Tailings Storage Facility - Operation, Maintenance and Surveillance Manual, Version 9

AGNICO EAGLE

MEADOWBANK GOLD PROJECT

TAILINGS STORAGE FACILITY

Operation, Maintenance and Surveillance Manual

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Division

Version 9
March 2019

TAILINGS STORAGE FACILITY

OPERATION, MAINTENANCE AND

SURVEILLANCE MANUAL

MEADOWBANK GOLD PROJECT

AGNICO EAGLE MINES LIMITED

IMPLEMENTATION SCHEDULE

This Plan is immediately implemented.

DISTRIBUTION LIST

AEM - General Mine Manager

AEM – General Superintendent

AEM- Environment Superintendent

AEM- Mine Operations Superintendent

AEM- Engineering Superintendent

AEM- Energy & Infrastructure Superintendent

AEM- Maintenance Superintendent

AEM- Process Plant Superintendent

AEM- Nunavut Division Engineer of Record

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 and Emergency Action Plan
V9	February 2019	All	All	

Approved by :

Luc Chouinard
Mine Manager

Pierre McMullen
Enngineering Superintendent

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SECTION 1 • INTRODUCTION

1.1 OBJECTIVE OF THE OMS MANUAL

The objective of this manual is to define the technical aspect related to the operation, maintenance and surveillance (OMS) of the tailings storage facility at the Meadowbank Mine operated by Agnico Eagle Mines Limited (AEM).

This manual is intended as a practical document used by the personnel involved in with the Tailings Storage Facility. It incorporates operating, maintenance and surveillance procedures recommended by the Canadian Dam Association (CDA) "Dam Safety Guidelines" (CDA 2013 & 2014) and the Mining Association of Canada (MAC) "Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities" (MAC, 2018). It also incorporate principle found in 'A Guide to the Management of Tailings Facilities" (MAC 2017). This manual was written by the Meadowbank Engineering team and the Nunavut Engineer of Record.

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

- Roles, responsibilities, and level of authority of personnel who perform activities related to the water management infrastructure
- The tailings management infrastructure covered in the scope of this OMS manual
- Plans, procedures and processes for :
    - The operation, maintenance and surveillance of the tailings storage facility infrastructures to ensure that it functions in accordance with their design, meets performance objectives and link to emergency response planning
    - Evaluating performance of the structures, and report performance results
    - Managing change

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

Element related to design, construction and closure of tailings management infrastructures, are out of scope of this manual.

1.2 REGISTERED MANUAL HOLDERS AND REVISIONS

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

The person responsible for the preparation, update and distribution of this manual is the Engineering Superintendent. Any change to this OMS manual must be submitted to and approved by the Engineering Superintendent who will be responsible to update the OMS manual in Intelex.

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

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

Table 1-1: OMS Manual Distribution List

Position	**Name**
General Mine Manager	Luc Chouinard
General Superintendant	Eric Côté / Jacques Proulx
Environment Superintendent	Nancy Duquet-Harvey
Mine Operations Superintendent	Yan Côté, Nicolas P. Deschamps (asst.)
Engineering Superintendent	Pierre McMullen, Miles Legault (asst.)
Maintenance Superintendant	Christian Quirion
Energy & Infrastructures Superintendent	Guillaume Gemme
Process Plant Superintendent	Michel Fortin
Engineer of Record, Meadowbank Division	Thomas Lepine

1.3 MANAGEMENT OF CHANGE

This manual will be reviewed on an annual basis at the beginning of Q3 and revised as necessary to accommodate changes in the condition and operation of the facilities. The Engineering Superintendent will be responsible to coordinate this review process.

In conducting the review and update of the OMS manual the following must be taken into account:

- Performance of the facility
- Current life cycle of the facility
- 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 need to be completed in a timely manner following the document control criteria specified in Section 1.2.

As a good practice the Engineering Superintendent should organise on a yearly basis a session to present the change in the OMS manual to the person in its distribution list.

1.4 REQUIRED LEVELS OF KNOWLEDGE

To preserve the integrity of the operation of these structures, the personnel must have a good comprehension of the factor that can impact the performance of the water management infrastructures. It must also be know that any deviation can signify the emergence of a problem and the role that each person must have in the operation, maintenance and surveillance of these infrastructures.

It is the responsibility of each person in the distribution list of this manual to be familiar with it and understand its whole content. They also need to ensure that everyone under their supervision who's duty involve task related to the operation, maintenance or surveillance of any component of the water management infrastructures have the appropriate level of knowledge and the resources to comply with the protocol presented in this document.

1.5 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 address conditions related to operation under normal or upset conditions, as opposed to emergency situation. An Emergency Response Plan (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 results this OMS manual contain the following information (refer to Section 4):

- Performance, occurrences, or observation that would results in an emergency being declared
- Roles and responsaibilities of key personnel in transition from normal or upset conditions to an emergency
- Actions to be taken to transition from normal or upset confitions to an emergency situation

Once an emergency has been declared reference must be made to the Emergency Response Plan (Reference included in Table 1-2). The most recent version of the ERP can be found on Intelex and in the Engineering Superintendant Office

Table 1-2 Emergency Response Reference Documents

Document	Current Revision
Emergency Response Plan	Updated by AEM. Version 12, January 2018. (Intelex)

SECTION 2 • ROLES AND RESPONSIBILITIES

A functional chart for the water management infrastructure at the Whale Tail project is shown in Figure 2-1.

The roles and responsibilities of the key personnel involved in the water management infrastructure of the Whale Tail Project are shown in Table 2-1. Contact information for each position is indicated in Table 2-2.

Personnel who have task directly related to the water management infrastructure need to receive a training when they start in the position to ensure they understand their roles and responsibility related to this OMS manual.

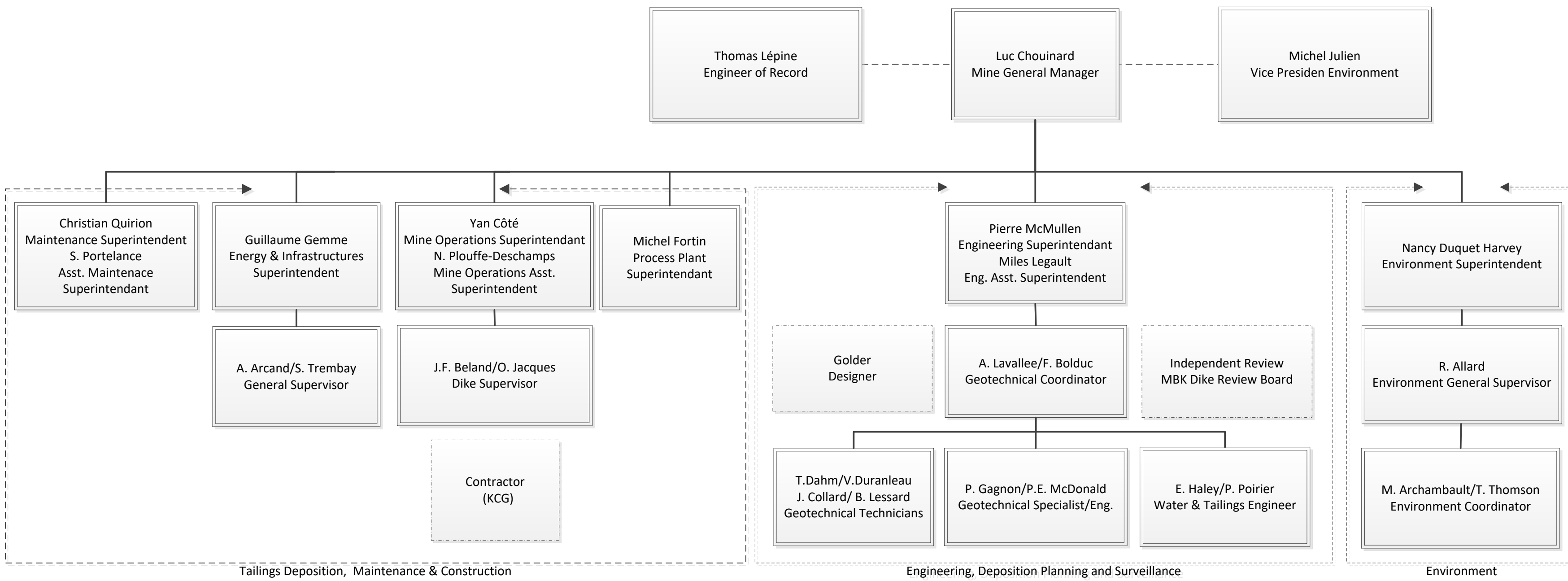

Figure 2-1 : Organizational Structure

Table 2-1: Responsibilities related to Tailings Management

Role	Responsibilities
Vice-President Environment	• Be aware of key outcome of water & tailings management risk assessment and how these risks are being managed • Has accountability and responsibility for putting in place appropriate management structure • Assign responsibility and appropriate budgetary authority for water & tailings management and defines the personnel duties, responsibility and reporting relationships, supported by job description and organisational charts to implements the water management system though all stages in the facility life cycles • Provide assurance to AEM and its Community of Interest that the water & tailings management infrastructure are managed responsibly
General Mine Manager	• Identifies the scope of work and budget requirement for all aspect of water & tailings management • Approve budget for OMS related activity • Establish an organisational structure with Roles and Responsibility that meets the operational needs • Delegate specific tasks and responsibilities for water management to qualified personnel • Liaise with independent reviewer (MDRB) as required
Engineer of Record (EoR)	• Input into the OMS activities in accordance with the design • Receive and review the OMS manual on a regular basis • Receive and review performance data at a frequency determined based on the risks • Either confirm operation is compliant or identify deviations from performance objectives and advise the Owner with recommendations • Advise on contemplated change on the facility operation • Maintain records relating to design construction and operation • Participate in inspection and independent review
Independent Reviewer – Meadowbank Dike Review Board (MDRB)	• Provide independent, objective, expert commentary, advice and recommendations, to assist in identifying, understanding, and managing risk associated with tailings management facilities
Engineering Superintendent	• Revise and update the OMS Manual to reflect as-built conditions and any other changes. • Review and update OMS manual into Intelex • Maintain up to date distribution list of the OMS Manual. • Establish a formal relationship with the EOR to ensure operation is compliant with design intent • Identify when/where contemplated operational changes are a potential deviation from the design intent and engage the EoR and Designer as part of processes to manage change • Coordinate work force as required for monitoring and maintenance.

Role	Responsibilities
Mine Operations Superintendent / Dike Supervisor	• Maintain access to the structure and seepage collection systems, including making road repairs, controlling dust and removing snow. • Carry out field maintenance related to earthwork as required, • Supervise Mine Contractor for aspect related to earthwork construction and maintenance
Geotechnical Coordinator	• Supervise the work of the geotechnical engineer, geotechnical technician and water and tailings engineer • Approve tailings deposition plan
Geotechnical Engineer	• Carry out inspections of the facility as required in the OMS Manual. • Carry out instrument monitoring as required in the OMS Manual. • Review and distribute surveillance reporting as required in the OMS Manual •
Geotechnical Technician	• Carry out inspections of the facility as required in the OMS Manual. • Monitor instrumentation as required in the OMS Manual. • Maintain instrumentation, readout units, data acquisition system and cabins • Responsible for data acquisition as required in the OMS manual • Prepare reports on instrumentation readings, dike performance, visual observations, etc. as required in the OMS Manual.
Water & Tailings Engineer	• Carry out inspections of the facility as required in the OMS Manual. • Carry out instrument monitoring as required in the OMS Manual. • Review and analyse surveillance data to evaluate dike performance with respect to design parameters. • Analyse geotechnical instrumentation monitoring data to evaluate performance with respect to design parameters • Coordinate equipment, labour, materials and maintenance activities required for pumps and pipelines associated with dewatering, seepage collection systems and any runoff diversions. • Prepare tailings deposition plan and water management plan
Environment Department Superintendent / General Supervisor / Coordinator / Technician	• Ensure monitoring of water quality and total suspended solids from the tailings storage facility as required in the water management plan • Review environmental monitoring data for compliance with Water License and regulations and to determine tailings management performance with respect to design parameters. • Liaise with external stakeholders including NIRB, Nunavut Water Board, NGO’s, government agencies.

Role	Responsibilities
Energy & Infrastructures Superintendent / General Supervisor / Pump crew supervisor / electrical supervisor	• Installation and operation of pumps and pipeline (electrical, mechanical) • Maintain and service pumps and pipelines • Coordinate equipment, labour and materials for maintenance of electrical and mechanical equipment • Carry out field operations including tailings deposition move, pipe cleaning (pig) and reclaim move • Carry out field maintenance on pumps and pipeline including electrical and mechanical repairs.
Process Plant Superintendant / General Supervisor	• Ensure tailings distribution from the mill to the tailings storage facility • Operation, maintenance and surveillance of mill pump and booster pump
Mine Contractor	• Rent equipment and manpower for construction and maintenance of water management infrastructure
Design Engineer	• Advise on contemplated change to the facility design • Advisor on structure performance as required • Participate in inspection and independent review as required
Maintenance Superintendent/ Pump mechanics	• Ensure preventive maintenance is carried out regularly on each pumping equipment • Repair pumping equipment as required • Update and maintain a list of operational pumping equipment • Keep records of maintenance on pumping equipment

Table 2-2: OMS Manual Contact for each position

Role	Name	Work Contact Info
Vice-President Environment	Michel Julien	416-947-1212 x3738 514-244-5876
General Mine Manager	Luc Chouinard	819-759-3555 x4606896
Engineer of Record (EoR)	Thomas Lepine	416-947-1212 x3722 418-473-8077
Engineering Superintendent / Assistant	Pierre McMullen Miles Legault	819-759-3555 x4606721
Mine Operations Superintendent / Assistant	Yan Côté Nicolas Plouffe-Deschamps	819-759-3555 x4606832
Dike Supervisor	Jean-François Béland Olivier jacques	819-759-3555 x4606807
Geotechnical Coordinator	Frédérick L.Bolduc Alexandre Lavallée	819-759-3555 x4606837
Geotechnical Engineer	Patrice Gagnon Pier-Eric McDonald	819-759-3555 x4606726
Geotechnical Technician	Vincent Duranleau	819-759-3555 x4606818

Role	Name	Work Contact Info
	Thomas Dahm Bruno Lessard Jerome Collard.	819-759-3555 x4606851
Water & Tailings Engineer	Eric Haley Pascal Poirier	819-759-3555 x4606752
Environment Superintendent	Nancy Duquette	819-759-3555 x4606980 x3175
Environment General Supervisor	Robin Allard	819-759-3555 x4606838
Environment Coordinator	Martin Archambault Tom Thomson	819-759-3555 x4606744
Process Plant Superintendent	Michel Fortin	819-759-3555 x4606814
Energy & Infrastructures Superintendent	Guillaume Gemme	819-759-3555 x4606632
Maintenance Superintendent	Pierre Laberge Sylvain Portelance	819-759-3555 x4606722
Energy & Infrastructure General Supervisor	Alexandre Arcand Steven Tremblay	819-759-3555 x4606822
Pump crew supervisor	Shawn Valiquette	819-759-3555 x4606616
Electrical Supervisor	Alain Villeneuve	819-759-3555 x4606762
Mine Contractor	KCG	819-759-3555 x4606963 418-615-0559
Designer – Golder	Yves Boulianne	514 383 6196 x7434 514 207-0264
Independent Reviewer – Meadowbank Dike Review Board (MDRB)	Anthony Rattue Don Hayley	anthony.rattue@bell.net don.hayley@icloud.com

SECTION 3 • TAILINGS MANAGEMENT INFRASTRUCTURES DESCRIPTION

3.1 BACKGROUND

The tailings storage facility (TSF) is the permanent storage facility for tailings produced during the operation of the mine. It is located north of the Process Plant Site within the dewatered portion of the northwestern arm of Second Portage Lake.

The tailings management include the operation of a series of water & tailings management infrastructures as shown in . Table 3-1 indicate the water management infrastructure of the Whale Tail Project.

The design criteria of the earthwork infrastructure are presented in Table 3-2. Reference to design and construction document are presented in Section 3.7

Table 3-1: Description of the tailings management infrastructures

Infrastructure	Function
North Cell Peripheral Structure : Saddle Dam 1, Saddle Dam 2, RF1, RF 2	Peripheral tailings retention structure for tailings containment within the North Cell
North Cell Internal Structure and associated ditches and sump	Upstream raise built on the tailings to increase capacity of the North Cell
South Cell Peripheral Structure : Saddle Dam 3, Saddle Dam 4, Saddle Dam 5, Central Dike	Peripheral tailings retention structure for tailings containment within the South Cell
Stormwater Dike	Internal structure that divide the TSF into the North and the South Cell
Diversion Ditches	Non-contact water diversion structure. Prevents runoff from the watershed to reach the TSF
Deposition and reclaim infrastructure	Infrastructure required for tailings deposition and to reclaim water within the TSF

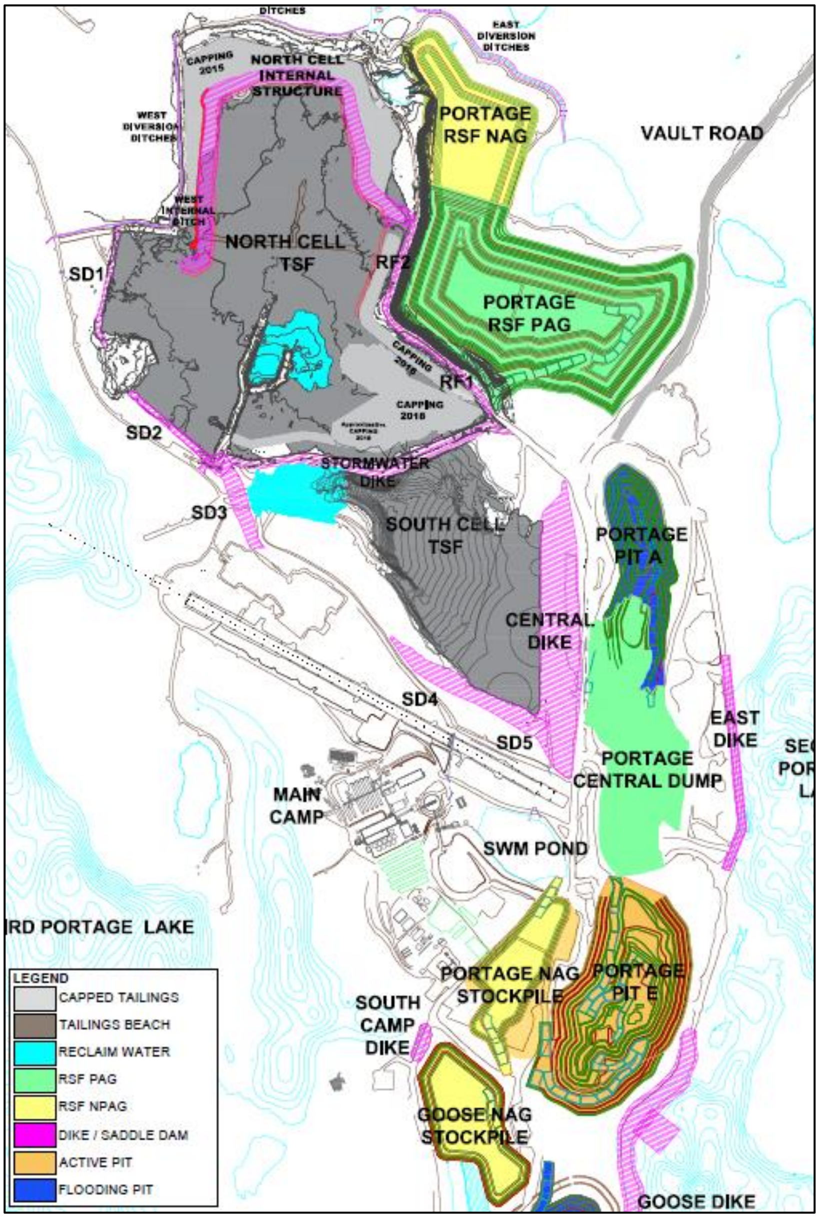

Figure 3-1 - Tailings Storage Facilities Infrastructures

Table 3-2: Tailing 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)

3.2 FACILITY COMPONENTS

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 and the closure of the TSF. Saddle Dam 1 crosses a depression between the northwestern arm of Second Portage Lake and Third Portage Lake.

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.

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.

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 and closure 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 one stage to El. 150 m in 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 factures were observed within the bedrock. The toe liner tie-in was then covered with till.

3.2.3 RF 1 and RF2 – North Cell

RF1 and RF2 are two rockfill access roads located between the eastern side of the North Cell and the Portage Waste Rock Storage Facility. These access roads were not designed as a containment structure and do not include a low permeability element due to the topography of the sector.

In 2013 a till plug was installed on RF1 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.

3.2.4 North Cell Internal Structure – North Cell

The North Cell Internal Structure is designed and constructed as a permeable zoned rockfill dam with filter zones built on the top surface of dried tailings and on an existing rockfill cover. Placement of the rockfill cover on the tailings was carried out in winter when the tailings foundation was frozen. The maximum elevation of the North Cell Internal Structure is designed to be El. 154 m and an offset is keep from the perimeter of the North Cell and the peripheral structure.

The typical section of the structure is a rockfill shell with a 3H:1V upstream slope and a 1.5H:1V downstream slope. The upstream face of the structure is comprised of two granular filter zones. The filter zones are designed to prevent tailings migration and internal erosion while allowing water to flow through the embankment. Fine ultramafic rockfill was used during the construction of the structure. Temporary ditches and sumps system were constructed on the downstream side of the internal structure within the existing tailings to collect seepage and runoffs during operation.

In 2018 the North Cell internal structure was built from Station 1+100 to 3+260 for a total of 2160 m. Section 1+100 to 1+660 and 2+750 to 3+260 were built to El. 152 with a width of 39 m and the part from Sta 1+660 to 2+750 was built to El. 154 m with a crest width of 30 m.

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.

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. The Saddle Dams 3, 4 and 5 cross-sections 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 polyethylene liner (LLDPE) extending along the upstream foundation. The filter zones mean 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 bulk part of Saddle Dams 3, 4 and 5 consists of coarse rockfill material.

The design of Saddle Dam 3 include 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 need to be maintained in that area for reclaim.

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. 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. 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.

3.2.6 Internal Structure for Reclaim – South Cell

An internal structure was built into the South Cell in 2017 in front of the reclaim area. The objective of this structure was to prevent tailings from filling the reclaim area near SD3 and to limit the turbidity of the reclaim water for mill usage. This structure was built by pushing rockfill in the South Cell with a dozer. In the winter of 2019 this structure was raised to El 142.5 m.

3.2.7 Central Dike

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.

Central Dike design includes a compacted rockfill embankment with an upstream seepage barrier, granular filters and a key trench along the centreline 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.

Construction of Central Dike started in 2012. Central Dike was built to El. 143 m during the 2016 construction season (Stage 5), and its north abutment raised to El. 145 m during the 2017 and 2018 construction season (Sta. 0+090 to 0+174 m). 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.

Seepage into the basin at the downstream toe of Central Dike was observed when tailings deposition was transferred from the North Cell of the TSF to the South Cell 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. Desktop studies were undertaken by Golder 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 Golder 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.

Willowstick was also 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. 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. In 2016, the MDRB recommended that the seepage model and stability analyses be updated.

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.

The Central Dike seepage is normally back into the South Cell. From September to October 2017 the seepage was transferred to Goose Pit as a mitigation measure. This measure, combined with an adapted tailings deposition plan was effective in reducing the seepage flow rate. As a results the average seepage rate at Central Dike decreased from 540 m^3/h in 2017 to 263 m^3/hr at the end of 2018 and is following the trend from the 2017 seepage modelling done by Golder.

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 re-occurred in the summer of 2018.

3.2.8 Stormwater Dike – 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. In this document, the North Cell side is taken 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 progressively constructed. 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. The crest of Stormwater Dike was raised to 150 m in 2013.

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.

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.

3.2.9 Water Control Structures

The diversion ditches (East and West), 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. The ditches are divided in two sections – the west and east sections, to divert non-contact water respectively to Third Portage Lake and to NP1 Lake. 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.

The perimeter water control structures will be used throughout the operating life of the TSF. These will continue to be used into the post-closure of the project until both the TSF and adjacent ground returns to pre-development permafrost conditions or the surface runoff and seepage waters are of acceptable quality to be discharged directly to the environment.

Following the construction of the North Cell Internal Structure, internal ditches and sump 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 will be operational only during deposition from the internal structure of the North Cell.

3.3 WATER & TAILINGS PUMPING INFRASTRUCTURE

Tailings is distributed from the mill to the TSF by pumping it as a slurry (details on tailings property are presented in Section 4). The infrastructure located inside the mill is out of scope of this OMS manual.

The pipe used for tailings distribution is insulated 14’’ and 16’’ HDPE pipe. The tailings pipe is heat traced form the mill to the pig launcher. The tailings pipe from the mill first reach the pig launcher station. The pig launcher station is the location where the tailings deposition can be switch to the by-pass point. This station is used for maintenance of the tailings pipe (passing the pig).

Tailings deposition at Meadowbank 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 points. The location of the tailings deposition point is determined during the tailings deposition plan exercise and are constructed as they become required. Location of the tailings discharge point are shown on Figure 3-2 and Figure 3-3. Each deposition point switch requires physical manipulation of the pipe (extension / shortening) as there is no valve system.

When tailings deposition occurs from a dike, the tailings deposition point is 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

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.

A reclaim station is located in the South Cell near SD3. This infrastructure is used to send back water from the TSF to be used as part of the milling process. The reclaim station is a pumphouse on skid that can be moved as the water level change in the South Cell. The suction line is placed at the bottom of the pond and is extended as needed. The pump of the reclaim station is electrical and is controlled remotely by the mill. The line that bring the reclaim water to the mill is a heat traced insulated 14’’ HDPE DR 17

Water ponding in the North Cell is transferred into the South Cell pond using a HL250 pump.

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 pump out as required during freshet using mobile pump. These sumps are located at SD1, SD3 and SD4, and around North Cell Internal Structure.

At freshet water from the interception sump of the western ditches is pumped back in the North Cell as well as water from ST-16. These setup are considered to be temporary and are used and installed as required.

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.

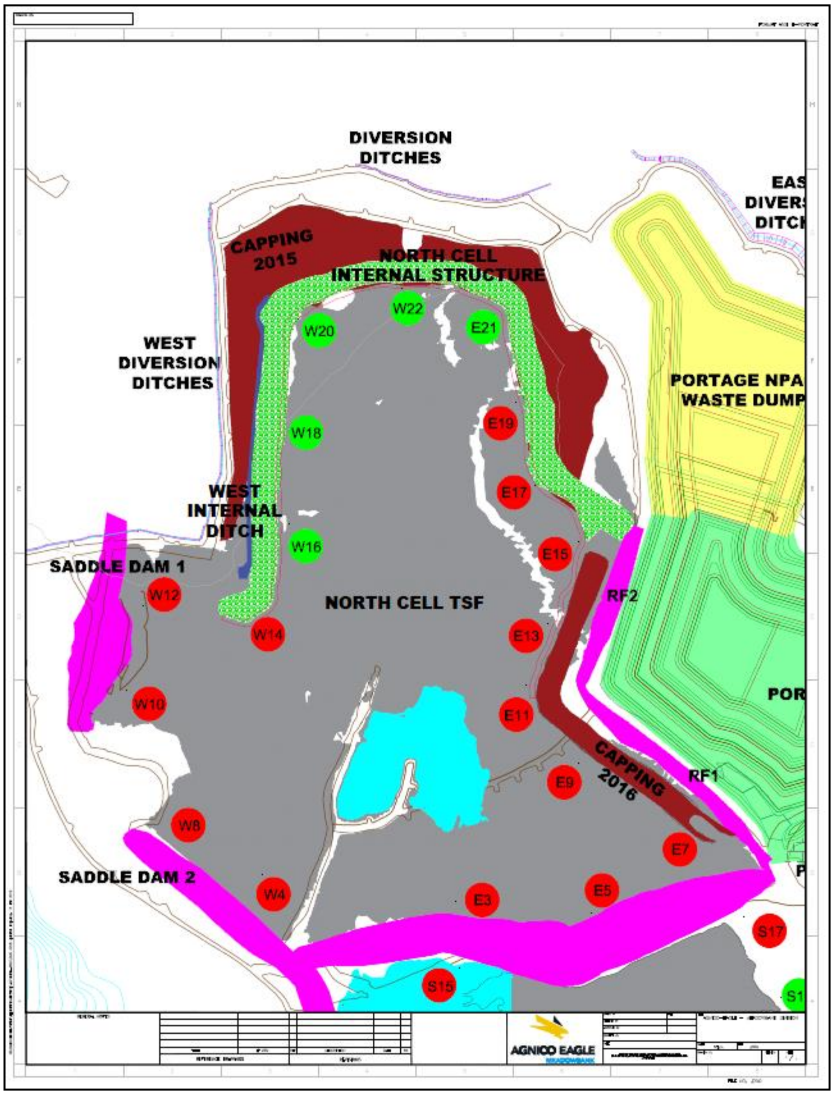

Figure 3-2 Deposition Point Locations in the North Cell

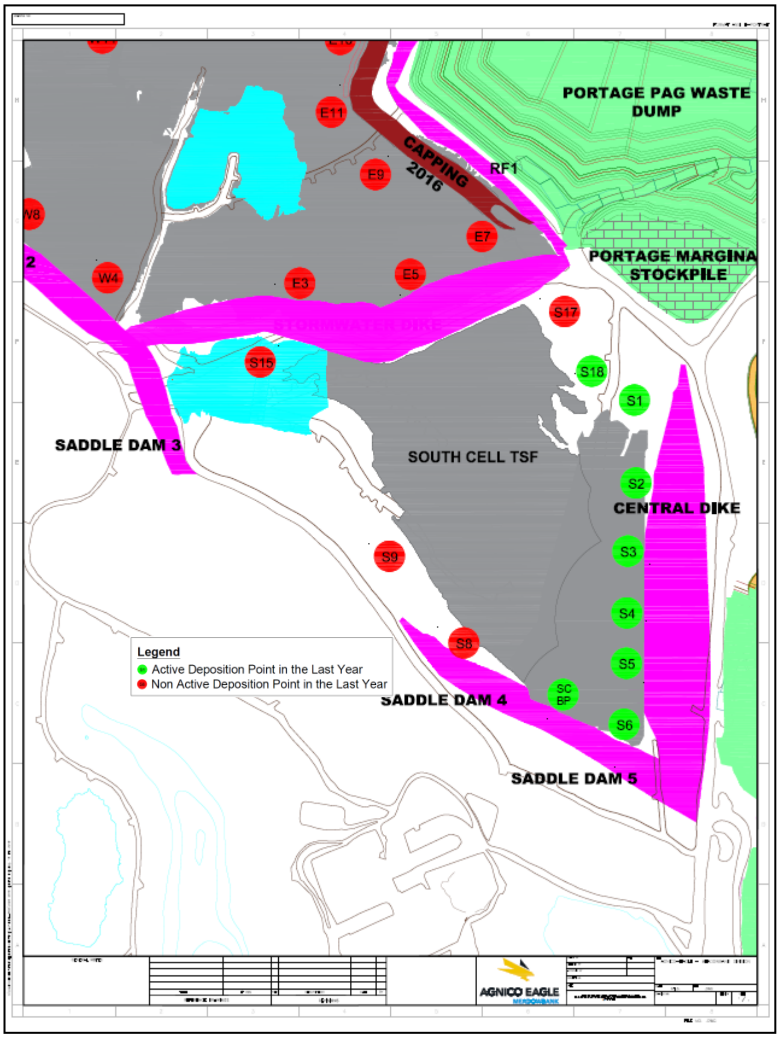

Figure 3-3 : Deposition Point Locations in the South Cell

3.4 INSTRUMENTATION

The TSF is instrumented with geotechnical instrumentation to monitor performance of the containment structure and the freeze back of the tailings. The instruments are installed within the structure and inside the tailings and includes piezometers, thermistors and survey monuments (prisms).

Reference document for the instrumentation installed within the TSF and their status are presented in Appendix 2. The summary of instrument installed is summarised in Table 3-3. Figure 3-4 show the instruments installed within the TSF.

Table 3-3 : Instrumentation Summary within the TSF

Structure	Piezometers	Thermistors	Survey Monument	Crackmeters	Staff Gauge
Central Dike	69	26	-	-	-
Stormwater Dike	3	3	19	3	-
Saddle Dam 1	-	4	-	-	-
Saddle Dam 2	-	4	-	-	-
Saddle Dam 3	-	5	-	-	-
Saddle Dam 4	-	4	-	-	-
Saddle Dam 5	-	3	-	-	-
RF1-RF2	-	4	-	-	-
North Cell Internal Structure	-	4	16	-	-
North Cell Tailings	-	9	-	-	1

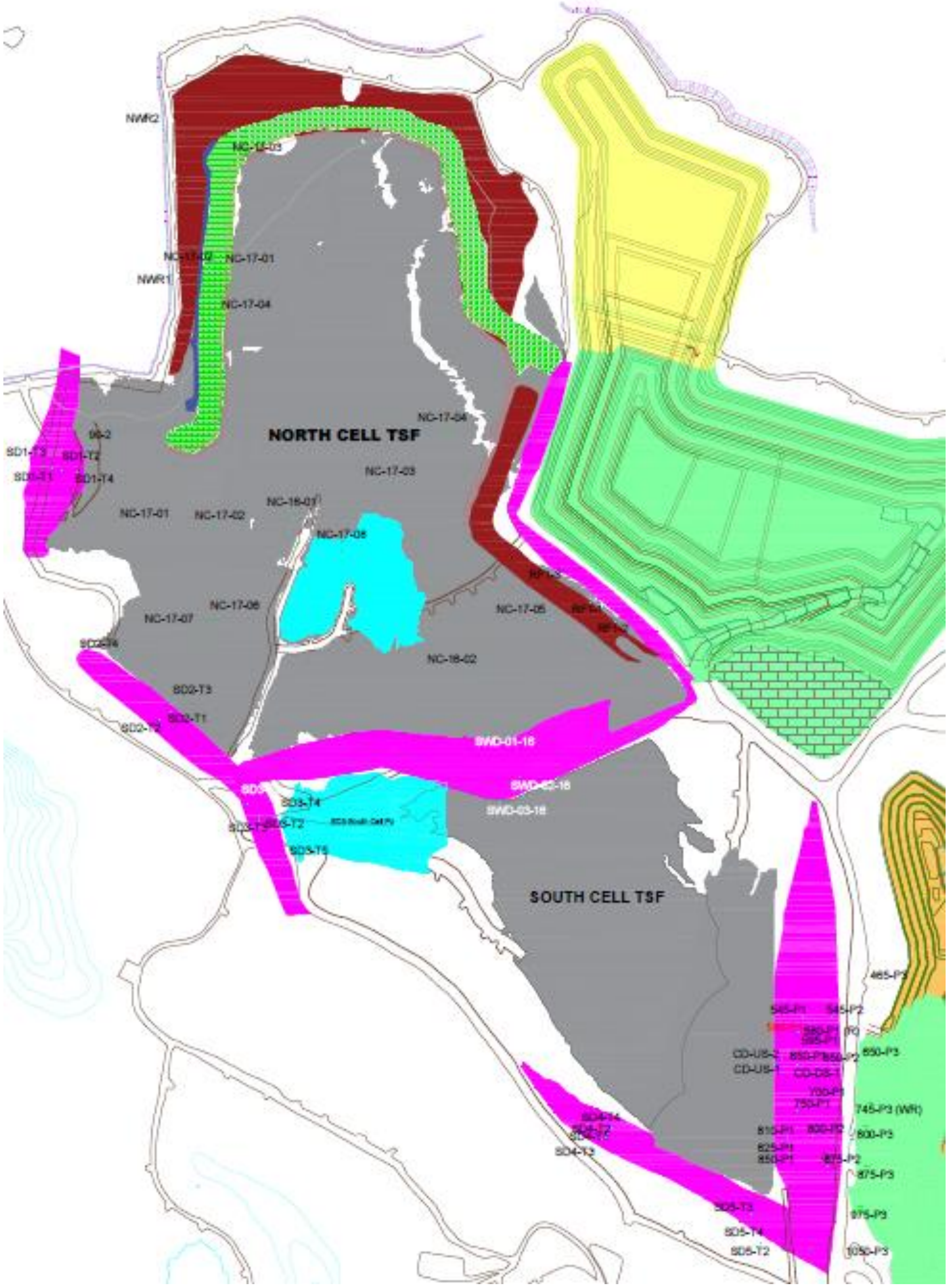

Figure 3-4 : Instruments Location Within the TSF

3.5 REFERENCE DOCUMENTS AND DRAWINGS

Reference to key document for the design and construction of the TSF infrastructures is presented in Table 3-4 to Table 3-6.

Table 3-4: Tailings Storage Facility Design Report and Specifications

Item	Description	Reference
Tailings Storage Facility Dike Design	Design Report	Doc. No. 784 Ver. 0, Golder 2008
TSF Dike Construction Technical Specifications	Technical Specifications	Doc. No. 796 Rev. 0, Golder 2009
Detailed Design Report for Central Dike	Design Report	Doc. No. 1349 Ver. 0 Rev. 1, Golder 2012
Central Dike Construction Technical Specifications	Technical Specifications	Doc. No. 1327 Rev. 0, Golder 2012
North Cell Diversion Ditches	Design Memorandum	Doc. No. 1370 Rev. 0, Golder 2012
Detailed Design Report for Saddle Dams 3, 4 and 5	Design Report, Technical Specifications and Drawings	Doc. No. 1504 Rev. 1, Golder 2015
Detailed Engineering Design of Internal Structure (TSF North Cell)	Design Report, Specifications and Drawings	Doc. No. 1784383 Rev. 0, Golder 2018

Table 3-5 Tailings Storage Facility Construction Summary Report

Item	Description	Reference
RF1, RF2 Stormwater Dike : Stage 1-2 SD1 : Stage 1-2 SD2 : Stage 1-2	2009-2011 Construction Season as-built report	AEM (June 2013)
North Cell Diversion Ditches	2012 construction summary report	AEM 2012
Central Dike Stage 1	Construction Summary Report Stage 1 – Central Dike 2012	AEM 2018
Central Dike Stage 3	Construction Summary Report Stage 3 – Central Dike 2014	AEM 2015
Central Dike Stage 4 SD3, SD4, SD5 Stage 1	2015 Construction Season as-built report	AEM 2015
Central Dike Stage 5 SD 3, SD4, SD5 Stage 2	2016 Construction Season as-built report	Doc. No. 1552 1656047 Rev. 0, Golder 2017

Central Dike North Abutment Raise SD3, SD4, SD5 Stage 3	2017 Construction Season as-built report	Doc. No. 1777687 1572 Rev. 0, Golder 2017
Central Dike Stage 6 Finalization SD3 Stage 3 North Cell Internal Structure	2018 Construction Season as-built report	Doc. No. 1897439 1578 Rev.0, Golder 2018

Table 3-6 List of Construction Drawings for Embankment Structures

Drawing No. (Prepared by)	Title	Revision No.	Date of Revision
4100-30 to 4100-39 (Golder)	Tailings Storage Facility – Stormwater Dike	0	July 10, 2009
4100-50 to 4100-60 (Golder)	Tailings Storage Facility – Saddle Dam 1	0	July 10, 2009
SD2-SD3-01 to SD2-SD3-13 (Golder)	Tailings Storage Facility –Saddle Dam 2 and Saddle Dam 3	A	August 25, 2010
SD6-01 to SD6-11 (Golder)	Tailings Storage Facility – Saddle Dam 6	A	September 13, 2010
Figure 1—Supersedes Drawing Nos. 4100-30, 4100-31, and 4100-32 (Golder)	Agnico-Eagle Mines Limited, Meadowbank Gold Project Nunavut, Stormwater Dike Staged Layout Plan	N/A	August 5, 2009
Figure 2—Supersedes Drawing Nos. 4100-33, Detail 3 on 4100-34 (Golder)	Tailings Storage Facility Typical Cross-Section and Details	N/A	August 5, 2009
Figure 1—Supersedes Drawing Nos. 4100-51, 4100-52, 4100-53, and 4100-58 (Golder)	Tailings Storage Facility Saddle Dam 1 Rockfill Plan and Liner Details	N/A	August 17, 2009
All drawings in the Construction Report TSF (AEM)	Construction Report Tailings Storage Facility	N/A	June 15, 2013
All drawings in the Detailed Design Report for Saddle Dams 3, 4 and 5 Doc 1504 1416081 SD3,4 & 5 Design Rev1	Detailed Design Report for Saddle Dams 3, 4 and 5	0	May 12, 2015
All drawings in the Detailed Design Report for North Cell Internal Structure Doc 1784383 Rev0	Detailed Engineering Design of Internal Structure	0	April 19, 2018
Update as Required			

Table 3-7 List of Construction Drawings for Infrastructure and Piping

Drawing No. (Prepared by)	**Title**	**Revision No. and Title**	**Date of Revision**
All Booster Pump Design Drawings	Booster Pump Design Drawings, MEAD-360	N/A	June 26, 2012
All drawings in the Construction Summary Report North Cell Diversion Ditches (AEM)	Construction Summary Report North Cell Diversion Ditches	N/A	July 27, 2013
All South Cell Infrastructures Drawings (AEM)	Reclaim pump drawings 61-430 Pig launcher drawings 61-360 Central Dike Seepage drawings P1607151-1000-00	N/A	2016
Update as Required			

SECTION 4 • OPERATIONS

The following section outlines the key operational procedure that need to be observed and followed during operation of the tailings management facility in accordance with the performance objectives.

4.1 REFERENCES

Reference to key documents for the operation of the tailings facility are presented in Table 4-1.

Table 4-1 : Reference Documents for Operation of Tailing Storage Facility

Type of information	Reference	Link to Retrieve Document
Tailings Deposition Plan	2019_V1B	..\..\..\..\06-TailingsManagement\4 - DEPOSITION PLAN\2019\1- Current Deposition Plan
Meadowbank Annual Water Balance	2019	..\..\..\..\05-WaterManagement\2019\Water Balance
Meadowbank Water Management Plan	V7 AEM 2018	..\..\..\..\..\12- Annual Report\2019\Water management plan
Meadowbank Waste Management Plan	V8 AEM 2018	..\..\..\..\..\12- Annual Report\2019\Waste rock and tailings management plan

4.2 SUMMARY OF PERFORMANCE OBJECTIVES AND OPERATION CONTROLS

The performance objectives and the operational criteria for tailings management are summarised in Table 4-2.

Table 4-2 : Performance Objectives and Operational Criteria for Tailings Management

Tailings Transportation and Placement
• Tailings must deposited within accepted compliance to the tailings deposition plan (respect of deposition duration and location). Tailings deposition plan has to have some flexibility to take into account variable tailings property and milling schedule. • 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)

• The tailings delivery system (pumps, pipe) must be operated and maintained as per the defined operating procedure • Tailings deposition need to limit ice-entrapment by limiting sub-aerial deposition in the winter over long distance
Tailings Containment
• All tailings must be stored within the TSF. Presence of tailings outside the TSF is considered a spill. • The tailings freeboard must be respected at all time (refer to section 4.4) • Tailings beaches need to be promoted along the peripheral structure (except SD3) • The construction schedule for the raise of the tailings containment structure must be aligned with the deposition plan.
Water Management
• A sufficient water volume must be maintained in the TSF ponds 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 location of the water pond must comply with the deposition plan and a minimum water head should pond against the peripheral structure (except SD3) • A sufficient water depth must be maintained within the reclaim area • Ice is not allowed to pond against the liner of the tailings retention structure. 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 4.4) • Water movement must be tracked and recorded on a monthly basis (volume, origin, destination) • The water management system (pump, pipes, WTP) must be operated and maintained as per the defined operating procedure • Any seepage must be captured by sump and pumped back to allowed location (or naturally report to an approved location)
Water Quality
• Water quality and quantity of seepage water is monitored
Surveillance
• Proper surveillance (inspection and data review) of the tailings facility occur and is documented (refer to section 6) • The performance of the tailings management facility is reviewed against the threshold for performance criteria and trigger pre-defined actions (refer to Table 4-6 to 4-9)

4.3 DEPOSITION PLANNING

Deposition of tailings in the TSF (location & duration) must be done according to an approved deposition plan. The process of preparing or updating a deposition includes defining the parameter analysis and the deposition strategy, preparing the deposition plan, having the deposition plan approved and distribution of the deposition plan. Also at the end of each month the actual deposition performed will be simulated to obtain end of month theoretical surface to verify if the deposition is on track with the plan.

Deposition plan are schedule to be updated twice a year following update to the LOM and Budget. The deposition planning is done by the Engineering Department (water & tailings engineer) using the software Muck 3D. Unplanned update to the deposition plan might be required if compliance to the deposition plan can no longer be reconciled (i.e change in deposition strategy, change in deposition parameter).

While defining the deposition strategy it is important to refer to Table 4-2 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 Engineering Superintendent and Engineer of Record.

Twice a year a bathymetry and scan of the TSF will be completed (one in June and one in September). The latest information is to be used to calculate some of the parameters used in the deposition planning. As much as possible the update of the tailings deposition plan will start from an existing bathymetry.

Table 4-3 presents the information required prior updating a deposition plan and how to obtain it. Input parameter need to be approved prior to beginning working on the deposition plan.

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.

Table 4-4 present what are the output of a deposition plan for each timestep modeled.Table 4-3

Once the deposition plan has been reviewed by the Engineering Coordinator and Superintendent it is ready to be approved. 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 4-3 : Input parameter into a deposition plan

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 using a bathymetric analysis
• Tailings dry density in t/m^3 (historically varied from 1.2 to 1.4 t/m^3) • Deposition slope angle (sub-aerial and sub-aqueous) for each tailings storage location • Ice entrapment by volume
Information obtained from the water balance
• Volume of water in the pond • Need for water transfer • Quantity of reclaim vs freshwater • Ice entrapment by volume •
Tailings property from the mill
• Tailings discharge solids content (usually around 52 %) • Specific gravity of tailings solid

Table 4-4 : 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 deposited (ensure compliance with milling schedulle)
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 (%)
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)
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 what is the timeline
- Verify if new deposition point creation are required
- Verify if action are required to maintain reclaim capability (i.e construction of internal structure to prevent tailings from reaching reclaim area)

4.4 FREEBOARD

The minimum freeboard to be respected for tailings and water is presented within the design report of the TSF and is summarised in Table 4-5.

Table 4-5 : Freeboard Criteria During Operation

Location	Type of freeboard	Value
North Cell / South Cell	Tailings freeboard with containment structure	0.5 m below crest of structure
North Cell	Water freeboard	El. 148 m (2m below El. Of peripheral structure)
South Cell	Water freeboard	El. 143 m (2m below El. Of peripheral structure)

4.5 TAILINGS MANAGEMENT

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 were built and deposition was resumed in the North Cell.

Deposition is done using end of pipe tailings deposition with one active point at a time. The deposition point location and duration is planned by the tailings deposition plan. 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 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.

4.6 WATER MANAGEMENT

The water management strategy for the TSF can be found in the water balance and in the water management plan. A schematic version of the water movement strategy for the TSF is summarised in Figure 4-1.

The strategy to deal with seepage 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 SD1, SD3, SD4, SD5, RSF (ST 16). Seepage from Central Dike is pump back on a continuous basis into the South Cell. The location of the Central Dike seepage discharge was moved in the winter of 2019 from upstream of Central Dike to upstream of Saddle Dam 4. This decision was made when rapid ice buildup was observed against SD5 due to the seepage water getting entrapped in that sector.

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 in the South Cell is to reclaim as much water as possible while avoiding excess storage of water due to the Central Dike situation. When the pond volume is too low for reclaim, additional freshwater is used at the mill. When the deposition plan predict that water will reach the reclaim pump area, action are taken to maintain the reclaim location. In 2017 and 2019 an internal structure was built into the South Cell to prevent tailings from reaching the reclaim area. The construction of such a structure in the North Cell is currently planned as part of the current tailings deposition plan.

As part of the water management strategy of the South Cell it is possible to send excess water into Goose Pit. This strategy was used in 2015 and 2017 and will be required in 2019 as part of the latest deposition plan update.

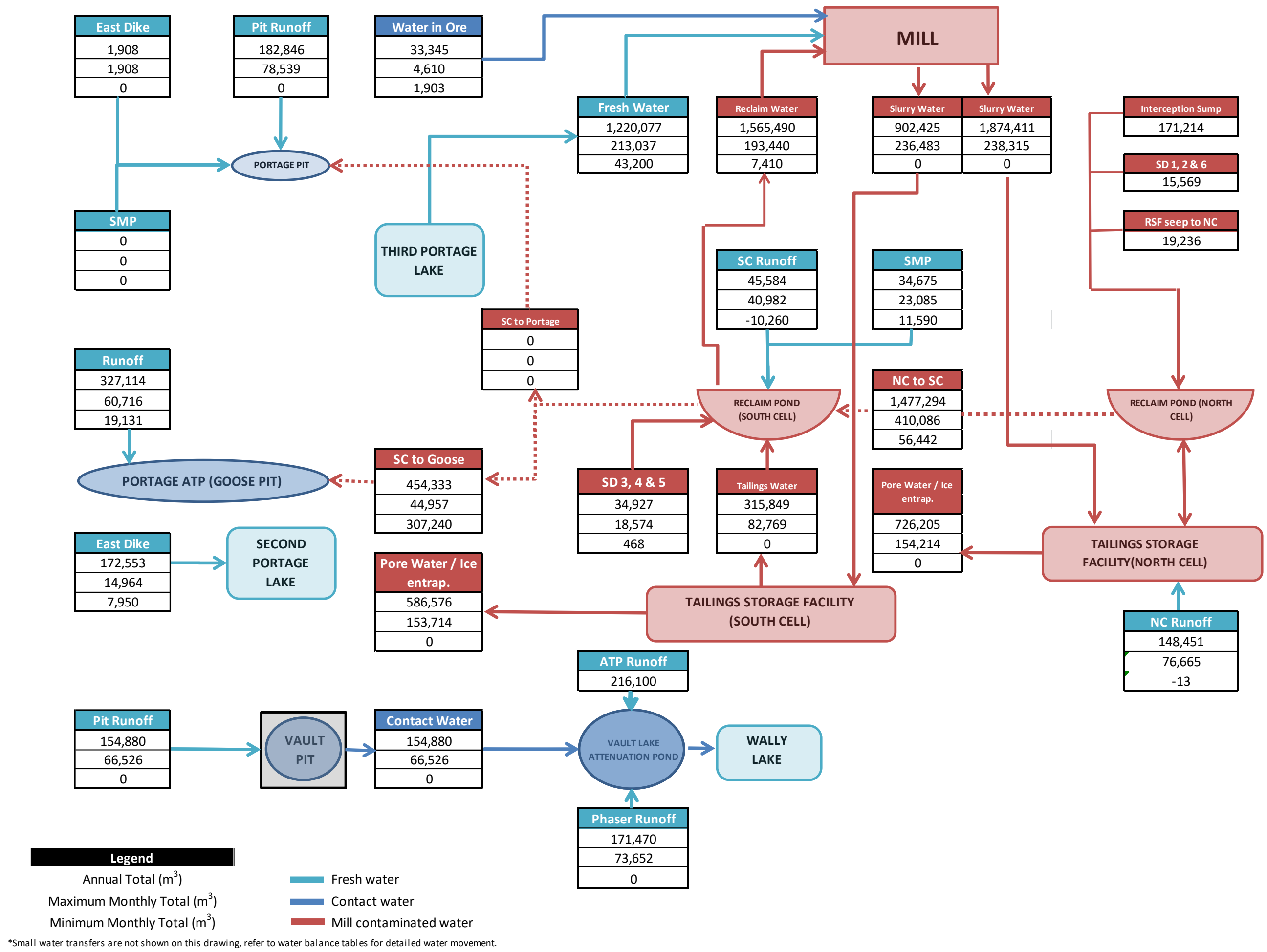

Figure 4-1 : Water Management Strategy for 2019

4.7 PERFORMANCE INDICATOR DURING TAILINGS MANAGEMENT

Table 4-6 to Table 4-9 below present performance indicator for each component of the tailings management system and the Trigger Action Response Plan (TARP) if the associated performance criteria deviate from defined range.

Table 4-6 Threshold Criteria and pre-defined action during operation of tailings retention structures (Excluding Central Dike)

		Threshold Criteria During Operation			
		Green **Acceptable Situation**	**Yellow** **Areas of Concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria	Cumulative crest settlement from operations start up	No settlement observed	< 0.2 m	> 0.2 m and < 1.0 m Increasing rate of settlement	> 1.0 m Increasing rate of settlement
	Downstream toe displacement	No displacement observed	Affecting seepage collection system	Loss of roadway	Loss of roadway
	Shear crack along rockfill embankment (differential settlement)	No shear crack observed	< 0.4 m deep	> 0.4 m and < 0.8 m deep	> 0.8 m deep
			< 5 m length along the dike	> 5 m and < 10 m length along the dike	> 10 m length along the dike
	Tension crack embankment alignment at crest	No tension crack observed	< 0.25 m deep	> 0.25 m and < 1 m deep	> 1 m deep
			< 0.10 m wide across the dike	> 0.10 m and < 0.20 m wide across the dike	> 0.20 m wide across the dike
			< 5 m length along the dike	> 5 m and < 10 m length along the dike	> 10 m length along the dike
	Sloughing along downstream rockfill embankment face	No sloughing observed	Observed	Observed and worsening from yellow situation	Observed and worsening from orange situation
	Embankment lateral cumulative deformation	No deformation observed	< 0.1 m	> 0.1 m and <0.25 m	> 0.25 m
	Seepage through embankment	No seepage observed	< 1/3 pumping rate capacity	> 1/3 and < 2/3 pumping rate capacity	> 2/3 pumping rate capacity
	Increase of seepage rate	No increase in seepage rate	< 5% per day over five consecutive days	> 5% < 10% per day over four consecutive days	> 10% per day over three consecutive days
	Turbidity of seepage water	No turbidity observed	Turbidity observed for first time	Turbidity observed and source of sediments matching cut-off wall or foundation till mineralogy	Turbidity observed and source of sediments matching cut-off wall or foundation till mineralogy
	Sinkhole on crest	No depressions or sinkholes on crest observed	Localized depression of embankment crest	Observed	Well developed
Action Required (general)			Monitor as normal All cracks filled or repaired If cracks re open implement engineering review Identify source of turbidity	Implement engineering review Suspend activities on embankment crest at chainage of concern Intensify monitoring at chainage of concern	Remove personnel and equipment from pit and suspend activities
		Take action and notify personel as per decision framework of Figure 4.2			

Table 4-7 Threshold Criteria and pre-defined action during operation of Central Dike (Part 1/3)

		Personnel notified	Seepage				
			Change in inferred Seepage Rate	*Total D/S pumped*	*Downstream Pond Elevation*	*Compliance to seepage model (1)*	
			Threshold	Threshold	Threshold	Threshold	Possible actions
Green	Normal	Take action and notify personel as per decision framework of Figure 4.2	Sudden or cumulative increase over last 3 days of < 25%	< 200 m3/h averaged on last 3 days (below capacity of one HL250 F.S ≥ 3)	Pond elevation stable at < 115.3 masl	Expected trend observed	General : Continue monitoring as per standard practices
Yellow	Monitor		Sudden or cumulative increase over last 3 days of > 25%	≥ 200 m3/h and < 1300 m3/h averaged on last 3 days (capacity of two HL250)	Pond elevation > 115.3 but < 115.8 masl	Stable seepage rate	Specific : Increase pumping capacity with back up HL250 pump in place General : Install additional instruments General : Implement engineering review
Orange	Proactive			≥ 1300 m3/h and < 1500 m3/h averaged on last 3 days (limit capacity of two HL250)	Pond elevation >115.8 but < 116 masl	Opposite trend observed	Specific : Evaluation and planning of parallel dewatering infrastructures Specific : Inspect West Road integrity General : Evaluation and planning of alternative deposition location General : Evaluation and planning of diminution of South Cell hydraulic head
Red	Reactive			≥ 1500 m3/h averaged on last 3 days (over capacity of two HL250)	Pond elevation > 116 masl		Specific : Install parallel dewatering infrastructures and consider installation of a 3rd HL250 pump Specific : Frequent inspection of Portage pit and West Road for flooding evidence Specific : Manage flood water in the pit General : Alter deposition sequence to increase tailings cover General : Execution of South Cell hydraulic head diminution strategy General : Grouting General : Initiate Emergency Response Plan

(1) Specific model: Doc1562 CD Seepage Modelling 16670255 Rev0 - must be interpreted by the designer and/or geotechnical coordinator

Table 4-8 : Threshold Criteria and pre-defined action during operation of Central Dike (Part 2/3)

		Personnel notified	Instrumentation monitoring (1)					
			Piezometers P1 installed in the till layer total head (2)	***Piezometers P2 installed in the till layer total head (3)***	***Change in Piezometric head***	***Thermistors***	***Downstream pond and TSS***	
			Threshold	**Threshold**	-	**Threshold**	**Threshold**	**Possible actions**
Green	Normal	Take action and notify personel as per decision framework of Figure 4.2	< 121.5 masl F.o.S > 1.5	< 115.5 F.o.S > 1.5	change less than 1 m in 3 day	Seasonal trend observed	Background TSS observed (4mg/L)	General : Continue monitoring as per standard practices Specific : Daily inspection of the structure by qualified personal and frequent instrumentation monitoring
Yellow	Monitor		121.6 - 126.2 masl 1.5 > F.o.S > 1.3	115.5 - 117.8 masl 1.5 > F.o.S > 1.3	change of 1 m in 3 days of piezometric head	Peak of temperature similar to South Cell TSF temperature observed in at least a single bead	Single TSS event of 30 mg/L	General : Evaluate needs to install additional instruments General : Implement engineering review
Orange	Proactive		126.3 - 127.4 masl 1.3 > F.o.S > 1.1 and based on interpretation by Geotechnical Coordinator or Designer	> 117.9 F.o.S < 1.3 and based on interpretation by Geotechnical Coordinator or Designer			Sustained high turbidity over 30 mg/L	Specific : Implement engineering review Specific : Increase in frequency of monitoring at station of concern Specific : Build buttress General : Evaluate needs to install additional instruments General : Evaluation and planning of alternative deposition location General : Evaluation and planning of diminution of South Cell hydraulic head
Red	Reactive							General : Alter deposition sequence to increase tailings cover General : Execution of South Cell hydraulic head diminution strategy (could include emptying the South Cell) General : Grouting General : Initiate Emergency Response Plan

(1) Instrumentation data must be interpreted by geotechnical coordinator or dike designer (Golder)
(2) Failure of till foundation: add report reference Specific model : Doc1562 CD Seepage Modelling 16670255 Rev0 - Section 6
(3) Backward erosion: add report reference. Specific model : Doc1562 CD Seepage Modelling 16670255 Rev0 - Section 7.3

Table 4-9Threshold Criteria and pre-defined action during operation of Central Dike (Part 3/3)

		Personnel notified	Visual Inspection							
			Loss of tailings	***Dike Vertical Movement - Cumulative crest settlement***	***Downstream toe displacement***	***Tension/shear crack at crest***	***Embankment lateral cumulative deformation (1)***	***Sloughing along downstream rockfill embankment face***	***Sinkhole on embankment***	
			Threshold	**Threshold**	**Threshold**	**Threshold**	**Threshold**	**Threshold**	**Threshold**	**Possible actions**
Green	Normal	Take action and notify personel as per decision framework of Figure 4.2	Normal operating conditions	No settlement observed	No displacement observed	No tension crack observed	No deformation observed	No sloughing observed	No depressions on crest	General : Continue monitoring as per standard practices Specific : Daily inspection of the structure by qualified personal and frequent instrumentation monitoring
Yellow	Monitor		Localized depression in tailings observed	<0.2m	Observed displacement at the toe	< 0.10 m wide across the dike & < 5 m length along the dike	< 0.1 m	Single event observed	Localized depression of embankment crest	Specific : Fill all cracks General : Install additional instruments General : Implement engineering review
Orange	Proactive		Presence of sustained localized depression in tailings and/or tailings observed inside the downstream pond	> 0.2 m and < 1.0 m Increasing rate of settlement	Displacement rate observed	> 0.10 m and < 0.20 m wide across the dike > 5 m and < 10 m length along the dike	> 0.1 m and <0.25 m	More than one events observed	Sinkhole identified	Specific : Implement engineering review Specific : Increase in frequency of monitoring at station of concern Specific : Build buttress General : Evaluation and planning of alternative deposition location General : Evaluation and planning of diminution of South Cell hydraulic head
Red	Reactive		Increase in depression hole dimension and/or tailings observed inside the Portage Pit	> 1.0 m Increasing rate of settlement	Acceleration of displacement rate	> 0.20 m wide across the dike > 10 m length along the dike	> 0.25 m	Continued event(s)	Development of sinkhole	General : Alter deposition sequence to increase tailings cover General : Execution of South Cell hydraulic head diminution strategy (could include emptying the South Cell) General : Grouting General : Initiate Emergency Response Plan

<u>NOTE:</u> *Specific action are triggered by specific risk (stability, seepage, environment)while general action are applied to all risk category*

If more than one criteria is triggered, a reevaluation of our global Alert level will be performed by the AEM team

4.8 COMMUNICATION AND DECISION MAKING

Figure 4-2 indicate the communication and decision process when the threshold criteria are met and when pre-defined action need to be implemented.

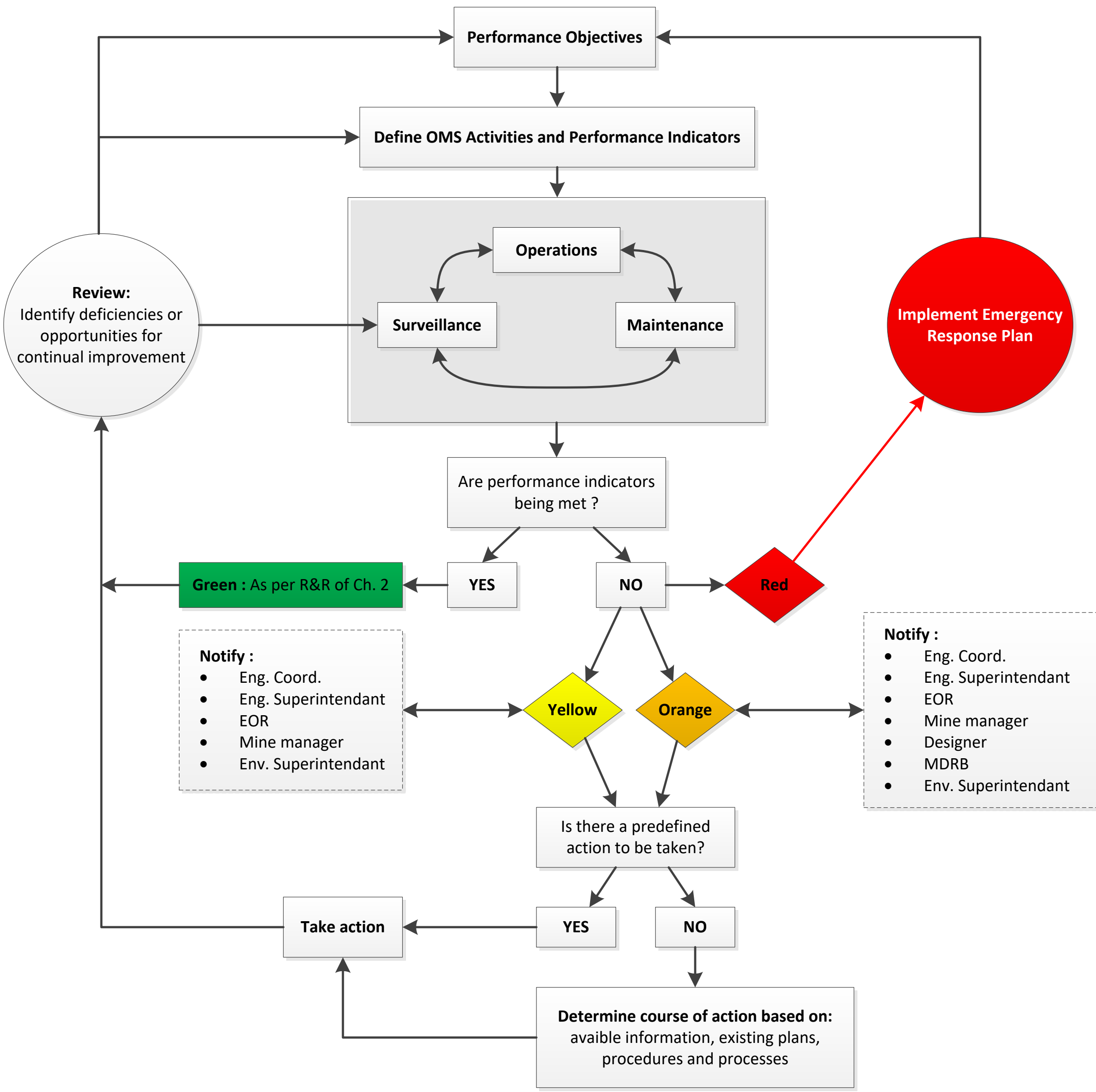

Figure 4-2 : Communication and Decision Process for Tailings Management TARP

SECTION 5 • MAINTENANCE

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

The objectives of the maintenance program are to review and identify maintenance requirements, executing corrective measures and timely repairs of the containment structures, perimeter water control structures, facility access, and infrastructure.

5.1 PREVENTATIVE, PREDICTIVE AND CORRECTIVE MAINTENANCE

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

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

Predictive maintenance are pre-defined maintenance 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 maintenance is based on surveillance activities, with surveillance results identifying the need and urgency of maintenance.

5.2 REFERENCES

Reference to key document for the maintenance of the Whale Tail water management infrastructure is presented in Table 5-1.

Table 5-1: Reference documents for Maintenance of Whale Tail water management infrastructure

Type of information	Link to Retrieve Information
Maintenance log of water 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)	In progress
Pump allocation tool	..\..\..\04- Water Management\4- Water Management Infrastucture\3- 2019\1 - Planning\9-Procurement\Pump Allocation\AMQ Pump Allocation 2019-2020.pptx
Geotechnical instrument & Datalogger inventory	In progress

5.3 COMPONENT OF THE TAILINGS MANAGEMENT INFRASTRUCTURE REQUIRING MAINTENANCE

Table 5-2 indicate all the component of the Whale Tail water management infrastructure that require maintenance.

Table 5-2: Component of the water management infrastructure requiring maintenance

Water Management Infrastructure
• Dike embankment (i.e repair erosion, reprofile slope) • Dike crest (i.e fill inactive tension cracks) • Seepage collection sump (i.e, reprofile slope, increase sump volume) • Ditches and diversions (i.e snow removal, repair erosion, remove sediment accumulation)
Pumping infrastructure
• Pumps (mechanical and electrical maintenance) • Pipes (steaming, drain line, repair leak, avoid snow blockage) • Flush pipes of tailings and water prior to periods of non-use
Surveillance
• Geotechnical instruments (thermistors, piezometers, inclinometers, survey monument) • Data acquisition system • Flowmeter
Other
• Dike crest access road • Access to sump

5.3.1 Maintenance component that are outside the scope of this OMS manual

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

- Infrastructures located within the process plant – 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 ACTIVITY

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

Table 5-3 :Description of maintenance activity for component of tailings management infrastructure

Component	Type of maintenance	Nature of the activity	Frequency of maintenance (preventative) OR Trigger of maintenance (predictive and corrective)	Responsible for the activity	Documentation Required	Reporting Requirement
Water Management Infrastructure						
Dike embankment - repair erosion	Corrective	Gullies and depression to be filled with rockfill and re-sloped	Following a demand from engineering superintendant following a visual inspection showing erosion	Mine Superintendent (can use a contractor alternatively)	Photo of remediation work	Engineering to update the maintenance log of the structure
Dike crest – fill inactive tension cracks	Corrective	Inactive tension cracks to be filled with bentonite to prevent widening due to water infiltration	Following a demand from engineering superintendant following a visual inspection showing inactive tension cracks	Geotechnical technician	Photo of remediation work	Engineering to update the maintenance log of the structure
Dike crest - compensate settlement	Corrective	Add rockfill to increase the height of the dike following observation of settlement	Following a demand from engineering superintendant following a visual inspection showing settlement that need to be compensated (i.e loss of freeboard)	Mine Superintendent (can use a contractor alternatively)	Photo of remediation work Surveying of remediation work	Engineering to update the maintenance log of the structure and provide surveying
Seepage collection sump– increase volume	Predictive	Excavate an additional sump or increase the capacity of an existing sump	Following a demand from engineering superintendant following a re-assessment of the sump capacity	Mine Superintendent (can use a contractor alternatively)	Photo of remediation work Surveying of remediation work	Engineering to update the maintenance log of the structure and provide surveying
Seepage collection sump – reprofile sump	Corrective	Excavate flatter slope for the sump or add material against the slope to reprofile them	Following a demand from engineering superintendant following a visual inspection showing instable sump slope	Mine Superintendent (can use a contractor alternatively)	Photo of remediation work	Engineering to update the maintenance log of the structure and provide surveying
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. Demand will be formulated by the Engineering Superintendent	Energy & Infrastructure Superintendant	Photo of remediation work	Engineering to update the maintenance log of the structure
Ditches – clean debris and sediment accumulation	Corrective	Remove any debris and accumulation of sediment that can hinder flow	Following a demand from engineering superintendant following a visual inspection showing accumulation of debris and sediment	Energy & Infrastructure Superintendant	Photo of remediation work	Engineering 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 demand from engineering superintendant following a visual inspection showing erosion of the ditches	Energy & Infrastructure Superintendant	Photo of remediation work	Engineering 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 the ditches using pump	Following a demand from the environment superintendant following sampling of a high turbidity event from the diches	Environment Superintendant	Water sample results Photo of remediation work	Engineering to update the maintenance log of the structure
Pumping infrastructure						
Pumps and Genset – maintenance as per manufacturer specification	Preventative	Do PM on the pumping unit as per manufacturer recommendation	As per manufacturer specification	Pump mechanics	Equipment log Maintenance record	Maintenance to update the pump maintenance log or Genset maintenance log
Pumps and Genset – maintenance when defiency are observed (cavitation, breakdown, electrical trouble)	Corrective	Troubleshoot the pump problem so that it is once again oeprational	When the E&I Superintendant ask that a pump be fixed following a visual inspection of defiecny	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 witner have been winterised	Once new pump is received on site that will be used in winter	Maintenance superintendant	Maintenance record	Maintenance to update the pump maintenance log
Pipe – drain the line	Preventative	Ensure that the line is empty of water and tailings during tailings deposition switch or mill shutdown	Every time tailings deposition is interrupted or switch	Energy & Infrastructure Superintendant	-	-
Pipe – unfreezing a line	Corrective	Steaming the line to unfreeze it in winter	When the E&I Superintendant ask that a line be unfroze following visual inspection of a frozen line	Energy & Infrastructure Superintendant	-	-
Pipe – maintenance when defiency are observed (leak, pipe burst)	Corrective	Replacing a deficient part of a line with new pipe	When the E&I Superintendant ask that a line be repaired following visual inspection of pipe deficiency	Energy & Infrastructure Superintendant	-	-
Surveillance						

Component	Type of maintenance	Nature of the activity	Frequency of maintenance (preventative) OR Trigger of maintenance (predictive and corrective)	Responsible for the activity	Documentation Required	Reporting Requirement
Geotechnical Instrument – loss of reading	Corrective	Investigate the status of an instrument who no longer gave data	When an instrument no longer gave data for an unknown reason	Geotechnical technician	Update status in instrument database	Update of the geotechnical instrument database by the geotechnical technician
Geotechnical instrument – unusual reading	Corrective	Investigate the status of an instrument who gave unusual data	When an instrument gave an unusual data	Geotechnical technician	Update status in instrument database	Update of the geotechnical instrument database by the geotechnical technician
Geotechnical instrument – replacement	Corrective	Replace an instrument that no longer work	When the engineering superintendant as for a geotechnical instrument to be replaced	Geotechnical technician	Instrument installation as-built report Update spare inventory Calibration sheet Initial instrument rading	Update of the geotechnical instrument database by the geotechnical technician
Geotechnical instrument –calibration of total station	Preventative	Send the total station to be calibrated	yearly	Geotechnical technician	Calibration sheet	Update of the geotechnical instrument database by the geotechnical technician
Geotechnical instrument –calibration of inclinometer probe	Preventative	Send the inclinometer probe to be calibrated	yearly	Geotechnical technician	Calibration sheet	Update of the geotechnical instrument database by the geotechnical technician
Datalogger – maintenance	Preventative	Do maintenance of datalogger as per manufacturer specification	yearly	Geotechnical technician	Maintenance report	Update of the geotechnical instrument maintenance log by the geotechnical technician
Datalogger – battery change	Predictive	Change battery when the battery level alarm get triggered	When the battery alarm is trigered in VDV	Geotechnical technician	Maintenance report	Update of the geotechnical instrument maintenance log by the geotechnical technician
Datalogger – troubleshooting	Corrective	Repair of a dataloger deficiency	When a dataloger is suspected of being deficient	Geotechnical technician	Update status in instrument database	Update of the geotechnical instrument maintenance log by the geotechnical technician
Flowmeter – calibration	Preventative	Send the flowmeter to be calibrated	yearly	Energy & Infrastructure Superintendant	Calibration sheet	Update of the geotechnical instrument maintenance log by the geotechnical technician
Flowmeter – deficient reading	Corrective	Repair of a flowmeter deficiency	When the Engineering Superintendant ask that a flowmeter be troubleshoot based on irregular data	Energy & Infrastructure Superintendant	Update status in instrument database	Update of the geotechnical instrument database by the geotechnical technician
Other						
Dike crest access	Predictive	Snow clearing, maintaining roadway, grading access	As required to maintain access	Mine Superintendent	-	-
Access to sump	Predictive	Snow clearing, maintaining roadway, grading access	As required to maintain access	Mine Superintendent	-	-

SECTION 6 • SURVEILLANCE

Surveillance Involves the inspection and monitoring (i.e collection of qualitative and quantitative observation and data) of activities related to tailings management infrastructures. Surveillance also includes the timely documentation, analysis and communication of surveillance results, to inform decision making and verify whether performance objective including critical controls are being met.

There are two type of surveillances activities which are further discussed in this chapter :

- Site observation and inspection
- Instrument monitoring

6.1 SITE OBSERVATIONS AND INSPECTIONS

The purpose of site observation and inspection is to identify warning signs for the development of potentially adverse conditions that could lead to a failure or some other form of loss of control. Site observation and inspection include the direct observations by personel on or adjacent to the tailings management infrastructure and may also include observation from helicopter or photo taken from unmanned airborne vehicle (UAV, satellites).

Site observation and inspections are used to identify and track visible change in the condition of the water management infrastructure. Changes that may be observed throughout site observations and inspections are included in Table 6-1.

Table 6-1: Changes that may be observed through site observation and inspection of tailings management infrastructure

Changes related to physical risk of dike, road, ramp, ditches
• Change in freeboard • Deformation or change in condition at the crest, slopes and toes (i.e bulge, cracks, sinkhole, sloughing, settlement) • Newly form 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) • Newly form of obstruction to flow in ditchs(i.e boulder, sediments, snow)
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 tailings & water storage and transport
• Change in sump level • Verify using the staff gauge that the pond is operated within its normal operating condition • Changes in the seepage quantity (pumping rate) and quality (turbidity) • Condition of pipe for tailings or water transport • Sign of leaks from tailings or water line • Condition of pumps and water reclaim infrastructure
Change related to surveillance instrumentation
• Condition of surveillance instruments and associate protection around instruments (i.e cover, barriers to prevent vehicle damage) • Condition of power supplies for instruments (i.e solar panel) • Condition of communication infrastructure associated with instruments (i.e antenna, datalogger)

6.1.1 Site observation

Site observation is conducted by personnel working on or adjacent to tailings management infrastructure as part of their daily activities, maintaining awareness of the facility in the course of carrying their duties. Trained personnel such as geotechnical technician should be on the lookout for sign of changing condition as indicated in **Error! Reference source not found.** as adverse condition can develop rapidly between inspection. 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 personel or Engineering Superintendant.

6.1.2 Inspection program

Inspection are conducted by the engineering department or other personel 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 inspection, dike safety inspection and dam safety review. The following sub-section describe in more details the scope, frequency and responsible for each type of inspection.

The main types of inspections are as follows:

- Routine visual inspections – performed on a predetermined basis by AEM geotechnical team;
- Special visual inspections – performed during and afeter unusual events by AEM geotechnical team ;
- Dike Safety Inspection (annual geotechnical inspection) – performed annually by a Geotechnical Engineering Consultant familiar with the design and operation of the facility to verify that the facilities are functioning as intended
- Independent Dam Safety Review – carried out by the dike review board of independent engineers every year to review all aspects of the design, construction, operation, maintenance, processes and other systems affecting the dam's safety, including the dam safety management system. The review defines and encompasses all components of the "dam system" under evaluation including the dam, foundations, abutments and seepage collection works.

6.1.2.1 Routine Visual Inspection

Routine visual inspection 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 inspection need to cover the aspect described in Table 6-1. Of particular significance are new occurrence or noted changed in seepage, erosion, sinkholes, boils, slope slumping, settlement, displacement, or cracking of structure components. These inspection are held during operation.

There are two approved inspection form for inspection ; a simplified one and a detailed one. The detailed form should be used for monthly inspection while the simplified one can be used when inspection are required at an increased frequency. All area of the form must be fill.

The person responsible for the inspection must :

- Do the inspection as per the required frequency
- Fill all information on the proper inspection form
- Take picture 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. Photos should be annotated or captioned and should include a date stamp.
- Store electronically all photo and inspection form
- Update the surveillance log

- Ensure that the reviewer is aware that the document is ready to be reviewed

During the review process, the reviewer must:

- Ensure that all require information is present
- Ensure that the observation does not trigger a change in alert level
- Sign the inspection form as a reviewer
- Update the surveillance log
- Distribute the inspection results

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

Table 6-2 summarise the Routine & Special visual inspection R&R, suggested frequency and scope in function of the alert level of the structure.

Table 6-2: Summary of routine inspection requirements

Structure	TARP Level	Inspection Responsible	Scope of inspection	Inspection Frequency	Reporting	Inspection Reviewer	Distribution List
SD1, SD2, SD3, SD4, SD5, RF1, RF2, Central Dike, Stormwater Dike, NCIS - Operation	Green	Geotechnical Technician	Physical risk and surveillance	Monthly	Detailled inspection form	Geotechnical Engineer	Engineering Geotechnical Team, EOR
				Weekly during period of flow (from May to October)	Simplified inspection form	-	
	Yellow	Geotechnical Technician	Physical risk and surveillance	Monthly	Detailled inspection form + presentation and analysis of instrumentation data	Geotechnical Engineer	Engineering Geotechnical Team, EOR
				Weekly	Simplified inspection form		
	Orange	Geotechnical Technician	All of Table 7-2	Weekly	Report on summary of surveillance activity + status of mitigation action	Geotechnical Engineer	Engineering Geotechnical Team, EOR, designer, Management
				Monthly	Detailled inspection form + presentation and analysis of instrumentation data	Geotechnical Engineer	Engineering Geotechnical Team, EOR
		Geotechnical Engineer		Daily	Simplified inspection form	Geotechnical Coordinator	Engineering Geotechnical Team, EOR
TSF Pond, Tailings distribution and Pumping Infrastructure – Operation	Green	Water & Tailings Engineer	Tailings & Water storage and transport	Monthly	Detailed Inspection	Geotechnical Coordinator	Engineering Geotechnical Team, E&I, EOR,
				Weekly (from May to October)	Simplified inspection form		
	Yellow	Water & Tailings Engineer or Geotechnical Engineer	Water storage and transport	Weekly in area of concern	Simplified inspection form	Geotechnical Coordinator	Engineering Geotechnical Team, E&I, EOR,
				Monthly	Detailled inspection form + presentation and analysis of relevant instrumentation data		
	Orange	Water & Tailings Engineer or Geotechnical Engineer	Water storage and transport + physical stability of ramp	Daily	Simplified inspection form	Geotechnical Coordinator	Engineering Geotechnical Team, EOR, designer, Management
				Weekly in area of concern	Detailed Inspection + report on summary of surveillance activity		

6.1.2.1 *Special Visual Inspection*

Special inspections are conducted during and after unusual or extreme events that may impact the facility. Special inspection are conducted by the geotechnical engineer or Engineer of Record using the detailed inspection form and using the same procedure for review and documentation. Special visual inspection must be done on each structure after each of these events:

- Following a blast that exceed 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 notice a change in condition
- Prior or immediately after increasing or decreasing the TARP level of a structure

6.1.2.2 *Dike Safety Inspection (annual geotechnical inspection)*

A dike safety inspection is a more comprehensive technical inspections, integrating inspections and results of monitoring instrument. This type of inspection is conducted by an external geotechnical engineer and supported by the Engineer of Record to have a more complete understanding of the facility performance and identify deficiencies in performance or opportunity for improvement. This will provide information to be used to revise the OMS manual.

Such inspection need to occur on an annual basis between the month of July and 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 channel

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

- Review of all inspections report performed since the last review
- Review of monitoring instruments data;
- Identify deficiencies in performance or opportunity for improvement
- Review OMS performance and operational criteria and confirm that these meet the performance objective of the design
- Review and provide recommendations regarding OMS for the following year.

After each safety inspection a report must be submitted to the Engineering Superintendant which include the results of the inspection done and addressing all point above. These report will be stored electronically.

6.1.2.3 Independent Dam Safety Review

Independent dam safety review are carried out by an independent third party to review all aspects of the design, construction, operation, maintenance, processes and other systems affecting the dam's safety, including the dam safety management system. The review defines and encompasses all components of the "dam system" under evaluation including the dam, foundations, abutments, instrumentation and seepage collection works. The independent third party for the tailings management infrastructure is the Meadowbank Dike Review Board (MDRB).

Modification to the MDRB composition can only be made by the Engineer of Record.

The Meadowbank Dike Review Board (MDRB) is comprised of the following member.

- Anthony Rattue
- Don Haley

An annual MDRB meeting will be held every year at the Meadowbank site. Other event that could trigger a MDRB meeting are:

- Major modifications to the design or design criteria;
- Discovery of unusual conditions that can compromise the integrity the water management infrastructure;
- After extreme hydrological or seismic events; and
- Decommissioning.

During the annual MDRB meeting, a dam safety review will be carried out according to the recommendations laid out in the Dam Safety Guidelines (CDA, 2013).

This review will include, but is not limited to:

- Review of the dikes classification;
- Site inspection;
- Review of design and construction records;
- Review of monitoring practices and the instrumentation records
- Assessment of the operation of the facilities;
- Provide recommendation on operation, maintenance and surveillance based on the results of the instrumentation readings, construction records and site observations;

6.2 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 infrastructure 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 water management infrastructure performance and provide a basis for informed decision. 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 Section3.4 of this OMS manual.

Table 6-3 indicate the type of information collected through instruments monitoring and how it is collected. Table 6-4 summarise the data acquisition program related to instrument monitoring

Table 6-3: Information collected using instrument monitoring

Direct collection of information
• In-situ thermistors to measure temperature profile within the structure and its foundation and within the tailings • In-situ piezometer to measure pore-water pressure providing information about flow of water through the structure and foundation stability • Survey monument to provide information on settlement and deformation • Staff gauge to inform about water level of a pond versus its operating level • Blast monitor to inform on potential impact of blasting vibration on the structure • Flow meters and seepage monitoring station to inform on volume of water movement • Surveys conducted to measure ice cover, water level, 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 • Water quality analysis of water discharged through diffuser to inform on Environmental compliance • Water quality analysis of water stored in the various pond on site to inform on water movement decision
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 6-4: Summaries of data acquisition program related to instrument monitoring of Whale Tail water management infrastructure

Instrument monitoring	Location of monitoring (3)	Parameter measured	Acquisition Methodology	Standard Acquistion 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	Geotechnical Technician	Data are exported from VDV into instrumentation report emited at a predetermined frequency (1)(2)	Geotechnical Engineer
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	Geotechnical Technician	Data are exported from VDV into instrumentation report emited at a predetermined frequency (1)(2)	Geotechnical Engineer
Survey monument	NCIS, SWD, CD	Elevation of monument which is then converted into mm of displacement (minimum precision of 3 mm required)	Data are acquired using a total station	Monthly in winter and bi-weekly from May to September	Geotechnical Technician	Data are exported into geoexplorer. Instrumentation report are emited at predetermined frequency (1)(2)	Geotechnical Technician
Staff Gauge	North Cell Pond	Water level in pond	Take picture of the gauge	During each inspection	Inspection officer	Within inspection report	Inspection officer
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 vicinity of the dike	Geotechnical Technician	Update the blast vibration log. Discussion on recorded vibration in instrumentation report	Geotechnical Technician
Flow meter	Central Dike D/S	Volume of water pump (m^3)	Pumpman operator will inscribe flowmeter value ona pumping sheet	Daily when pump is operating	E&I Pump crew supervisor	Data will be integrated in the water balance	Water & Tailings engineer
Seepage monitoring station (manual reading with a V notch)	Where umpumped seepage is observed	Seepage flow (m^3/s)	Using a bucket and a stopwatch	Weekly during period of flow	Geotechnical Technician	Documented within instrumentation	Geotechnical Engineer
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	Surveyor Leader	Integrated in the tailings deposition plan	Water & Tailings engineer
Airborne survey	Whole TSF	Topographic aerial survey made using drone	Surveyor will take a drone survey	Once per year after freshet	Surveyor Leader	Within survey database	Surveyor Leader
Water quality	Central Dike seepage (4)	Parameter 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

(1)Refer to section 6-4 for more information on reporting methodology and the frequency of reporting
(2) Refer to section 6-5 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

6.3 ADDING INSTRUMENT TO THE MONITORING PROGRAM

Any addition to the monitoring program must be validated by the Engineering Superintenant or by the Environment Superintendant for aspect relating to water quality. 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 coordinate (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

6.4 ANALYSIS OF SURVEILLANCE RESULTS

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

For visual inspection the process of analysing the data and communicating the results is describe in Section 6.1 and happen at the same time 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 inform the action to take if performance indicator are not met.

For the instrumentation monitoring to be effective the data must be reviewed, analysed and reported at the proper frequency. Table 6-5 summarise the requirement for review, analyses and reporting of instrumentation data.

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

Table 6-5 : Requirement for Review, Analyses and Reporting of Instrument Data

Instrumentation	TARP Level	Expected range of observation	Responsible for review & analyse	Frequency of review	Responsible for reporting	Reporting frequency	Responsible for review and distribution	Distribution List
Piezometer, thermistor, survey monument	Green	Define in TARP of each structure	Geotechnical Engineer	Bi-Weekly	Geotechnical Technician	Quaterly instrumentation report	Geotechnical Engineer	Engineering geotechnical team, designer, EOR
			Geotechnical technician	Weekly				
	Yellow	Define in TARP of each structure	Geotechnical Engineer	Weekly	Geotechnical Technician	Instrumentation reporting included within monthly inspection report	Geotechnical Engineer	Engineering geotechnical team, designer, EOR
			Geotechnical technician	Every 3 days				
	Orange	Define in TARP of each structure	Geotechnical Engineer	Daily	Geotechnical Engineer	Instrumentation reporting included within weekly update report	Geotechnical Coordinator	Engineering Geotechnical Team, EOR, designer, Management
			Geotechnical technician	Daily				
Staff Gauge / Survey shot (freeboard)	Green	Define in TARP of each structure	Water & Tailings Engineer	Weekly	Water & Tailings Engineer	Within the monthly attenuation pond and pumping infrastructure inspection report	Geotechnical Coordinator	Engineering geotechnical team, designer, EOR
	Yellow	Define in TARP of each structure	Water & Tailings Engineer	Daily	Water & Tailings Engineer	Within the monthly attenuation pond and pumping infrastructure inspection report	Geotechnical Coordinator	Engineering geotechnical team, designer, EOR
	Orange	Define in TARP of each structure	Water & Tailings Engineer	Twice a day	Water & Tailings Engineer	Included within weekly update report	Geotechnical Coordinator	Engineering Geotechnical Team, EOR, designer, Management
Blast Monitor	-	PPV> 50 mm/s	Geotechnical Technician	After retrieving a blast monitor on a water management structure	Geotechnical Technician	In Quaterly instrumentation report	Geotechnical Engineer	Engineering geotechnical team, designer, EOR
Flow meter / Seepage monitoring	Green	Define in TARP of each structure	Water & Tailings Engineer	Weekly	Water & Tailings Engineer	During the monthly update of the water balance	Geotechnical Coordinator	Engineering geotechnical team, designer, EOR
	Yellow	Define in TARP of each structure	Water & Tailings Engineer	Daily	Water & Tailings Engineer	During the monthly update of the water balance	Geotechnical Coordinator	Engineering geotechnical team, designer, EOR
	Orange	Define in TARP of each structure	Water & Tailings Engineer	Twice a day	Water & Tailings Engineer	Included within weekly update report	Geotechnical Coordinator	Engineering Geotechnical Team, EOR, designer, Management
Water quality	Green	Define in TARP of each structure	Environment General Supervisor	As per water management plan	Environment General Supervisor	As per water management plan	Environment Superintendant	Engineering geotechnical team
	Yellow	Define in TARP of each structure	Environment General Supervisor	As per water management plan	Environment General Supervisor	As per water management plan	Environment Superintendant	Engineering geotechnical team
	Orange	Define in TARP of each structure	Environment General Supervisor	As per water management plan	Environment General Supervisor	As per water management plan	Environment Superintendant	Engineering geotechnical team

6.4.1 Procedure in case of data exceeding 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:

- Re-read to check the reading (if the reading is from VDV, take a manual reading in the field);
- Check readout equipment to verify that it is functioning correctly;
- Verify calibration;
- If instrument has stopped functioning, notify the Engineering Superintendent 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 Engineering Superintendent. Any malfunctioning instrument or frozen piezometer must be documented.
- In the case of valid data that would exceed the TARP level do a special inspection if possible.

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

6.4.1.1 Blast Monitor

If a reading exceeding the PPV limit for a water 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 changing condition.

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

6.4.2 Anomalous Instrumentation Data

Anomalous instrumentation data includes the following as presented in Table 6-6. These anomaly could happen without triggering a TARP level change and need to be investigated and recorded:

Table 6-6: Example of anomalous data and some common cause

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); • Sharp increase in reading (verify that the instrument is not frozen) • Loss of data (could be a transmission error, faulty hardware or a sheared cable)
Inclinometer
• Cumulative increases in displacement (greater than 3 cm); • Erratic movement. This is usually a sign of water infiltration
Survey Monument
• Accelerating displacement rate of the survey monuments (x, y, z directions) (over two or more readings) (could be due to a prism shooting error or problem with the total station)
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 and staff gauge
• Sudden change in staff gauge reading. Or reading that seem to not reflect the probable water elevation. This could be due to a settlement or displacement of the staff gauge. • Increase or decrease in 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 taken at the good location, wave actions or daily variances in GPS signal

6.5 SURVEILLANCE DOCUMENTATION & REPORTING

One visual inspection report per structure needs to be completed, reviewed and distributed per the frequency in Table 6-2.

An instrumentation report need to prepare at predetermined frequency to present all instrumentation monitoring data as described in Table 6-4.

Table 6-7 describe how instrumentation data should be reported.

Instrumentation report need to include the following information :

- Table presenting all the instruments installed on each structure, their status and pertinent installation information
- Graph of all instruments for all structure covered by the report. The graph need to present data for a minimum period of 1 year. Higher recurrence should be presented if clarity of the presented information allows it. The graph need to be presented in a way that allow for data interpretation without referring to other document
- Analyses of all instruments data presented highlighting specific trend
- Discussion on anomalous trend

For the structure having a yellow Tarp level the instrumentation data relevant to the cause of the alert need to be included with each visual inspection report.

For the structure having an orange Tarp level the instrumentation data relevant to the alert level need to be included with each inspection report. In addition the weekly update report need 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
- What is the mitigation plan and what action have been taken since the last update report
- Discussion on the result of the instrumentation data

Table 6-7 : How data should be presented in report for instrumentation monitoring

Thermistance
• Temperature vs. depth plots over time. • The plot should indicate the thermistor string reference number and date of each measurements presented • The plot need to indicate relevant stratigraphy and their depth • Plot need to be presented with a cross-section of the installation (if on a structure) as well as a plan view showing the instrument location
Piezometer
• Plots of total head as elevation versus time; and • Plot need 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 need to indicate the instrument number, the dates of each measurement and a mention if the temperature read by the instrument is less than 0 degree
SAA
• Cumulative displacement plots (to view total displacement); • Incremental displacement plots (to present increasing or accelerating movements between readings); • Cumulative displacement at crest versus time; and • Time plots at zones of identified displacement. • The plot need to indicate the SAA number, what is considered positive and negative displacement and the dates of each measurement • Both elevations and depths should be presented together with the lithology. • A plan view need to be included showing the instrument location
Survey Monument
• Total net movement plots (to present total displacement); • Vertical displacement plots; and • Lateral displacement plots parallel and perpendicular to the dike axis • The plot need to indicate the survey monument number, what is considered positive and negative displacement and the dates of each measurement • A plan view need to be included showing the instrument location

6.6 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 the hard copy and/or electronic format.

- Instrumentation report
- Visual inspection report
- Weekly report for structure in orange Tarp level
- Dike safety inspection (annual geotechnical inspection)
- Dam Safety Review report;
- Surveillance log
- Instruments database and map
- Maintenance log of geotechnical instrument
- Maintenance log of water management infrastructure
- Pump maintenance record

SECTION 7 • REFERENCES

Canadian Dam Association (CDA) 2007. Dam Safety Guidelines.

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Mining Associate of Canada (MAC) 2005 Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities.

Mining Association of Canada (MAC) 2008. A Guide to the Management of Tailings Facilities. Second Edition.

AEM, Emergency Response Plan, Ver.10, August 2016

Appendix A
Tailings Storage Facility – Inspection Form

XX INSPECTION REPORT

AGNICO EAGLE
MEADOWBANK

The instrumentation data for TARP yellow level structures is attached at the end of each inspection report

Inspecting Officer	
Report No.	XX-VIR-XX
Inspection Date	

Dike name	
Crest Elevation (m)	
D/S Toe Pond Elev. (m)	
South Cell Water Elev. (m)	

Last Inspection Date						
Weather during the current inspection	-XX C°	Sunny ☐	Overcast ☐	Rain ☐	Snow ☐	Wind ☐
	Comments:					
Main changes since the last inspection	None					

Tarp level (Based on OMS manual revision from February 2019)	Green

GENERAL CONDITION SUMMARY

-

RECOMMENDATIONS

-

AGNICO EAGLE
MEADOWBANK

XX INSPECTION REPORT

FIELD OBSERVATIONS

Location	***Observations***	***Recommendations***
Downstream slope	▪	▪
Upstream slope	▪	▪
Crest	▪	▪

XX INSPECTION REPORT

AGNICO EAGLE
MEADOWBANK

SEEPAGE REPORT

Location	*Observations*	*Recommendations*
	▪	▪

Appendix B
Tailings Storage Facility Instrumentation List

Legend	
(green)	Instrument fully working
(yellow)	PZ frozen or TH bead missing but still giving data
(red)	Instrument not communicating

Central Dike

Hole	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
465-P3	465-P3-A	Piezo	Frozen	Automatic (DL37)	65	Bedrock	-	-
	465-P3-B	Piezo	Frozen	Automatic (DL37)	85	Bedrock	-	-
	465-TH-P3	Thermistor	✓	Automatic (DL37)	-	-	10/13	105/69
545-P1	545-P1-A	Piezo	✓	Automatic (DL12)	65	Bedrock	-	-
	545-P1-B	Piezo	× (since Nov. 2018)	Automatic (DL12)	76	Bedrock	-	-
	545-P1-C	Piezo	✓	Automatic (DL12)	80	Dense Till	-	-
	545-P1-D	Piezo	× (since Dec. 2018)	Automatic (DL12)	88	Dense Till	-	-
	545-TH-P1	Thermistor	✓	Automatic (DL12)	-	-	13	111/63
545-P2	545-P2-A	Piezo	× (since Jan 2, 2019)	Automatic (DL44)	65	Bedrock	-	-
	545-P2-B	Piezo	× (since Jan 2, 2019)	Automatic (DL44)	85	Bedrock	-	-
	545-P2-C	Piezo	× (since Jan 21, 2019)	Automatic (DL44)	100	Bedrock	-	-
	545-P2-D	Piezo	Frozen	Automatic (DL44)	104	Rock fill/Till	-	-
	545-TH-P2	Thermistor	✓	Automatic (DL44)	-	-	13	105/51
580-P1	580-P1-A	Piezo	× (since July 2016)	Automatic (DL12)	-	-	-	-
	580-P1-B	Piezo	× (since July 2016)	Automatic (DL12)	-	-	-	-
	580-P1-C	Piezo	× (since July 2016)	Automatic (DL12)	-	-	-	-
	580-P1-D	Piezo	× (since July 2016)	Automatic (DL12)	-	-	-	-
	580-P1-E	Piezo	× (since July 2016)	Automatic (DL12)	-	-	-	-
	580-TH-P1	Thermistor	× (since July 2016)	Automatic (DL12)	-	-	-	-
595-P1	595-P1-A	Piezo	✓	Automatic (DL12)	69.25	Bedrock	-	-
	595-P1-B	Piezo	✓	Automatic (DL12)	85.2	Bedrock (Casing)	-	-
	595-P1-C	Piezo	✓	Automatic (DL12)	92.2	Bedrock (Casing)	-	-
	595-P1-D	Piezo	× (June 2017)	-	96.2	Dense Till (Casing)	-	-
	595-P1-E	Piezo	× (June 2017)	-	105.2	Rock fill (Casing)	-	-
	595-TH	Thermistor	✓	Automatic (DL12)	-	-	16	114.60/69.60
650-P1	650-P1-A	Piezo	× (since February 2016)	Automatic (DL11)	-	-	-	-
	650-P1-B	Piezo	× (since September 2016)	Automatic (DL11)	-	-	-	-
	650-P1-C	Piezo	× (since September 2016)	Automatic (DL11)	-	-	-	-
	650-P1-D	Piezo	× (since September 2016)	Automatic (DL11)	-	-	-	-
	650-TH-P1	Thermistor	× (since August 2016)	Automatic (DL11)	-	-	-	-

Hole	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
650-P2	650-P2-A	Piezo	✓	Automatic (DL11)	65	Bedrock	-	-
	650-P2-B	Piezo	✓	Automatic (DL11)	85	Bedrock	-	-
	650-P2-C	Piezo	✓	Automatic (DL11)	99.5	Bedrock	-	-
	650-P2-D	Piezo	✓	Automatic (DL11)	103.5	Rock fill/Till	-	-
	650-TH-P2	Thermistor	✓	Automatic (DL11)	-	-	13	105/51
650-P3	650-P3-A	Piezo	Frozen	Automatic (DL38)	65	Bedrock	-	-
	650-P3-B	Piezo	Frozen	Automatic (DL38)	85	Bedrock	-	-
	650-TH-P3	Thermistor	✓	Automatic (DL10)	-	-	13	105/51
750-P1	750-P1-A	Piezo	✓	Automatic (DL10)	65	Bedrock	-	-
	750-P1-B	Piezo	✓	Automatic (DL10)	76	Bedrock	-	-
	750-P1-C	Piezo	✓	Automatic (DL10)	80	Dense Till	-	-
	750-P1-D	Piezo	✓	Automatic (DL10)	88	Dense Till	-	-
	750-P1-E	Piezo	✓	Automatic (DL10)	100	Rock fill	-	-
	750-TH-P1	Thermistor	✓	Automatic (DL10)	-	-	13	111/63
810-P1	810-P1-A	Piezo	× (since Dec. 2017)	-	67.7	Bedrock	-	-
	810-P1-B	Piezo	× (since January 2017)	-	-	-	-	-
	810-P1-C	Piezo	× (since Sept 2018)	-	86.9	Dense Till	-	-
	810-P1-D	Piezo	× Elev. Working only	-	93.9	Dense Till	-	-
	810-TH	Thermistor	× (since February 2018)	Automatic (DL18)	-	-	0/16	134.84/114.84
825-P1	825-P1-A	Piezo	✓	Automatic (DL18)	74.15	Bedrock	-	-
	825-P1-B	Piezo	✓	Automatic (DL18)	93.5	Bedrock	-	-
	825-P1-E	Piezo	✓	Automatic (DL18)	101	Till (Casing)	-	-
	825-TH	Thermistor	✓	Automatic (DL18)	-	-	14/16	131.25/71.25
850-P1	850-P1-A	Piezo	✓	Automatic (DL18)	72	Bedrock	-	-
	850-P1-B	Piezo	✓	Automatic (DL18)	93.7	Bedrock	-	-
	850-P1-E	Piezo	✓	Automatic (DL18)	106	Rock fill	-	-
	850-TH	Thermistor	✓	Automatic (DL18)	-	-	13/16	133.02/73.02
875-P3	875-P3-A	Piezo	✓	Automatic (DL41)	65	Bedrock	-	-
	875-P3-B	Piezo	✓	Automatic (DL41)	85	Bedrock	-	-
	875-TH-P3	Thermistor	✓	Automatic (DL41)	-	-	11/13	105/51
875-P2	875-P2-A	Piezo	✓	Automatic (DL10)	65.08	Bedrock	-	-
	875-P2-B	Piezo	✓	Automatic (DL10)	85.08	Bedrock	-	-
	875-P2-C	Piezo	Frozen	Automatic (DL10)	105.38	Bedrock	-	-
	875-P2-D	Piezo	Frozen	Automatic (DL10)	107.58	Till	-	-
	TH-875-P2	Thermistor	✓	Automatic (DL10)	-	-	15/16	120.08/63.08
800-P2	800-P2-A	Piezo	✓	Automatic (DL11)	70.07	Bedrock	-	-
	800-P2-B	Piezo	✓	Automatic (DL11)	85.07	Bedrock	-	-
	800-P2-C	Piezo	✓	Automatic (DL11)	95.07	Bedrock	-	-
	800-P2-D	Piezo	✓	Automatic (DL11)	105.07	Rock fill/Till	-	-
	TH-800-P2	Thermistor	✓	Automatic (DL11)	-	-	16	120.07/70.07

Hole	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
700-P1	700-P1-A	Piezo	✓	Automatic (DL11)	63.43	Bedrock	-	-
	700-P1-B	Piezo	✓	Automatic (DL11)	86.93	Bedrock	-	-
	700-P1-C	Piezo	✓	Automatic (DL11)	97.43	Bedrock	-	-
	700-P1-D	Piezo	✓	Automatic (DL11)	101.43	Void before bedrock	-	-
	TH-700-P1	Thermistor	✓	Automatic (DL11)	-	-	16	118.43/63.43
580-P1 (R)	580-P1-R-A (R)	Piezo	✓	Automatic (DL12)	69.55	Sand	-	-
	580-P1-R-B (R)	Piezo	✓	Automatic (DL12)	75.55	Bedrock	-	-
	580-P1-R-C (R)	Piezo	✓	Automatic (DL12)	79.05	Bedrock	-	-
	TH-580-P1 (R)	Thermistor	✓	Automatic (DL12)	-	-	16	120.55/65.55
1050-P3	1050-P3-A	Piezo	Frozen	Automatic (DL43)	66.37	Bedrock	-	-
	1050-P3-B	Piezo	Frozen	Automatic (DL43)	86.37	Bedrock	-	-
	TH-1050-P3	Thermistor	✓	Automatic (DL43)	-	-	16	134.77/65.77
975-P3	975-P3-A	Piezo	✓	Automatic (DL42)	64.53	Bedrock	-	-
	975-P3-B	Piezo	✓	Automatic (DL42)	84.53	Bedrock	-	-
	TH-975-P3	Thermistor	✓	Automatic (DL42)	-	-	16	131.12/64.12
800-P3	800-P3-A	Piezo	✓	Automatic (DL40)	62.95	Bedrock	-	-
	800-P3-B	Piezo	✓	Automatic (DL40)	82.95	Bedrock	-	-
	800-P3-C	Piezo	✓	Automatic (DL40)	96.45	Till	-	-
	TH-800-P3	Thermistor	✓	Automatic (DL40)	-	-	16	118.95/62.95
745-P3 (WR-P3)	TH-745-P3	Thermistor	✓	Automatic (DL39)	-	-	8/16	125.08/102.08
CD_US -0+650	CD-US-1	Thermistor	✓	Automatic (DL29)	-	-	16	126.40/111.056
	CD-US-2	Thermistor	✓	Automatic (DL29)	-	-	16	143/127
SD5	TH-02	Thermistor	✓	Automatic (DL58)	-	-	12/16	144/129
	TH-03	Thermistor	✓	Automatic (DL58)	-	-	16	141/126
	TH-04	Thermistor	✓	Automatic (DL58)	-	-	9/16	144/129

Stormwater Dike

Hole	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
SWD-01	SWD-01	Thermistor	✓	Automatic (DL19)			16	148/118
SWD-02	PZ-SWD-02-A	Piezo	✓	Automatic (DL19)	62	Bedrock		
	TH-SWD-02	Thermistor	✓	Automatic (DL19)			6	127/117
SWD-03	PZ-SWD-03A	Piezo	×	Automatic (DL19)	110	Bedrock		
	PZ-SWD-03B	Piezo	×	Automatic (DL19)	122			
	TH-SWD-03	Thermistor	✓	Automatic (DL19)			14	125/111
CRK	#1	Crakcmeter	✓	Automatic				
	#2	Crackmeter	✓	Automatic				
	#3	Crackmeter	✓	Automatic				
EXT	#2	Extensometer	Removed	Manual				
	#3	Extensometer	Removed	Manual				
	#4	Extensometer	✓	Manual				
	#5	Extensometer	Removed	Manual				
PSM	000 to 119	Prisms	✓	Manual				

SD1

Hole	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
SD1-T2	SD1-02	Thermistor	✓	Automatic (DL14)	-	-	16	140/110
SD1-T4	SD1-04	Thermistor	✓	Automatic (DL14)	-	-	16	134/119
SD1-T1	SD1-01	Thermistor	✓	Automatic (DL14)	-	-	16	149/132.84
SD1-T3	SD1-03	Thermistor	✓	Automatic (DL14)	-	-	15/16	148/118

SD2

Hole	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
SD2-T1	SD2-01	Thermistor	✓	Automatic (DL15)	-	-	16	148.05/145.31
SD2-T2	SD2-02	Thermistor	✓	Automatic (DL15)	-	-	16	148/118
SD2-T3	SD2-03	Thermistor	✓	Automatic (DL15)	-	-	16	144/129
SD2-T4	SD2-04	Thermistor	✓	Automatic (DL15)	-	-	16	148/123

SD3

Hole	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
SD3-T2	SD3-02	Thermistor	✓	Automatic (DL16)	-	-	16	139.1/123.1
SD3-T3	SD3-03	Thermistor	✓	Automatic (DL16)	-	-	15	138.6/121.6
SD3-T4	SD3-04	Thermistor	✓	Automatic (DL16)	-	-	15	137.3/122.3
SD3-T5	SD3-05	Thermistor	✓	Automatic (DL16)	-	-	16	138.4/122.4
SD3-T6	SD3-06	Thermistor	✓	Automatic (DL16)	-	-	16	143.9/113.9

SD4

Hole	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
SD4-T2	SD4-02	Thermistor	✓	Automatic (DL17)	-	-	16	139/129
SD3-T3	SD3-03	Thermistor	✓	Automatic (DL17)	-	-	16	144/129
SD4-T4	SD4-04	Thermistor	✓	Automatic (DL17)	-	-	5/14	137.3/127.8
SD4-T1	SD4-01	Thermistor	× (since August 2018)	Automatic (DL17)	-	-	16	143.4/139.6

SD5

Hole	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
SD5-02	SD4-02	Thermistor	✓	Automatic (DL58)	-	-	16(cap)	144/129
SD5-03	SD3-03	Thermistor	✓	Automatic (DL58)	-	-	16	141/126
SD5-04	SD4-04	Thermistor	✓	Automatic (DL58)	-	-	16(cap)	144/129

RF1-RF2

Hole	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
121-1	121-RF1-1	Thermistor	✓	Manual	-	-	16/16	136/90
73-6	73-6-RF1-2	Thermistor	✓	Manual	-	-	14/16	149.5/133
RF1-3	RF1-3	Thermistor	✓	Manual	-	-	11/11	148/144
122-1	122-1RF2	Thermistor	✓	Manual	-	-	14/16	137/90

North Cell

Hole	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
NC-T1	NC-T1	Thermistor	✓	Manual	-	-	16	146.6/86.6
NC-17-01	NC-17-01	Thermistor	✓	Automatic (DL20)	-	-	16	148/112
NC-17-02	NC-17-02	Thermistor	✓	Automatic (DL21)	-	-	16	147.6/102
NC-17-03	NC-17-03	Thermistor	✓	Automatic (DL22)	-	-	16	147.6/102.6
NC-17-04	NC-17-04	Thermistor	✓	Automatic (DL23)	-	-	16	148.5/122
NC-17-05	NC-17-05	Thermistor	✓	Automatic (DL24)	-	-	16	146.6/112.6
NC-17-06	NC-17-06	Thermistor	✓	Automatic (DL25)	-	-	16	148/112
NC-17-07	NC-17-07	Thermistor	✓	Automatic (DL26)	-	-	16	148/112
NC-17-08	NC-17-08	Thermistor	✓	Automatic (DL27)	-	-	16	146/99

North Cell Internal Structure (NCIS)

Hole	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
NCIS-T1	NCIS-18-01	Thermistor	✓	Automatic (DL55)	-	-	16	140/110
NCIS-T2	NCIS-18-02	Thermistor	✓	Automatic (DL55)	-	-	16	134/119
NCIS-T3	NCIS-18-03	Thermistor	✓	Automatic (DL56)	-	-	16	149/132.84
NCIS-T4	NCIS-18-04	Thermistor	✓	Automatic (DL57)	-	-	15/16	148/118
PSM	NCIS1 TO NCIS16	PRSME	✓	Manual	-	-	15/16	148/118

Appendix C
Potential Mitigation for Upset Condition

Potential Mitigation Plan for Upset Condition on Tailings Management Infrastructures

Upset Condition	Area / Cause		Comments/Monitoring	Contingency or Corrective Action
Overtopping and Subsidence	1a	Water level rise / storm event	Water levels and crest elevations is monitored as part of the 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 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 comprises 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 from the mining operations can be placed to raise the dike crest and compensate settlement. Mining operations 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 makes this a low concern	rip-rap can be added and/or 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 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 mining.	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. Seepage could 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 in to 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.
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 construction of cut-off 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 stabilising berm

Upset Condition	Area / Cause		Comments/Monitoring	Contingency or Corrective Action
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 and 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, 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 trained inspector is an appropriate monitoring strategy in addition the instrumentation. Survey of crest face and toe is conducted.	Re-assess stability (numerical modelling) and construct a stabilising berm if required Fill inactive tension cracks with bentonite
	4b	Earthquake Induced: Slope Failure	Site is located in a low seismic zone. Dike consisting of massive rock zone has a low sensitivity to seismic motion.	Do 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
Subsidence	5	Foundation Soils	Unexpected foundation soils consolidated during dike construction. A significant quantity of clay would be required to generate settlement resulting in a water release event. Prism and monument monitoring is done routinely.	This scenario would be readily repaired by excavating rockfill above the cut-off wall and placing more till. Soil conditions will be observed during dewatering to accommodate actual conditions.
Premature Closure	6	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	7	Pumping infrastructures	Freezing protection is provided by heat tracing and insulation. Pipelines monitored pump pressures at plant and frequent site inspection.	Replace defect in pipeline Repair the pump and use another pump in the meantime