument damage	Comments:	

*Immediate action: Communicate information to Geotech Coordinator

Attach photos of any relevant observation withis form

Appendix E

Potential Mitigation for Unusual Conditions

Potential Mitigation Plans for Unusual Conditions on Tailings Management Infrastructures

Unusual Condition	Area / Cause		Comments/Monitoring	Contingency or Corrective Action
Overtopping and Subsidence	1a	Water level rise / storm event	Lake levels and crest elevations are monitored as part the tailings management infrastructure surveillance program Outflow channels are inspected during thaw, open water season and during ice break-up.	Add additional pumping unit If rise is caused by a channel obstruction, remove the obstruction
	1b	Dam crest settlement	This scenario requires extensive loss of support in the foundation since the rockfill of the dikes is essentially not settlement prone itself after construction and dewatering. For foundation settlement of this magnitude to occur, a piping event must develop or there is an unexpected layer of compressible soil in the foundation. The situation would develop slowly with crest settlement evident at least several weeks before a run-away event develops. Easily observed cracks should be evident. Monitoring of the crest settlement is conducted routinely.	The crest is wide and constructed of coarse rockfill. Significant damage to the dike is not credible, based on performance of other rockfill structures subjected to overtopping or flow through events Rockfill can be placed to raise the dike crest and compensate settlement. Operations in the area may need to be suspended, but there will be considerable warning time given the slow development of the scenario.
	1c	Wave action	Large freeboard and wide crest zone make this a low concern	Rip-rap can be added and/or the dam crest can be raised.
Internal Erosion	2a	Dike section: geomembrane is defective, allowing high water flow. This defect occurs at a location where the core allows high flows and where the fills/geomembrane are defective; the combination allows erosion of the filters and/or the Core Backfill.	The geomembrane and/or core backfill will develop a progressively increasing void ratio, thereby increasing the rate of water flow through the dike. This is not a catastrophic failure mode but could lead to an inability to manage water on site	Monitor seepage from downstream face for rate of seepage and for presence of sediment in seepage. Identify zone of seepage and establish a seepage capture and monitoring station with sufficient pumping capacity Re-evaluate the impact of this water inflow on the site wide water balance
	2b	Dike section: geomembrane is defective.	Results in increasing the rate of water flow through the dike. This is not a catastrophic failure mode as the rockfill will be stable and at its worst would lead to temporary suspension of operations.	Monitor seepage from downstream face for rate of seepage and for presence of sediment in seepage. Identify zone of seepage and establish a seepage capture and monitoring station with sufficient pumping capacity Re-evaluate the impact of this water inflow on the site wide water balance
	2c	Foundation till is possibly non-uniform with more transmissive zones and not self-filtering. It is possible that one of these zones may align with defective construction of the liner allowing high flows. Seepage would lead to erosion of the filters into the downstream rockfill. Seepage could also erode the foundation tills at the downstream toe or into the downstream rockfill because of the lack of filtering.	Limited seepage at the toe or into the rockfill would accelerate into a large inflow and could lead to the undermining of the dike if no action was taken. This is a credible catastrophic mode if increased seepage is not detected in time. No particular instrumentation is needed as this failure mode will show itself as localized and increasing seepage. It could be detected by walk-over inspection by an experienced engineer or technician.	Remedial action could comprise a reverse filter and rockfill buttress depending on location of the flow and configuration of the foundation, freezing, or grouting, if identified in time. In the worst case, the pit may be deliberately flooded in a controlled manner, the liner repaired and the pit dewatered. Build additional dike downstream increasing pumping.

Unusual Condition	Area / Cause		Comments/Monitoring	Contingency or Corrective Action
Seepage	3a	Within the Embankment	Seepage on its own is not a credible failure scenario. The downstream rockfill shell has extremely high flow through capacity. The rockfill zone is both large and pervious, so that seepage will not daylight and lead to instability.	Monitor seepage from downstream face for rate of seepage and for presence of sediment in seepage. Identify zone of seepage and establish a seepage capture and monitoring station with sufficient pumping capacity Re-evaluate the impact of this water inflow on the site wide water balance
	3b	Within the Foundation	Defective installation of liner leading to transfer of unexpectedly high fraction of the reservoir head into the downstream part of the dike foundation or leading to a piping event as described in internal erosion (2c). If this mechanism arises it should show itself during initial dewatering or very shortly thereafter.	Monitor seepage from downstream face for rate of seepage and for presence of sediment in seepage. Identify zone of seepage and establish a seepage capture and monitoring station with sufficient pumping capacity Re-evaluate the impact of this water inflow on the site wide water balance Re-assess stability (numerical modelling) and construct a stabilizing berm
Structural - Slope Instability	4a	Normal Operation: Slope Failure	The rockfill shoulders of the dike are wide and have high shear strength Slope failure requires failure in the foundation which would extend into the overlying dike. Sliding failure is considered unlikely given the low horizontal forces generated by the water and ice relative to the normal frictional force due to the weight of the dikes and the frictional angles of foundational materials. This mechanism should develop during construction or dewatering, due to the increase in load and associated pore water pressure development. Initial stages of failure should be observable as tension cracks in the dike crest. Walk-over inspection of the dike by a trained inspector is an appropriate monitoring strategy in addition to the instrumentation. Survey of crest face and toe is conducted.	Re-assess stability (numerical modelling) and construct a stabilizing berm if required Fill inactive tension cracks with bentonite
	4b	Earthquake Induced: Slope Failure	Site is in a low seismic zone. Dam consisting of massive rock zone has a low sensitivity to seismic motion.	Perform an inspection and repair damage
	4c	Erosion; washout, ice scour	Crest – minimum 50 m section, Downstream – large quarry rock face.	Repair erosion by placing additional rockfill and material
Structural – Lateral Movement	5a	Failure of Liner	Differential horizontal movement of the dike due to dewatering, water or ice loading or pit wall failure may create a breach in the liner. Ice and water forces are not credible due to the ratio of frictional forces generated by the weight of the dike versus ice loads and water pressure. Large inflows through the breach may occur consequently if the liner breached. Pit would flood requiring suspension of operations. Potential for loss of life of workers inside dikes. Inclinometer, settlement prism and monument monitoring is done routinely.	Repair the liner
Subsidence	6	Foundation Soils	Unexpected foundation soils consolidated during dike construction or dewatering. A significant quantity of clay would be required to generate settlement resulting in a water release event. Prism and monument monitoring is done routinely.	A 1 m core settlement would be required to allow water to flow through the rockfill and over the settled liner. This flow would not cause failure of the rockfill shells. It would also be readily repaired by excavating rockfill above the liner and placing more till. Soil conditions were observed during dewatering to accommodate actual conditions.
Premature Closure	7	Corporate Bankruptcy or Early Resource Depletion	Bond is provided for this eventuality. Design of rehabilitation is the same as rehabilitation at closure of project.	This would trigger the closure plan
Pump and Pipeline Failure	8	Pumping infrastructures	Freezing protection is provided by heat tracing and insulation. Pipelines monitored by pump pressures at plant and frequent site inspection.	Replace defect in pipeline Repair the pump and use another pump in the meantime