

PRELIMINARY

TIA Filtered Tailings Conceptual Design Assessment

TIA Filtered Tailings Permitting, Hope Bay, Nunavut, Canada
Agnico Eagle Mines Limited



SRK Consulting (Canada) Inc. ■ CAPR003823 ■ July 2025



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Prepared for:

Agnico Eagle Mines Limited
145 King Street East, Suite 400
Toronto, ON, Canada
M5C 2Y7



+1 416 947 1212
www.agnicoeagle.com

Prepared by:

SRK Consulting (Canada) Inc.
2600–320 Granville St.
Vancouver, BC V6C 1S9
Canada

+1 604 681 4196
www.srk.com

Lead Author: Barbara Amar, Consultant, Eng. **Initials:** BA

Reviewer: Peter Luedke, P.Eng., John Kurylo, PEng **Initials:** PL/JBK

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Contents

1	Introduction.....	1
1.1	General.....	1
1.2	Scope of Work.....	1
2	Site Description.....	2
2.1	Regional Geology.....	3
2.2	Hydrology.....	3
2.3	Foundation Conditions.....	3
2.4	Seismic Hazard.....	4
3	Design Overview.....	6
4	Hydrotechnical Design.....	7
5	Geotechnical Stability.....	8
5.1	Assessment Methods.....	8
5.2	Design Criteria.....	8
5.2.1	Stability Acceptance Criteria.....	8
5.3	Loading Conditions.....	9
5.4	Material Models.....	10
5.5	Model Setup.....	11
5.6	Geometry.....	11
5.7	Material Properties.....	13
5.8	Seismic Load.....	15
5.9	Pore Water Pressures.....	15
5.10	Stability Sensitivity Analysis.....	15
5.11	Stability Analysis Results.....	15
5.11.1	Base Case.....	15
5.11.2	Sensitivity Analysis.....	16
5.12	Mitigation Measures.....	19
5.13	Discussion.....	20
6	Monitoring.....	22
	References.....	24

Tables

Table 2-1:	Horizontal Seismic Coefficient for the Project, Soil Class E.....	5
Table 4-1:	24-h Design Event Precipitation.....	7
Table 5-1:	Factor of Safety and Allowable Strain Design Criteria.....	9
Table 5-2:	Section Coordinates.....	11
Table 5-3:	Material Properties Used in Stability Analysis.....	14
Table 5-4:	Summary of Base Case Slope Stability Results – North Section.....	15
Table 5-5:	Summary of Base Case Slope Stability Results – South Section.....	16
Table 5-6:	Sensitivity Analysis- During, or at End of Construction – Undrained Peak Condition.....	17

Table 5-7: Sensitivity Analysis- Post-liquefaction – Undrained Residual Condition..... 18

Figures

Figure 2-1 Site Layout 2
Figure 5-1 Filtered Tailings Stack Sections Location 12

Appendices

Appendix A Design Section Geometry
Appendix B Stability Model Runs
Appendix C Sensitivity Analysis
Appendix D Mitigation runs
Appendix E Convergence Criteria
Appendix F Hydrotechnical Design

1 Introduction

1.1 General

Agnico Eagle Mines Limited (AEM) has been retained SRK Consulting (Canada) Inc. (SRK) to advance the design of the Tailings Impoundment Area (TIA) at the Hope Bay Mine (Hope Bay). The design concept being advanced is based on the preferred alternative selected as an outcome of the Multiple Accounts Analysis (MAA) conducted in 2024 (SRK 2024). The alternative included slurry deposition of tailings (9 Mt), filtered tailings placement within the permitted TIA footprint (25 Mt), and paste tailings placement underground (7 Mt). The tailings is first deposited as slurry tailings within the current TIA and subsequently a transition to filtered tailings placement is made within a similar footprint. This alternative was preferred based on a range of factors, including: the transition to filtered tailings once the existing facility is at capacity, which is viewed as a transition to a best available technology, and the arrangement of the alternative was selected on the basis of its limited footprint expansion from the slurry tailings, which limits the extent of the disturbance to a single catchment, while also limiting the height of the final landform to below the surrounding height of land. Based on this assessment, the overall concept for the tailings design is considered technically feasible and appropriate for the current site conditions.

1.2 Scope of Work

The purpose of this document is to advance the preferred TIA alternative concept, particularly the geotechnical and hydrotechnical design of the filtered tailings stack during operations and closure, with a focus on the period of transition from the slurry tailings deposition to filtered tailings placement, the potential geotechnical challenges associated with the proposed design (due to the consolidated footprint) and proposed geotechnical monitoring details. The assessment also aims to confirm, that the proposed design is technically feasible.

2 Site Description

The Hope Bay Project (the Project) is a gold mining. The Project is located 705 km northeast of Yellowknife and 153 km southwest of Cambridge Bay in Nunavut Territory and is situated east of Bathurst Inlet. The Project comprises three distinct areas of known mineralization, Doris, Madrid, and Boston.

The Project is currently permitted under the Doris and Madrid Project Water License 2AM-DOH1335 which includes mining and infrastructure.

Figure 2-1 presents the preferred alternative selected from the MAA. As illustrated, slurry tailings are deposited from the existing North and South Dam. As slurry tailings deposition is completed from south to north, the tailings beach will be capped with a trafficability and drainage layer consisting of waste rock or run of quarry (ROQ) material. The proposed location filtered tailings stack would be placed above this rock layer. In total, the final tailings surface includes 130 ha of slurry tailings surface and 191 ha of filtered stack tailings. The area of filtered tailings placed above the filtered tailings and rock layer is 85 ha, and the remaining area of filtered tailings placed on the surrounding overburden and bedrock is 106 ha.

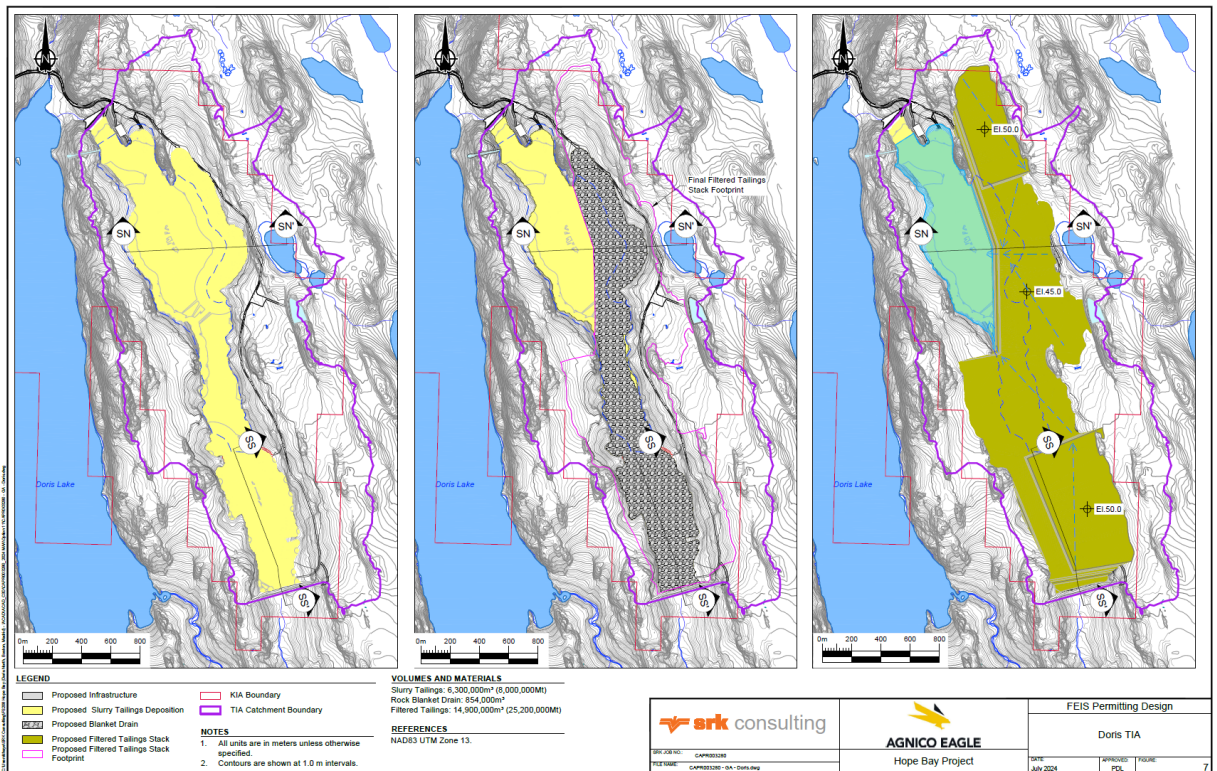


Figure 2-1 Site Layout

2.1 Regional Geology

As described by SRK (2017) the Hope Bay Volcanic Belt (the Belt) is a mafic volcanic dominated greenstone belt located in the northeast portion of the Slave Structural Province. The Belt is typified by massive to pillowed tholeiitic flows interbedded with calc-alkaline felsic volcanic and volcanoclastic rocks, clastic sedimentary rocks, and rarely synvolcanic conglomerate and carbonates.

During the last Quaternary Period, the region was subjected to multiple glaciations. Ice flows were predominantly towards the north-northwest and north, and the melting ice sheets left an extensive blanket of basal till. Immediately following the de-glaciation, the entire region was submerged approximately 200 metres below present mean sea level (SRK 2017).

Fine sediment, derived from meltwater was deposited onto the submerged Hope Bay shelf as marine clays and silts onto the basal tills. The greatest thicknesses accumulated in the deeper water zones, now represented by valleys.

Isostatic rebound after the de-glaciation resulted in emergent landforms and reworking of the unconsolidated marine sediments and tills along the prograding shoreface (SRK 2017). Sediments were easily stripped off the uplands and redeposited in valleys, leaving relatively continuous north-northwest trending bedrock ridges and elongate lakes.

2.2 Hydrology

The region experiences a polar climate characterized by long, extremely cold winters and short, cool summers. Average winter temperatures can reach below -30°C , while summer temperatures rarely exceed 10°C (SRK 2023a, SRK 2023b). The area is subject to permafrost, which significantly influences both construction and operational activities.

The Hope Bay project experiences low annual precipitation, typical of its Arctic location. On average, the region receives annual precipitation of approximately 250 mm, the majority of which falls as snow during winter months. Rainfall is sparse and primarily occurs during the brief summer season, typically between June to September (SRK 2023a, SRK 2023b).

The TIA filtered tailings stack is located within the TIA catchment and has a catchment area of 3.0 km^2 . Additional details on the hydrology of the site and specifically the TIA are presented in Appendix F.

2.3 Foundation Conditions

The foundation conditions in the general TIA area, including within the former lakebed, along the shoreline and near the existing and proposed dams have been thoroughly characterized through field investigations and thermal monitoring, as outlined in SRK (2017). The foundation conditions beneath the filtered tailings stack are supported by geotechnical drill holes (SRK39, 40, 53, 54, 55, 56, 57, 58) and CPTu tests (SRK-DH/CPT-01, 02, 03, 04, and 05) (SRK 2016). Based on the understanding of the foundation conditions, available geotechnical and geological data, and tailings deposition observations, a conceptual stratigraphic profile has been developed, which provides the proposed stratigraphy for the

sections used in the stability assessment.

Based on the interpretation of soil data, three distinct geotechnical units have been identified as foundation soil units: lakebed sediments, marine silt and clay and gravelly till. These units are briefly described below, with information primarily sourced from SRK (2016 and 2017) investigations in the area.

■ **North Area of the Dry Stack Footprint**

In the northern portion of the filtered tailings footprint, the stratigraphic profile consists of up to 10.0 m of slurry tailings overlying approximately 10.0 m of lakebed sediments. Beneath the lakebed sediments lies a layer of gravelly till, approximately 3.0 m thick, which rests directly on the host basalt bedrock. Above the historic lake shoreline, the overburden and bedrock profile is within cold permafrost conditions. Within the original lake shoreline, the lakebed sediments are expected to be unfrozen as the lake is within a closed talik. Below the deposited slurry tailings, above the historic shoreline, the permafrost conditions are expected to be variable, with freezeback of the foundation and slurry tailings over time after deposition at each spigot is stopped.

■ **South Area of the Dry Stack Footprint**

In the southern portion of the Dry Stack footprint, the stratigraphic profile consists of 3.0 to 4.0 m of slurry tailings overlying an upper soil layer of marine silt, which is approximately 5.5 m thick. This layer transitions into marine silt and clay. Beneath these sediments lies a layer of gravelly till, 4.0 to 5.0 m thick, which rests on the host basalt bedrock. The marine silts and clays in the southern area are ice-rich, with visible ice lenses present throughout the profile. Above the historic lake shoreline, the overburden and bedrock profile is within cold permafrost conditions. Within the original lake shoreline, the lakebed sediments are expected to be unfrozen as the lake is within a closed talik. Below the deposited slurry tailings, above the historic shoreline, the permafrost conditions are expected to be variable, with freezeback of the foundation and slurry tailings over time after deposition at each spigot is stopped.

2.4 Seismic Hazard

As outlined in SRK (2017), the selection of the seismic event for each structure follows the Canadian Dam Association (CDA) design guidelines (CDA, 2014) and the BC *Mined Rock and Overburden Piles Investigation and Design Manual* (Piteau, 1991), and the peak ground acceleration (PGA) for the 2% in 50 year return period (1 in 2,475 years) has been selected based on the potential interaction with the Hope Bay dams. The horizontal seismic coefficients have been estimated based on NBCC Seismic Hazard Tool (2020) PGA of 0.0702 g and adjusted for structure height (FWHA, 2011), assuming the tailings are founded on a minimum of 3 m of marine silt and clay overburden (classified as Site Class E). The horizontal seismic coefficients are presented in Table 2-1.

Table 2-1: Horizontal Seismic Coefficient for the Project, Soil Class E

Dam / Embankment Height (m)	1:2,475 year
≤ 5	0.032
10	0.030
15	0.027
20	0.025
25	0.022
30	0.019
≥ 35	0.019

3 Design Overview

The design concept being advanced includes both slurry tailings deposition and filtered tailings placement. Slurry tailings will be deposited within the current permitted TIA, then once at capacity of the current dams, the tailings deposition would transition from slurry deposition to filtered tailings placement. The filtered tailings stack will be located within the existing TIA, on a foundation of both slurry tailings and surrounding overburden. Prior to placement of filtered tailings, the slurry tailings are planned to be covered with a rock fill trafficability and drainage layer which will form the base of the filtered tailings placement.

To facilitate construction on the slurry tailings beach, the intent is to progressively construct a rock trafficability layer of 1 to 2 meters thick in total, and may be constructed from waste rock or quarried rock. The trafficability layer will be placed in winter following completion of tailings deposition at each spigot location as the tailings reach the final deposition elevation from south to north, in accordance with the deposition plan. This approach will encapsulate frozen tailings and intends to allow the frozen tailings to remain frozen over the subsequent summer, and aggrade frozen ground conditions over time. Once slurry tailings deposition is reaching completion near the north end of the TIA, the tailings encapsulated at the south end are expected to be partially to fully frozen, based on site observations to date. Depending on the details of the filtered tailings placement, filter zones may be required within portions of the trafficability layer to provide adequate drainage, or the continuous trafficability layer may be replaced by periodic spur roads to maintain access and adequate drainage conditions. These details are to be advanced at a later stage.

Filtered tailings will be placed on the trafficability layer and will be placed in compacted lifts of 0.3 to 0.5 meters depending on the compaction conditions which can be achieved in the field. It is expected that a large area will be prepared for tailings placement, such that any loading or change to thermal regime will be gradual and limit the potential for rapid thaw or porewater pressure increases.

The filtered tailings stack is designed to a maximum height of 15 meters and will tie into the surrounding terrain, while remaining below the height of land immediately surrounding the TIA. This is intended to provide a broad and flat final landform, while also requiring less permanent surface water diversion infrastructure and allowing runoff to be conveyed across the facility and into the Reclaim Pond through a series of channels.

In the southern section, the filtered tailings will be placed upstream of the South Dam. The South Dam is a frozen foundation tailings retaining structure, constructed using Run of Quarry (ROQ) and incorporating an internal Geosynthetic Clay Liner (GCL) as the water-retaining element. The South Dam will form part of the toe of the final filtered tailings landform, as illustrated in Figure 3 in Appendix A. It is expected that a rock erosion cover (waste rock or ROQ) will be placed on the south slope of the filtered tailings as a temporary measure until the closure cover is placed.

4 Hydrotechnical Design

A hydrotechnical design was completed to determine the size of required surface water management infrastructure on the filtered tailings stack during operations and at closure. The analysis focused on the surface water conveyance of the filtered tailings stack and management of runoff reporting to the TIA Reclaim Pond, within the overall TIA. Water management and discharge from the Reclaim Pond will be managed through active water discharge, treatment and overflow during emergencies via the Emergency Overflow Channel (EOC) once constructed. The hydrotechnical design details are provided in Appendix F.

Surface water will be conveyed across the filtered tailings stack by a combination of grading of tailings placement (minimum 1% grade) and strategically placed conveyance channels or chutes. All design events for channels and chutes were designed based on AEM Water Management Guidelines (AEM, 2021):

- Design Event 1: 100-year, 24-h rainfall event plus median 30-day snowmelt (operational period)
- Design Event 2: 1,000-year, 24-h rainfall event plus median 30-day snowmelt (closure period).

Climate change has been accounted for using radiative forcing scenario SSP2-4.5 as the base case and SSP5-8.5 as a sensitivity case, using the period from 2040 to 2079.

Table 4-1: 24-h Design Event Precipitation

Design Event	Radiative Forcing Scenario	Rainfall (mm)	30-day Snowmelt (mm)	Total Precipitation (mm)
100	SSP2-4.5	58.5	194	252.5
2	SSP2-4.5	115.1	194	309.1
1	SSP5-8.5	59.8	210	269.8
2	SSP5-8.5	110.9	210	320.9

The analysis shows that the design channel requires a base width of 1.0 m and depth ranging from 0.5 to 1.7 meters, with riprap D_{50} of 0.05 to 0.1 meters. The channels flow into the chute which runs down the sloped portion of the filtered tailings stack (~8H:1V) which require an armored channel with a depth of 0.4 meters, with riprap D_{50} of 0.8 to 0.95 meters.

The results of this analysis indicate that the channels and chutes can be constructed using materials available on site and can be adapted to future design changes, or higher runoff design events.

5 Geotechnical Stability

5.1 Assessment Methods

The physical stability assessment utilized Factor of Safety (FoS) values as the primary indices for evaluating slope performance. The analysis focused on mechanisms leading to overall slope failure, excluding minor surface skin failures less than 2 m deep. A minimum slip failure depth of 5.0 m was established as a convergence input criterion.

The assessment was conducted using the commercially available 2D limit equilibrium software program Slope/W from Geostudio (version 24.2.0.298). Slip surfaces were analyzed using the Morgenstern-Price method, with optimization settings detailed in Appendix E. Semi-circular optimized slip failure surfaces were employed as the search method for identifying potential failure mechanisms, using the Cuckoo search slip surface option.

5.2 Design Criteria

5.2.1 Stability Acceptance Criteria

The stability assessment acceptance criteria for this evaluation followed the guidelines suggested by Hawley and Cuning (2017) and British Columbia Ministry of Energy, Mines and Petroleum Resources (1991). These guidelines are intended for waste rock dumps, however for internal slopes of a filtered tailings stack within a tailings facility, these are expected to be appropriate. For the south end of the TIA filtered tailings stack, the CDA guidelines are also considered.

Table 5-1 outlines the stability assessment acceptance criteria used in the analysis, based on the consequence and confidence classifications and guidelines described above. The Factors of Safety (FoS) were selected considering the following criteria:

- The strength properties of all materials used in the stability assessment are derived from limited site investigations and moderately conservative values from the literature. As a result, the confidence category for this stability assessment is considered **low**.
- The consequence level of the North section is low based on the potential failure displacement being contained within the TIA footprint.
- The consequence level of failure at the South section, above the South Dam is treated as medium based on the potential for impacts to the South Dam and potential for release of tailings outside the footprint of the ultimate TIA. However, based on the conditions of the filtered tailings stack, deformation and flow of tailings a significant distance from the South Dam is unlikely.

Table 5-1: Factor of Safety and Allowable Strain Design Criteria

Section	Consequence	Confidence	FoS Criteria (Static)	FoS Criteria (Static)	FoS Criteria (Static)	FoS Criteria (Pseudo static or Post-liquefaction)
			Shallow	Moderate	Deep	
North (internal to TIA)	Low	Low	1.1	1.2	1.3	1.1
South (South Dam)	Medium	Low	1.1	1.2	1.5	1.1

5.3 Loading Conditions

Stability analyses were performed for the following loading conditions:

- **Static Loading Condition:**

- **Long Term - Drained Condition**

Corresponds to a slow shear condition, without the generation of pore pressures. The strength of the materials is then characterized by the parameters of effective friction angle (ϕ') and effective cohesion (c').

For this analysis, the drained condition was used to evaluate the long-term scenario, considering two possible states for the underlying slurry tailings: fully thawed slurry tailings, representing long term thawing of the underlying tailings and partially thawed slurry tailings, representing the expected case of strategic encapsulation of frozen conditions within the slurry tailings, during placement of the rock trafficability layer.

- **During, or at End of Construction - Undrained Peak Condition**

This condition corresponds to a scenario where load is applied faster than the dissipation of pore pressures within the soil-air-water matrix, leading to an increase in pore pressures. It was used to evaluate the short-term scenario, which includes the construction period and the immediate period following the completion of the filtered tailings stack.

The filtered tailings stack will be constructed directly on saturated and unsaturated slurry tailings overlying lakebed sediments, regardless of the season of construction. Given these conditions, it is reasonable to assume that the materials might be in an undrained state during this period, as pore pressures may not fully dissipate in the short term.

- **Post-liquefaction - Undrained Residual Condition**

This condition assesses the potential impact of a design earthquake or liquefaction triggering event on the shear strength of embankment and foundation materials, particularly for sensitive materials where liquified shear strengths may approach residual values. A post-liquefaction static analysis serves as an initial screening tool to evaluate the stability of the facility, applying reduced shear strength parameters to the tailings material in the foundation to account for potential strain softening.

- **Pseudo-static Loading Condition:**

Pseudo-static analysis is performed to simulate the transient seismic accelerations that may occur during the design earthquake by applying a constant horizontal acceleration to the tailings mass.

The key assumption in this method is that the horizontal and vertical seismic forces generated by an earthquake can be approximated by applying constant horizontal (k_h) and vertical (k_v) accelerations to the slices in the dump slope analysis. These seismic forces are proportional to the mass of the slope and are calculated using seismic coefficient factors. For sensitive materials, it is important to note that post-earthquake shear strengths may approach residual values.

5.4 Material Models

Three constituent models will be used to represent the geotechnical behavior of materials: Mohr Coulomb, SHANSEP and High Strength.

- **Mohr-Coulomb**

This model represents the strength for materials that exhibit a dilating behavior during the variation of stresses in the soil, or draining during shear. It is characterized by the following equation:

$$\tau = c' + \sigma'_n \tan(\phi')$$

where (i) τ is the effective shear strength, (ii) c' is the effective cohesion of the soil, (iii) σ'_n is the effective normal stress on the shear plane, and (iv) ϕ' is the effective angle of internal friction of the soil.

The above equation corresponds to a straight line on a graph whose abscissa is represented by the effective normal stress on the shear plane (σ'_n) and the ordinate is represented by the shear strength (τ). The y-intercept of the line corresponds to the minimum shear strength, i.e. the effective cohesion of the ground (c'). The slope of the line represents the angle of internal friction of the ground (ϕ').

This model will be used to represent the drained loading condition of the materials (drained-long-term condition).

- **SHANSEP**

The Stress History and Normalized Soil Engineering Properties (SHANSEP), Ladd and Foott (1974) model represents the increase in undrained shear strength of the soil as a function of the increase in the principal effective stresses on the shear plane. This model allows us to consider the effect of pore water pressure on resistance as well as the consolidation history. It is used for materials that exhibit contracting behavior during stress variation in the soil, or undrained behavior during shear.

The SHANSEP technique is applicable only to soils without a sensitive structure, for which the undrained shear strength increases in direct proportion to the consolidation pressure (Duncan et al, 2014). For some tailings containing a significant amount of fine material, low hydraulic conductivity is expected, which prevents rapid dissipation of pore pressures during shear processes. In less compact areas, these materials may exhibit contracting behavior, leading to an increase in pore pressures (Mohamad and Dobry, 1986), and thus undrained behavior.

The SHANSEP model establishes the shear strength of the ground as follows:

$$\tau = \tau_{min} + (S_{NC})\sigma'_v OCR^m$$

where (i) τ is the shear strength of the soil, (ii) τ_{min} is the minimum shear strength, (iii) S_{NC} is the ratio of the undrained strength to the effective vertical stress (S_u/σ'_v), peak or residual, depending on the case of analysis, (iv) σ'_v is the effective vertical stress on the shear plane, (v) OCR is the overconsolidation ratio, and (vi) m is an exponent controlling the nonlinearity.

This model will be used to represent the undrained loading condition of the materials (non-drained condition: peak and residual).

■ **High strength**

The bedrock will be modeled as a "high-strength or impenetrable" material. This description of the material tells the software that the sliding surface cannot pass through that material. It is an indirect mechanism for controlling the trajectory of sliding surfaces.

5.5 Model Setup

Two specific sections, referred to as Section North and Section South, were selected to assess the stability of the proposed filtered tailings stack. These sections were chosen to represent critical sections of the facility and capture the stratigraphic variability across its footprint. The North section is considered to have more geotechnical challenges as the slope is broader and the filtered tailings are placed on the thickest layers of slurry tailings, founded on lakebed sediments. The South section has more favorable foundation conditions, however the filtered tailings are placed upstream of the South Dam, which is the primary tailings retaining structure at the south end of the TIA.

The stability analysis was conducted for two scenarios: partially thawed foundation conditions and fully thawed foundation conditions. For the partially thawed condition, the first two meters of the slurry tailings were assumed to remain frozen. Loading conditions, as described in Section 5.3, were applied based on the material models and parameters outlined in Sections 5.4 and 5.7, respectively.

Convergence criteria used in the stability runs are summarized in Appendix E.

5.6 Geometry

The locations of the North and South sections are shown in Figure 5-1, and their coordinates are provided in Table 5-2. Details of the cross sections, including dimensions and stratigraphy, are presented in Appendix A.

Table 5-2: Section Coordinates

Section	Easting (m)	Northing (m)	Point location
South (SS)	435316.99	7556898.23	North
	435691.30	7555767.39	South
North (SN)	435684.49	7558295.15	East
	434572.12	7558245.53	West

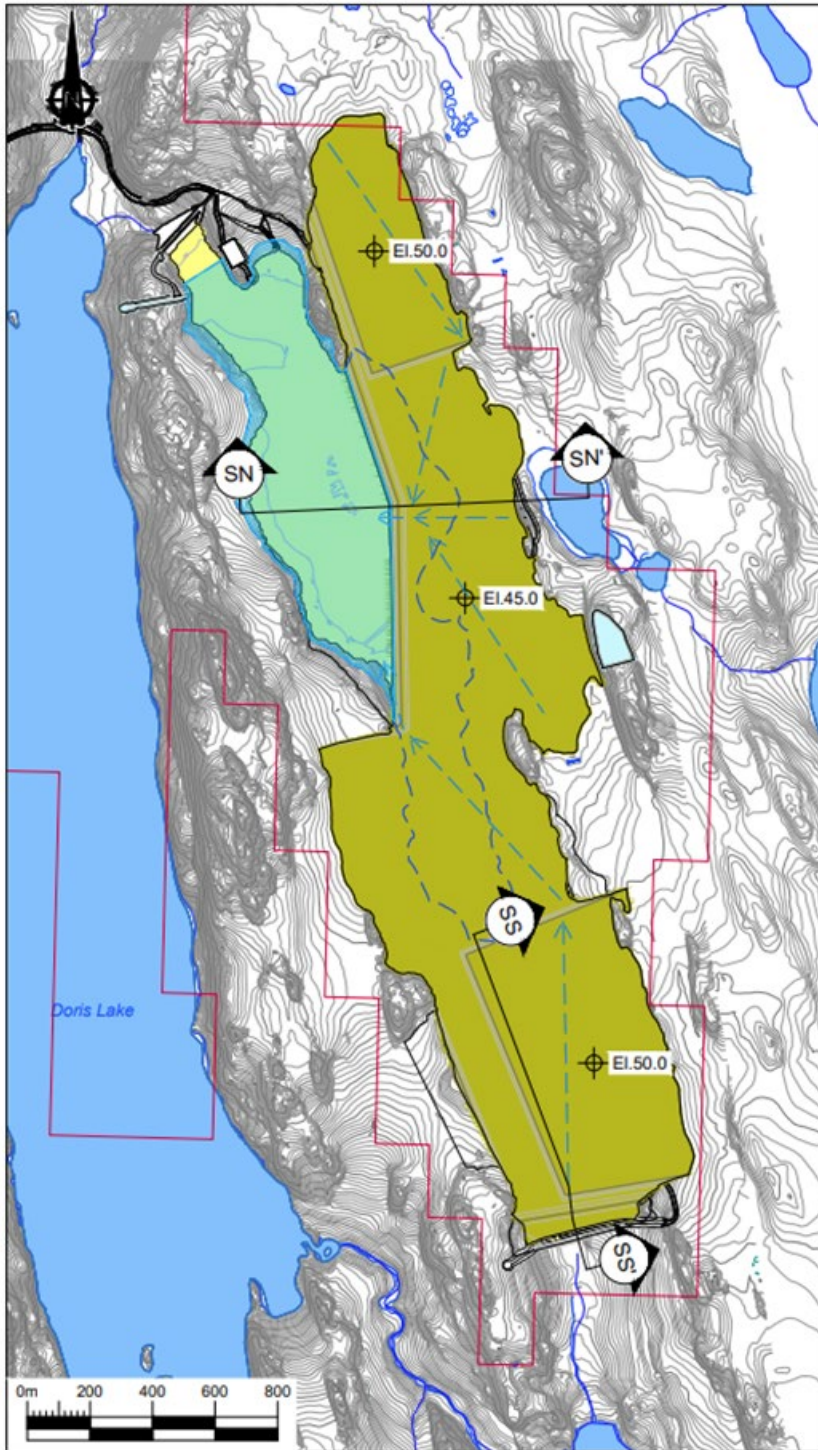


Figure 5-1 Filtered Tailings Stack Sections Location

5.7 Material Properties

The material properties used in the stability analysis are summarized in Table 5-3 for the loading conditions described in Section 5.3 and material models described in Section 5.4. These values are derived from existing geotechnical data obtained from past field investigations and laboratory testing, literature values, and engineering judgment.

As discussed in Section 5.2, the strength properties of all materials used in the stability analysis are based on limited site investigations and moderately conservative values from the literature. Given these assumptions, a sensitivity analysis of the critical resistance parameters was conducted and is presented in Section 5.11.2.

Table 5-3: Material Properties Used in Stability Analysis

Material	Loading condition →		Drained Long term		Undrained peak During or at end of construction		Undrained residual Post-earthquake / Pseudo static	
	Material model →		Mohr-Coulomb		SHANSEP		SHANSEP	
	Resistance parameters →	Unit Weight	Effective friction angle	Effective cohesion	Minimum shear strength	tau/sigma	Minimum shear strength	tau/sigma
		γ (kN/m ³)	ϕ' (°)	c' (kPa)	τ_{min} (kPa)	s_u/σ'_v (-)	τ_{min} (kPa)	s_u/σ'_v (-)
Filtered tailings	19.4 ⁽¹⁾	30 ⁽¹⁾	0 ⁽¹⁾	-	-	-	-	
Rock drain	21.0 ⁽²⁾	40 ⁽²⁾	0 ⁽²⁾	-	-	-	-	
Slurry tailings - Unfrozen	16 ⁽³⁾	28 ⁽³⁾	0 ⁽³⁾	0 ⁽³⁾	0.2 ⁽³⁾	0 ⁽³⁾	0.08 ⁽³⁾	
Slurry tailings - Frozen	16 ⁽³⁾	28 ⁽³⁾	112 ⁽²⁾	-	-	-	-	
Lake bed sediments - Clay and silt	17 ⁽²⁾	26 ^(2,4)	0 ⁽²⁾	13 ⁽²⁾	0.25 ⁽⁵⁾	13 ⁽²⁾	0.25 ⁽⁵⁾	
Marine silt and clay	17 ⁽⁴⁾	30 ⁽⁴⁾	0 ⁽⁴⁾	-	-	-	-	
Gravelly till	18.5 ⁽²⁾	36 ⁽²⁾	0 ⁽²⁾	-	-	-	-	
GCL (within South Dam structure)	18 ⁽⁴⁾	15 ⁽⁴⁾	0 ⁽⁴⁾	-	-	-	-	
Bedrock	High strength							

References

- ¹ Estimated values based on similar AEM Project (Tetra Tech, 2024)
- ² SRK, 2017.
- ³ SRK, 2025.
- ⁴ SRK, 2016.
- ⁵ Average value obtained from geotechnical correlation between s_u/s'_v and PI between 3 to 41 (from Table 9 - SRK, 2017)

5.8 Seismic Load

The Project site is located in a region of low seismicity. As presented in Section 2.4, the horizontal seismic coefficient is 0.035 g has been used for the pseudostatic analysis. The vertical seismic coefficient was assumed to be zero.

5.9 Pore Water Pressures

At this stage of design, the pore pressure distribution was calculated by defining the piezometric line and applying phreatic correction to the proposed piezometric line. For the initial stability assessment, the water level was set above the slurry tailings, following the topographical relief, and below the rock drain layer. Water levels are expected to fluctuate, and a sensitivity analysis was conducted to evaluate the system's response to these variations. At closure, the North Dam is planned to be breached, and would therefore result in long term drainage of the filtered tailings and upper slurry tailings.

A sensitivity analysis was carried out to evaluate how an increase in the groundwater level would affect the stability of the stack, in addition to the base case of fully saturated foundation materials. This represents an unlikely scenario, which, if it were to occur, is unlikely to persist for an extended period.

5.10 Stability Sensitivity Analysis

A sensitivity analysis was conducted to better understand the relationships between model inputs and outputs, reduce inherent model uncertainty, and improve the robustness of the stability assessment models and their associated recommendations. The results obtained and conclusions are presented in Section 5.11.2.

5.11 Stability Analysis Results

5.11.1 Base Case

The results of the stability assessment are summarized in Table 5-4 and Table 5-5, with detailed model outputs provided in Appendix B.

Table 5-4: Summary of Base Case Slope Stability Results – North Section

Loading Condition		Target FoS	Tailings Physical State	Calculated FoS	Figure Appendix B
Static	Drained Long term	1.3	Non frozen (fully thawed)	2.8	Figure 2
			Partially frozen	3.0	Figure 3
	Undrained Peak	1.3	Non frozen (fully thawed)	1.3	Figure 4

Loading Condition		Target FoS	Tailings Physical State	Calculated FoS	Figure Appendix B
	During or at end of construction		Partially frozen	1.7	Figure 5
	Undrained residual Post-earthquake	1.1	Non frozen (fully thawed)	0.5	Figure 6
			Partially frozen	1.1	Figure 7
Pseudo static	Undrained residual	1.1	Non frozen (fully thawed)	0.4	Figure 8
			Partially frozen	0.9	Figure 9

Table 5-5: Summary of Base Case Slope Stability Results – South Section

Loading Condition		Target FoS	Tailings Physical State	Calculated FoS	Figure Appendix B
Static	Drained Long term	1.5	Non frozen (fully thawed)	2.5	Figure 10
			Partially frozen	2.6	Figure 11
	Undrained Peak During or at end of construction	1.5	Non frozen (fully thawed)	1.7	Figure 12
			Partially frozen	2.4	Figure 13
Undrained residual Post-earthquake	1.1	Non frozen (fully thawed)	1.1	Figure 14	
		Partially frozen	2.5	Figure 15	
Pseudo static	Undrained residual	1.1	Non frozen (fully thawed)	1.0	Figure 16
			Partially frozen	1.6	Figure 17

Based on the results obtained, the following conclusions can be drawn:

- Drained (long-term) loading conditions: the base case stability analysis for the filtered tailings stack meets the design acceptance criteria for both the north and south sections.
- Undrained Peak (short-term) loading conditions: the base case stability analysis also meets the design acceptance criteria for both the north and south sections.
- Undrained Residual (short-term) loading conditions: the base case stability analysis meets the design acceptance criteria for the south section but does not meet the criteria for the north section for the non-frozen (fully thawed) condition.

As illustrated in the figures in Appendix B, the failure surfaces obtained from the stability analyses are generally deep, passing through the slurry tailings and, in some cases, extending into the foundation materials.

5.11.2 Sensitivity Analysis

The sensitivity analysis was performed on the north section, where the factor of safety determined in under the base case conditions did not meet the design criteria. Static loading conditions were used to

evaluate the behavior of the filtered tailings facility under various scenarios of undrained loading conditions (both peak and residual), as it represents the most conservative case and the case (Table 5-1). An optimized semi-circular failure surface was used for this purpose.

The scenarios assessed as part of the sensitivity analysis include:

- Variations in the groundwater table:
 - Case 1: Located within the filtered tailings (at approximately one-third of the height)
 - Case 2: Base case¹ scenario (groundwater table above the slurry tailings),
 - Case 3: Located within the slurry tailings (at mid-depth)
- Changes in slurry tailings thickness:
 - Case 1: Decrease of slurry tailings thickness,
 - Case 2: Base case scenario,
 - Case 3: Increase of slurry tailings thickness,
- Variations in undrained resistance parameters:
 - Undrained peak shear resistance: the ratio $s_u/\sigma'_v = 0.20$ used in the base case is evaluated within a range of (0.15 – 0.25).
 - Undrained residual shear resistance: the ratio $s_u/\sigma'_v = 0.08$ used in the base case is evaluated within a range of (0.05 – 0.13).

The results of this analysis are summarized in Table 5-6 and Table 5-7 and presented in detail in Appendix C.

Table 5-6: Sensitivity Analysis- During, or at End of Construction – Undrained Peak Condition

Tailings Condition	Scenario	Case	FOS	Target FOS
Non frozen (fully thawed)	Variations in groundwater table	Case 1 – Within the Dry Stack	0.9	1.3
		Case 2 – Base case	1.3	
		Case 3 – Within the slurry tailings	1.7	
	Changes in slurry tailings thickness	Case 1 – Increase thickness	1.2	
		Case 2 – Base case	1.3	
		Case 3 – Decrease thickness	1.3	
	Variations in undrained resistance parameters	$s_u/\sigma'_v = 0.15$	1.0	
		$s_u/\sigma'_v = 0.20$ – base case	1.3	
		$s_u/\sigma'_v = 0.25$	1.5	

¹ The term "base case" refers to the scenarios analyzed during the stability assessment presented in Section 5.1

Tailings Condition	Scenario	Case	FOS	Target FOS
Partially frozen	Variations in groundwater table	Case 1 – Within the Dry Stack	1.4	1.1
		Case 2 – Base case	1.7	
		Case 3 – Within the slurry tailings	2.0	
	Changes in slurry tailings thickness	Case 1 – Increase thickness	1.5	
		Case 2 – Base case	1.7	
		Case 3 – Decrease thickness	1.7	
	Variations in undrained resistance parameters	$s_u/\sigma'_v = 0.15$	1.6	
		$s_u/\sigma'_v = 0.20$ – base case	1.7	
		$s_u/\sigma'_v = 0.25$	1.7	

Table 5-7: Sensitivity Analysis- Post-liquefaction – Undrained Residual Condition

Tailings Condition	Scenario	Case	FOS	Target FOS
Non frozen (fully thawed)	Variations in groundwater table	Case 1 – Within the Dry Stack	0.4	1.1
		Case 2 – Base case	0.5	
		Case 3 – Within the slurry tailings	0.8	
	Changes in slurry tailings thickness	Case 1 – Increase thickness	0.5	
		Case 2 – Base case	0.5	
		Case 3 – Decrease thickness	0.5	
	Variations in undrained resistance parameters	$s_u/\sigma'_v = 0.05$	0.3	
		$s_u/\sigma'_v = 0.08$ – base case	0.5	
		$s_u/\sigma'_v = 0.13$	0.8	
Partially frozen	Variations in groundwater table	Case 1 – Within the Dry Stack	1.0	1.1
		Case 2 – Base case	1.1	
		Case 3 – Within the slurry tailings	1.2	
	Changes in slurry tailings thickness	Case 1 – Increase thickness	0.8	
		Case 2 – Base case	1.1	
		Case 3 – Decrease thickness	1.6	
	Variations in undrained resistance parameters	$s_u/\sigma'_v = 0.05$	0.9	
		$s_u/\sigma'_v = 0.08$ – base case	1.1	
		$s_u/\sigma'_v = 0.13$	1.6	

Regarding the sensitivity results, the following conclusions can be drawn:

- **During or at End of Construction – Undrained Peak Condition:** The sensitivity analyses indicate that the Factor of Safety (FOS) remains close to the target value for all conditions, except for the scenario involving fully thawed conditions combined with a groundwater table located within the Dry Stack. However, this scenario appears to be highly unlikely given the site conditions.
- **Post-Liquefaction – Undrained Residual Condition:** In this case, the sensitivity analyses show that the target FOS is not achieved under the fully thawed slurry tailings condition. If such a condition is considered credible, then mitigations measures would need to be implemented to meet the design criteria in the post-liquefaction residual shear strength case, as discussed in Section 5.12.

5.12 Mitigation Measures

Based on the results of the base case stability assessment and the sensitivity analysis, the filtered tailings stack does not meet the design criteria factor of safety under the post-liquefaction, undrained residual shear strength conditions without some additional geometry modifications, buttressing or tailings foundation improvements. To address this issue, potential mitigation strategies are proposed including:

- A placement strategy to maximize freeze-back: the rock cover placed on top of the slurry tailings beach would be placed during the winter to maximize freeze back of the tailings and limit thaw in the subsequent summer. The rock cover would be placed at a thickness of 1 – 2 m, the depth of the seasonal active layer.
- If frozen conditions cannot be achieved due to operational constraints or other factors, or unfrozen tailings are unlikely to be maintained based on the modelled or observed conditions, additional mitigation measures would be required to improve stability. Potential actions include:
 - Flattening of the outer slope of filtered tailings and / or changing the geometry to have more over the southern end or areas and eastern sides (and generally minimize loading over areas where tailings foundation thicknesses may be thicker)
 - Construction of a rock fill zone within the slurry tailings beach, during deposition (pre-determined location)
 - Tailings replacement along the planned toe of the filtered stack by tailings replacement
 - Stretching out construction timelines and keeping foundation unfrozen to maximize controlled loading and consolidation. With consideration to initially overbuilding areas (overload or pre-load) and then removing material to design lines. Would require more material movement but could be used to improve foundation conditions.
 - Vibro-compaction of the deposited tailings or pre-failing the tailings foundation to build upon those tailings starting at post-liquefaction strengths
 - Installation of stone columns
 - Construction of a toe buttress

Multiple methodologies are expected to be able to achieve the required ground improvement and design criteria factor of safety of 1.1. At the next stage of design, the foundation improvement design will be refined and assessed further. The results of the mitigation options stability analysis are presented in Appendix D.

5.13 Discussion

An analysis of the overall tailings filtered tailings stack stability was conducted to demonstrate that the proposed configuration concept was reasonable and had merit to move forward to the next stages of design, based on the current projects stage and starting review of associated levels of risk. This analysis looked at if the initial conceptual layouts meet or exceeded the minimum stability acceptance criteria considering the proposed conceptual design to confirm concepts and to help guide and prepare for the next stages of design. Based on the assessment, the overall concept for the tailings design is considered technically feasible and could be made appropriate for the current site conditions. The results presented in this report advance the conceptual design, based on available data which will require refinement of the design approach through laboratory testing and additional analysis at later stages of design. Specifically additional information on the dry stack and conventional tailings materials would be looked at in more detail at the next stages of design.

Based on the available geotechnical information, the slurry tailings consist of fine-grained material primarily consisting of sand and silt. Under saturated conditions, the potential for liquefaction cannot be entirely ruled out and was looked at as part of this initial stage in the design process under both static and dynamic conditions.

The south section successfully meets all required minimum stability acceptance criteria factors of safety, even under the most conservative assumption of a fully thawed, undrained residual shear strength foundation condition. It is expected that the slurry tailings beach closest to the South Dam would be the first area to freeze back or become drained, as the beach is above the long-term water elevation in the TIA, and therefore is expected to be the most favorable slurry tailings foundation for the filtered tailings placement to begin. Starting placement in this area would also allow for more operational flexibility and the dry stack construction approaches and filtering is initially optimized on site.

The north section, of the conceptual layout, does not meet the required minimum safety criteria under the fully thawed, residual shear strength slurry tailings foundation conditions. This analysis is expected to be conservative as extensive triggering event would be required to result in liquefaction, however it is appropriate for this early stage of design and an important consideration that will need to be carried forward and looked at in more detail at the next stages of design. In order to meet the design FOS, additional mitigations may be required (Section 5.12) and developed as part of the next stage of design which utilizes a combination of the proposed mitigations, and the deposition strategy to limit the additional effort required.

As the design progresses, the next phase will include additional site investigation and laboratory testing to address current data limitations on material properties, foundation conditions, and detailed analysis (which most likely would also include deformation analysis). This phase will focus on

characterizing the existing and anticipated slurry tailings, filtered tailings and foundation conditions along the facility. Detailed analysis should include detailed stability analysis considering construction sequencing, thermal response and hydrogeological response to the proposed deposition strategies. This next stage of work will aim to validate the hypotheses and resistance parameters proposed in this report and assess additional loading conditions.

6 Monitoring

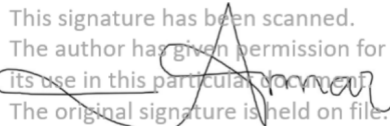
A monitoring system will be required as part of the filtered tailings placement to monitor the underlying tailings and confirm performance objectives can be achieved. The conceptual monitoring design includes:

- **Ground Temperatures:** Ground temperature cables (GTC) should be installed following completion of slurry tailings placement at each spigot to monitor the thermal response and freeze back of the tailings to confirm the foundation conditions are suitable for construction of the drainage layer and filtered tailings stack. Distributed temperature sensing may also be implemented to increase monitoring resolution in key areas.
- **Porewater Pressures:** Piezometers (coupled with thermistors or GTCs) should be installed within the slurry tailings, drainage layer and within lifts of the filtered tailings stack. These instruments will allow monitoring of potential pore pressure build up due to loading rates or change in hydrological/hydrogeological regime, in an effort to mitigate potential instability conditions.
- **Displacement:** displacement monitoring should be completed by a range of techniques, including settlement plates for ground based displacement validation, aerial or remote sensing deposition monitoring and displacement monitoring using periodic LiDAR/photogrammetric and InSAR techniques to allow broad coverage of change and displacement monitoring over the large placement area.
Inclinometers or shape accel arrays should be implemented at key stages during construction of the filtered tailings. At a minimum, these should be installed once filtered tailings placement has reached its final grade.
- **Visual:** In addition to displacement monitoring, it will be important to monitor the filtered tailing placement visually on a regular basis to compliment the other monitoring techniques and identify changes such as tension cracks which may not be identified by other methods (depending on frequency).
- **Dust:** Filtered tailings has the potential to generate dust and must be monitored closely during construction and following construction once an area of the filtered tailings placement becomes inactive. A monitoring program should be developed in alignment with current industry practices and experience of AEM with filtered tailings facilities in northern climates.
- **Water Quality:** All filtered tailings placement is planned within the existing TIA. Beyond environmental characterization and monitoring, the seepage monitoring program is expected to remain similar to the existing program, or as proposed by AEM.

Closure

This report, TIA Filtered Tailings Conceptual Design Assessment, was prepared by

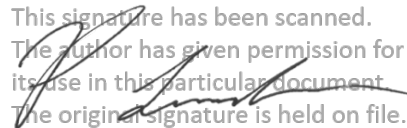
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Barbara Amar, Consultant, Eng.
Consultant

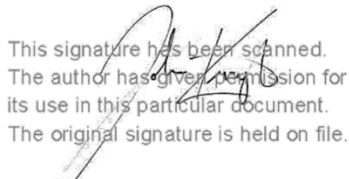
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Senior Consultant

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John Kurylo, MSc., P.Eng.
Principal Consultant

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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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Appendix A Design Section Geometry

Section Geometry for Stability Assessment

Hope Bay, Nunavut, Canada

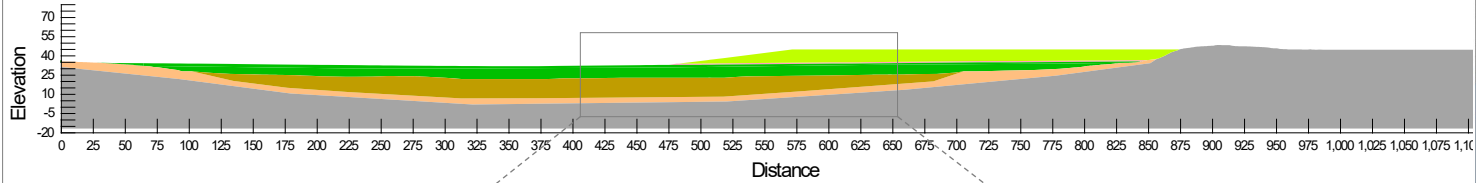
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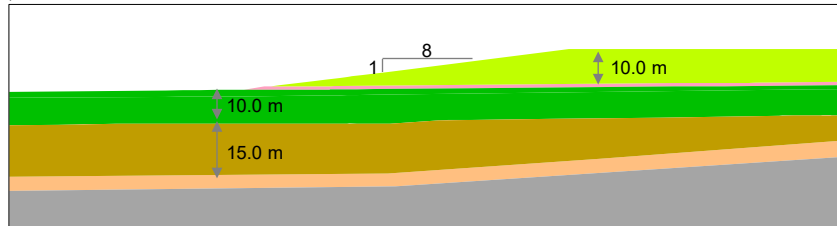
Hope Bay – Filtered Tailings
Conceptual Design
Project N#: CAPR003823

Title : Section Geometry
Date : June, 2025
Figure: 1

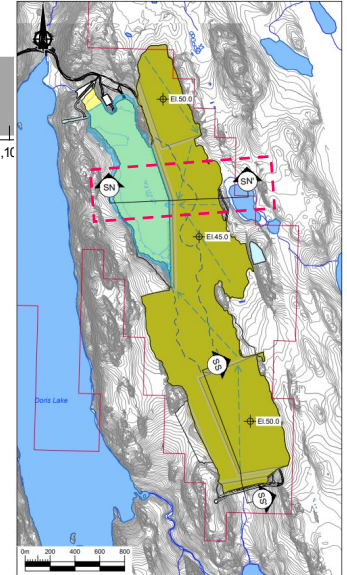
North Section Geometry



Color	Name
Grey	Bedrock
Light Green	Filtered tailings (D)
Orange	Gravelly till (D)
Brown	Lake bed sediments (LD Peak)
Pink	Rock drain (D)
Dark Green	Slurry tailings (D)-Non frozen



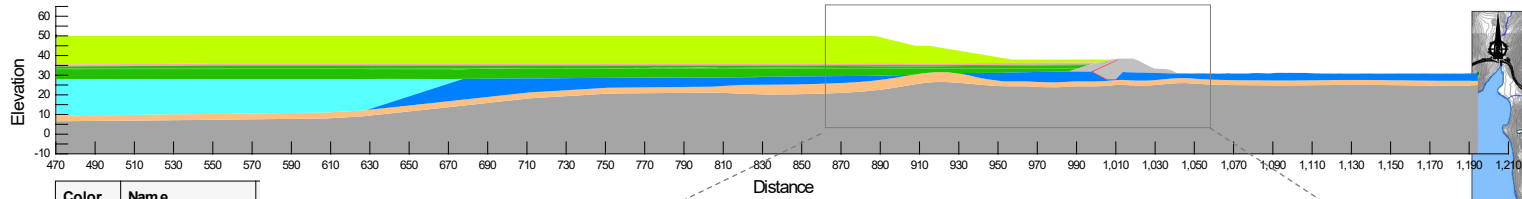
Section location and coordinates



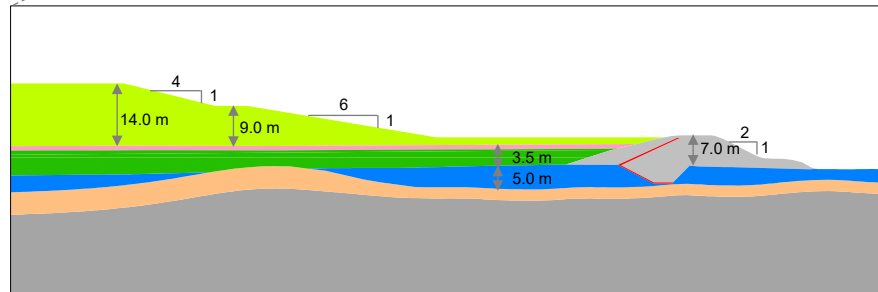
Easting (m)	Northing (m)	Point location
435684.49	7558295.15	East
434572.12	7558245.53	West

Notes:

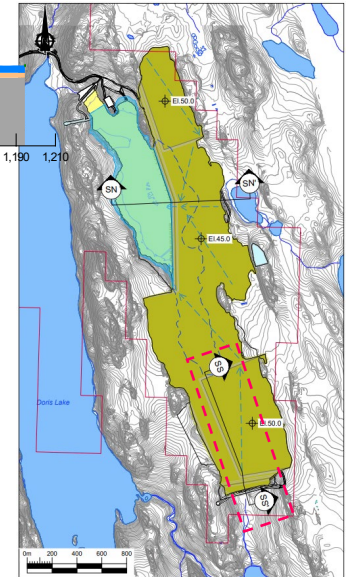
South Section Geometry



Color	Name
Grey	Bedrock
Light Green	Filtered tailings (D)
Red	GCL
Orange	Gravelly till (D)
Cyan	Lake bed sediments (D)
Blue	Marine silt and clay (D)
Pink	Rock drain (D)
Dark Green	Slurry tailings (D)-Non frozen
Light Grey	Waste Rock (D)



Section location and coordinates



Eastings (m)	Northing (m)	Point location
435316.99	7556898.23	North
435691.30	7555767.39	South

Notes:

Appendix B Stability Model Runs

Stability Assessment Results

Hope Bay, Nunavut, Canada

Notes:

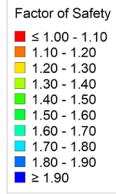


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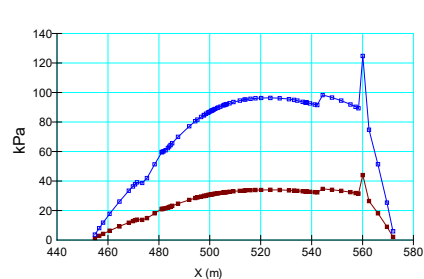
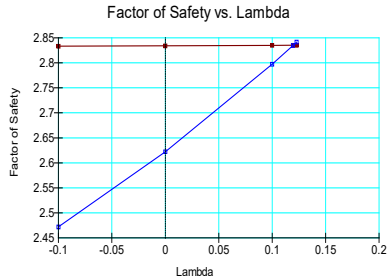
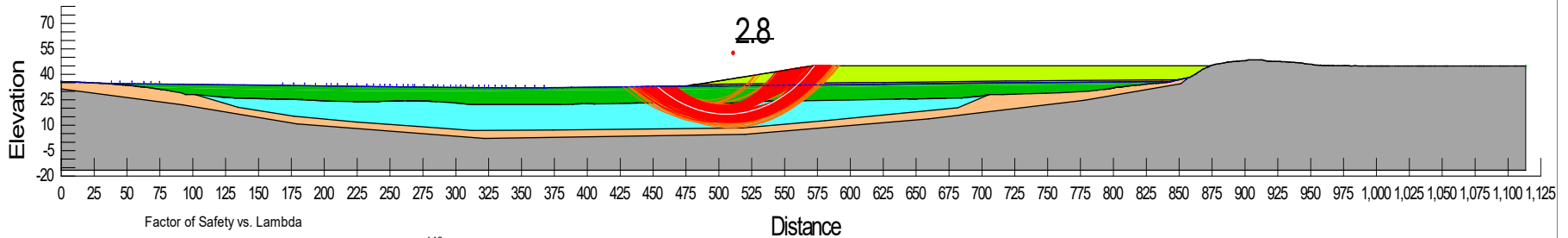
Title : Stability Analysis Runs
Date : June 2025
Figure: 1

North Section: Stability results

Loading condition: Static - Drained
 Tailings state: Non frozen (fully thawed)
 Search method: Entry-Exit
 Surface geometry: Semi-circular (non optimized)
 Minimum slip surface depth: 5,0 m



Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
Grey	Bedrock	High Strength	22			1
Yellow	Filtered tailings (D)	Mohr-Coulomb	19.4	0	30	1
Orange	Gravelly till (D)	Mohr-Coulomb	18.5	0	36	1
Cyan	Lake bed sediments (D)	Mohr-Coulomb	17	0	26	1
Pink	Rock drain (D)	Mohr-Coulomb	21	0	40	1
Green	Slurry tailings (D)-Non frozen	Mohr-Coulomb	16	0	28	1

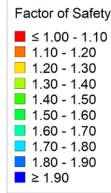


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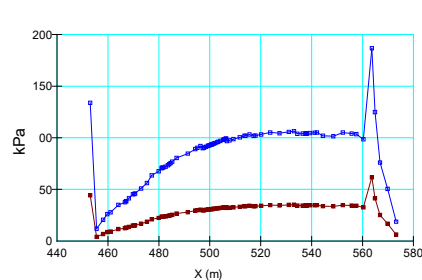
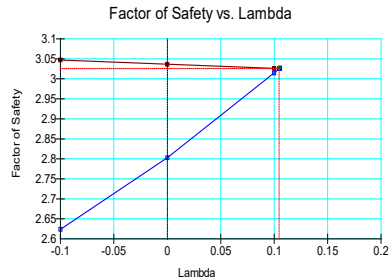
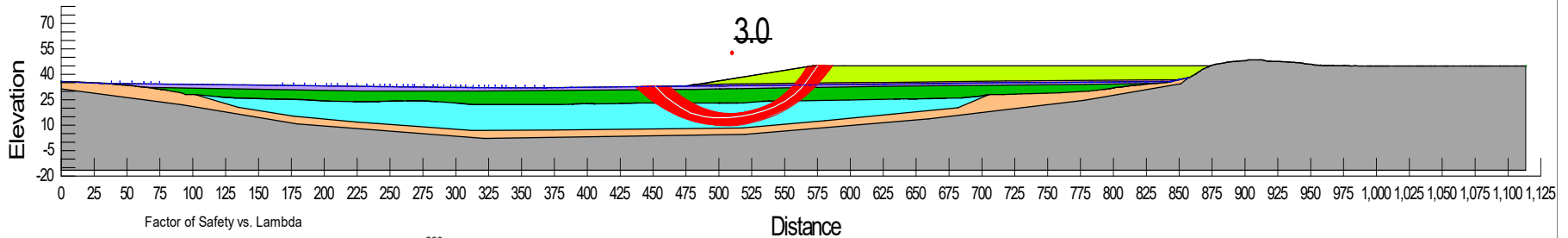
- Moment equilibrium (figure on the left) - Shear resistance (figure on the right)
- Horizontal force equilibrium (figure on the left) - Mobilized shear resistance (figure on the right)

North Section: Stability results

Loading condition: Static - Drained
 Tailings state: Partially frozen (first 2 m frozen)
 Search method: Entry-Exit
 Surface geometry: Semi-circular (non optimized)
 Minimum slip surface depth: 5,0 m



Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
Grey	Bedrock	High Strength	22			1
Yellow	Filtered tailings (D)	Mohr-Coulomb	19.4	0	30	1
Orange	Gravelly till (D)	Mohr-Coulomb	18.5	0	36	1
Cyan	Lake bed sediments (D)	Mohr-Coulomb	17	0	26	1
Pink	Rock drain (D)	Mohr-Coulomb	21	0	40	1
Purple	Slurry tailings (D)-Frozen	Mohr-Coulomb	16	112	28	1
Green	Slurry tailings (D)-Non frozen	Mohr-Coulomb	16	0	28	1



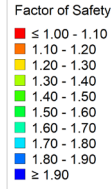
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- Blue square: Moment equilibrium (figure on the left) - Shear resistance (figure on the right)
- Red square: Horizontal force equilibrium (figure on the left) - Mobilized shear resistance (figure on the right)

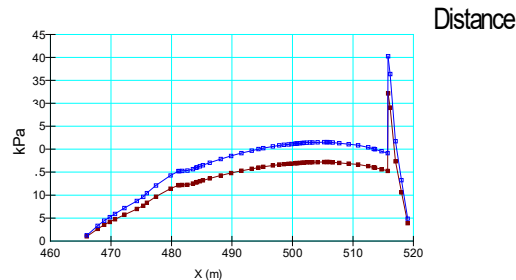
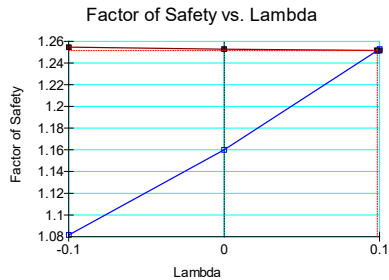
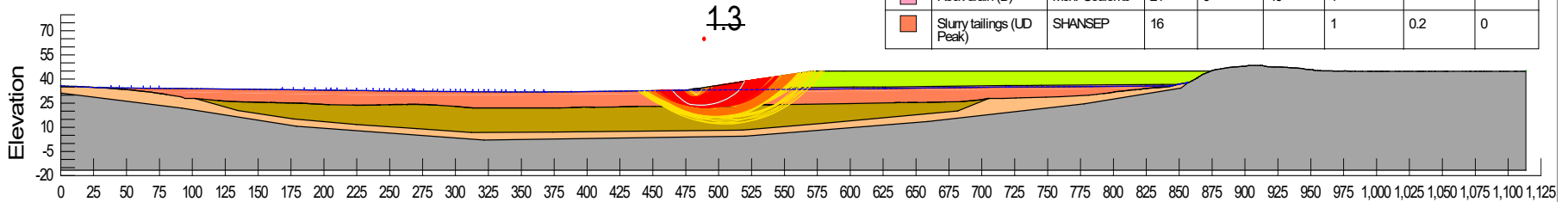
North Section: Stability results

Loading condition
 Tailings state:
 Search method
 Surface geometry
 Minimum slip surface depth

Static – Undrained Peak
 Non frozen (fully thawed)
 Entry-Exit
 Semi-circular (non optimized)
 5,0 m



Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Tau/Sigma Ratio	Minimum Shear Strength (kPa)
Grey	Bedrock	High Strength	22			1		
Light Green	Filtered tailings (D)	Mohr-Coulomb	19.4	0	30	1		
Light Orange	Gravelly till (D)	Mohr-Coulomb	18.5	0	36	1		
Dark Green	Lake bed sediments (UD Peak)	SHANSEP	16			1	0.25	13
Pink	Rock drain (D)	Mohr-Coulomb	21	0	40	1		
Dark Orange	Slurry tailings (UD Peak)	SHANSEP	16			1	0.2	0



Notes:
 □ Moment equilibrium (figure on the left) - Shear resistance (figure on the right)
 ■ Horizontal force equilibrium (figure on the left) - Mobilized shear resistance (figure on the right)

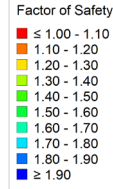


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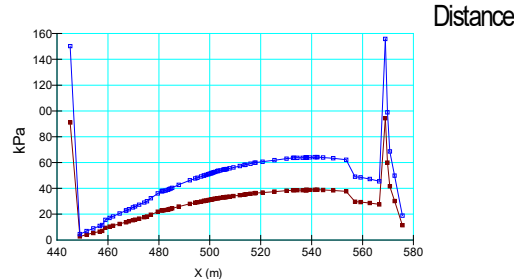
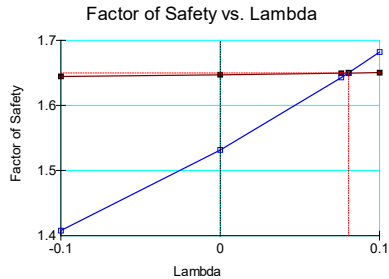
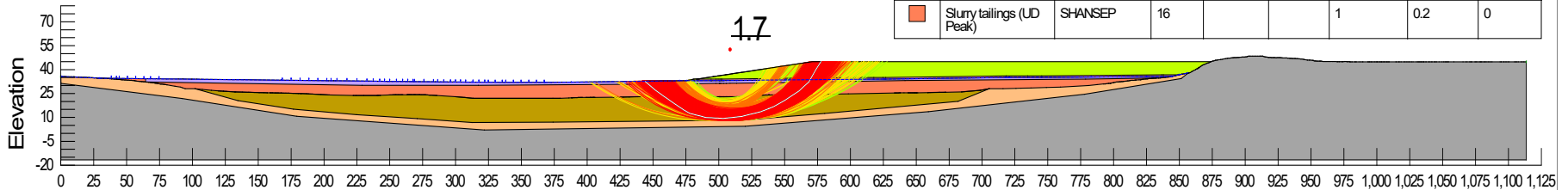
Title: Stability Analysis Runs
 Date: June 2025
 Figure: 4

North Section: Stability results

Loading condition: Static – Undrained Peak
 Tailings state: Partially frozen (first 2 m frozen)
 Search method: Entry-Exit
 Surface geometry: Semi-circular (non optimized)
 Minimum slip surface depth: 5,0 m



Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Tau/Sigma Ratio	Minimum Shear Strength (kPa)
Grey	Bedrock	High Strength	22			1		
Light Green	Filtered tailings (D)	Mohr-Coulomb	19.4	0	30	1		
Light Orange	Gravelly till (D)	Mohr-Coulomb	18.5	0	36	1		
Dark Green	Lake bed sediments (UD Peak)	SHANSEP	16			1	0.25	13
Pink	Rock drain (D)	Mohr-Coulomb	21	0	40	1		
Purple	Slurry tailings (D)-Frozen	Mohr-Coulomb	16	112	28	1		
Orange	Slurry tailings (UD Peak)	SHANSEP	16			1	0.2	0



Notes:

- Moment equilibrium (figure on the left) - Shear resistance (figure on the right)
- Horizontal force equilibrium (figure on the left) - Mobilized shear resistance (figure on the right)

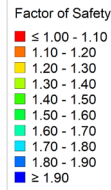


Hope Bay – Filtered Tailings
 Conceptual Design
 Project N#: CAPR003823

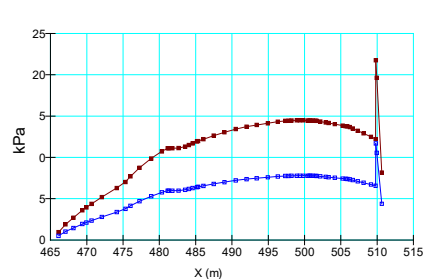
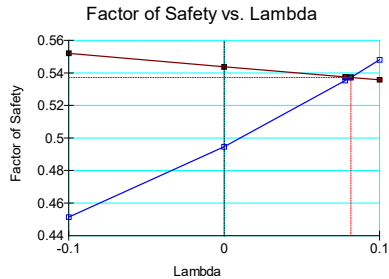
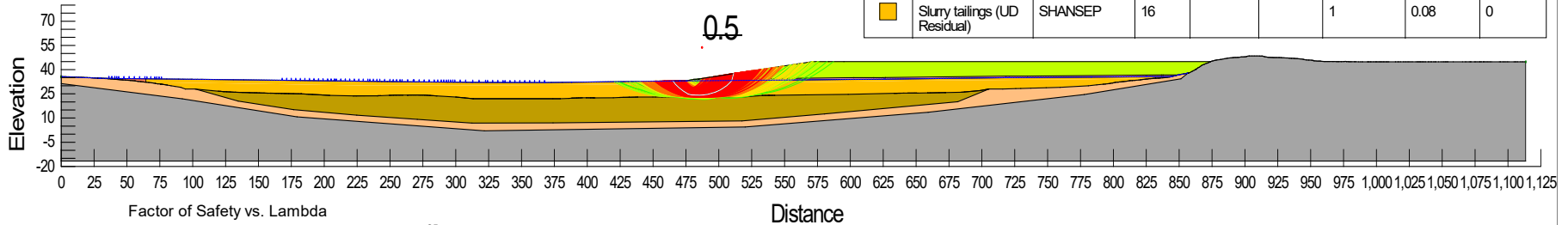
Title: Stability Analysis Runs
 Date: June 2025
 Figure: 5

North Section: Stability results

Loading condition: Static – Undrained Residual
 Tailings state: Non frozen (fully thawed)
 Search method: Entry-Exit
 Surface geometry: Semi-circular (non optimized)
 Minimum slip surface depth: 5,0 m



Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Tau/Sigma Ratio	Minimum Shear Strength (kPa)
Grey	Bedrock	High Strength	22			1		
Light Green	Filtered tailings (D)	Mohr-Coulomb	19.4	0	30	1		
Light Orange	Gravelly till (D)	Mohr-Coulomb	18.5	0	36	1		
Yellow	Lake bed sediments (UD Peak)	SHANSEP	16			1	0.25	13
Pink	Rock drain (D)	Mohr-Coulomb	21	0	40	1		
Orange	Slurry tailings (UD Residual)	SHANSEP	16			1	0.08	0



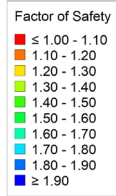
Notes:

- Moment equilibrium (figure on the left) - Shear resistance (figure on the right)
- Horizontal force equilibrium (figure on the left) - Mobilized shear resistance (figure on the right)

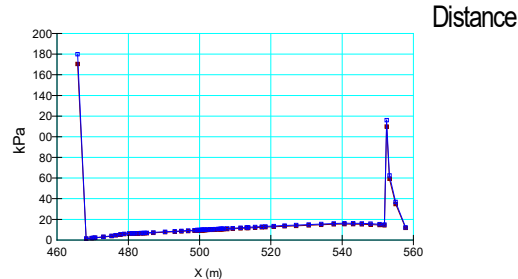
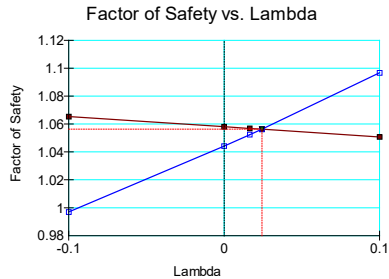
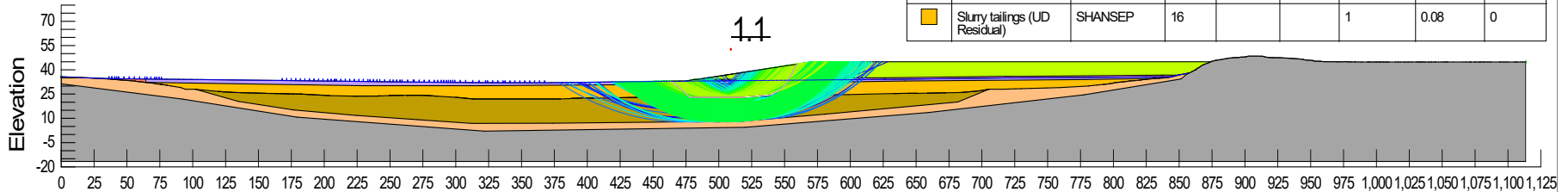
North Section: Stability results

Loading condition
 Tailings state:
 Search method
 Surface geometry
 Minimum slip surface depth

Static – Undrained Residual
 Partially frozen (first 2 m frozen)
 Entry-Exit
 Semi-circular (non optimized)
 5,0 m



Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Tau/Sigma Ratio	Minimum Shear Strength (kPa)
Grey	Bedrock	High Strength	22			1		
Light Green	Filtered tailings (D)	Mohr-Coulomb	19.4	0	30	1		
Light Orange	Gravelly till (D)	Mohr-Coulomb	18.5	0	36	1		
Dark Orange	Lake bed sediments (UD Peak)	SHANSEP	16			1	0.25	13
Pink	Rock drain (D)	Mohr-Coulomb	21	0	40	1		
Purple	Slurry tailings (D)- Frozen	Mohr-Coulomb	16	112	28	1		
Yellow	Slurry tailings (UD Residual)	SHANSEP	16			1	0.08	0



Notes:

- Moment equilibrium (figure on the left) - Shear resistance (figure on the right)
- Horizontal force equilibrium (figure on the left) - Mobilized shear resistance (figure on the right)



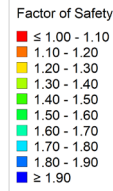
Hope Bay – Filtered Tailings
 Conceptual Design
 Project N#: CAPR003823

Title: Stability Analysis Runs
 Date: June 2025
 Figure: 7

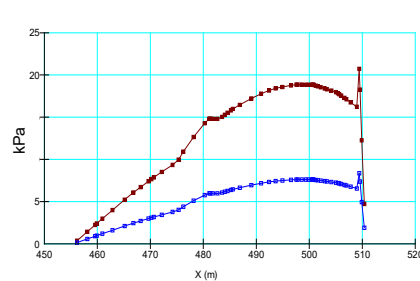
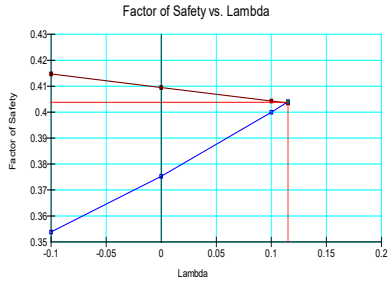
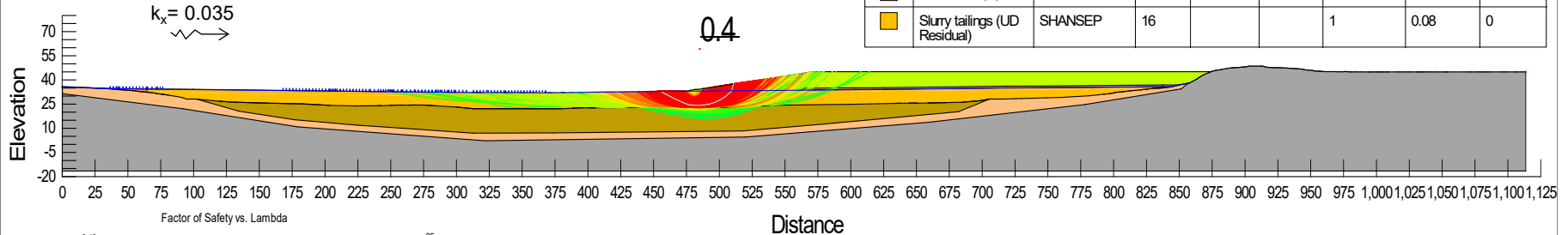
North Section: Stability results

Loading condition
 Tailings state:
 Search method
 Surface geometry
 Minimum slip surface depth

Pseudostatic – Undrained Residual
 Non frozen (fully thawed)
 Entry-Exit
 Semi-circular (non optimized)
 5,0 m



Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Tau/Sigma Ratio	Minimum Shear Strength (kPa)
Grey	Bedrock	High Strength	22			1		
Light Green	Filtered tailings (D)	Mohr-Coulomb	19.4	0	30	1		
Light Orange	Gravelly till (D)	Mohr-Coulomb	18.5	0	36	1		
Yellow-Green	Lake bed sediments (UD Peak)	SHANSEP	16			1	0.25	13
Pink	Rock drain (D)	Mohr-Coulomb	21	0	40	1		
Yellow	Slurry tailings (UD Residual)	SHANSEP	16			1	0.08	0



Notes:

- Moment equilibrium (figure on the left) - Shear resistance (figure on the right)
- Horizontal force equilibrium (figure on the left) - Mobilized shear resistance (figure on the right)



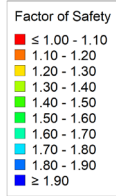
Hope Bay – Filtered Tailings
 Conceptual Design
 Project N#: CAPR003823

Title: Stability Analysis Runs
 Date: June 2025
 Figure: 8

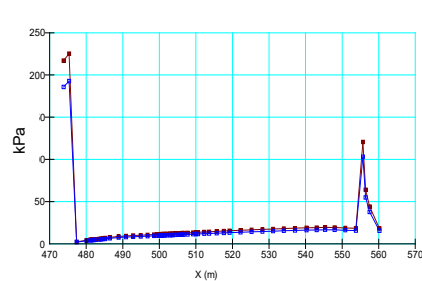
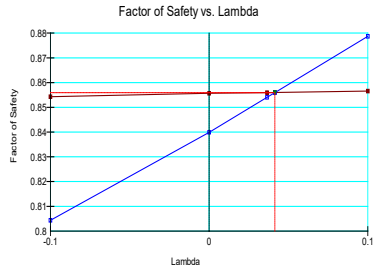
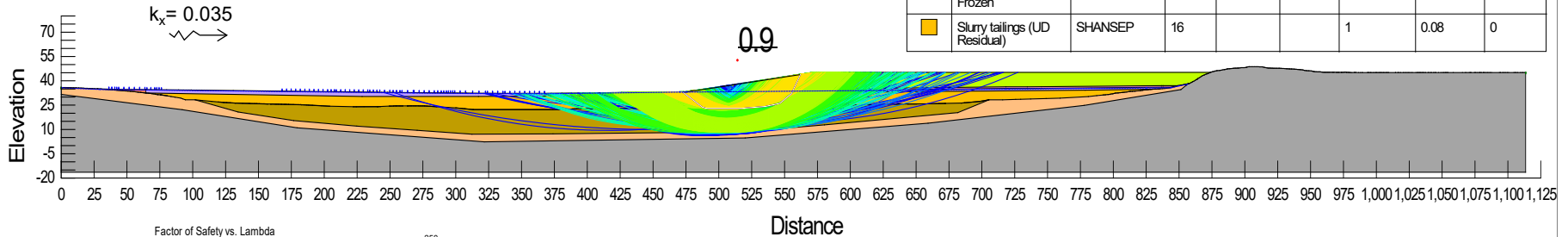
North Section: Stability results

Loading condition
 Tailings state:
 Search method
 Surface geometry
 Minimum slip surface depth

Pseudostatic – Undrained Residual
 Partially frozen (first 2 m frozen)
 Entry-Exit
 Semi-circular (non optimized)
 5,0 m



Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Tau/Sigma Ratio	Minimum Shear Strength (kPa)
Grey	Bedrock	High Strength	22			1		
Light Green	Filtered tailings (D)	Mohr-Coulomb	19.4	0	30	1		
Light Orange	Gravelly till (D)	Mohr-Coulomb	18.5	0	36	1		
Dark Green	Lake bed sediments (UD Peak)	SHANSEP	16			1	0.25	13
Pink	Rock drain (D)	Mohr-Coulomb	21	0	40	1		
Purple	Slurry tailings (D)- Frozen	Mohr-Coulomb	16	112	28	1		
Yellow	Slurry tailings (UD Residual)	SHANSEP	16			1	0.08	0



Notes:

- Moment equilibrium (figure on the left) - Shear resistance (figure on the right)
- Horizontal force equilibrium (figure on the left) - Mobilized shear resistance (figure on the right)

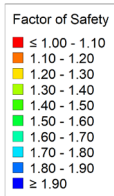


Hope Bay – Filtered Tailings
 Conceptual Design
 Project N#: CAPR003823

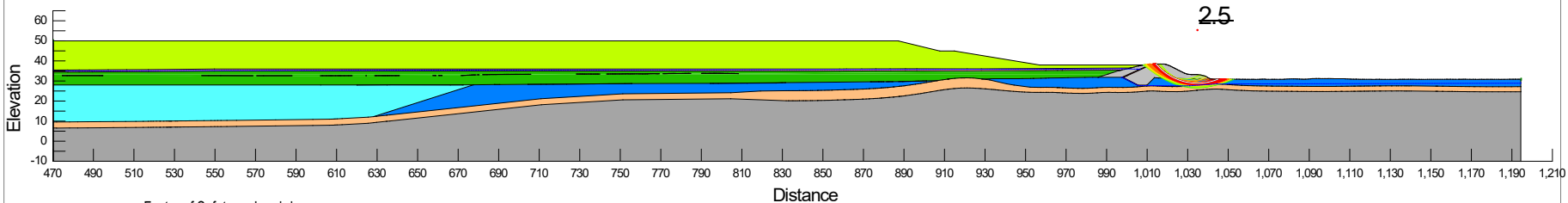
Title: Stability Analysis Runs
 Date: June 2025
 Figure: 9

South Section: Stability results

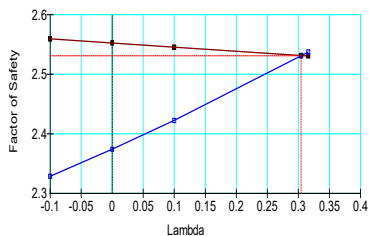
Loading condition: Static - Drained
 Tailings state: Non frozen (fully thawed)
 Search method: Entry-Exit
 Surface geometry: Semi-circular (non optimized)
 Minimum slip surface depth: 5,0 m



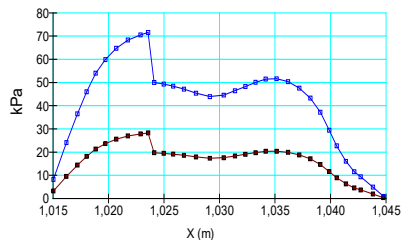
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
Grey	Bedrock	High Strength	22			1
Light Green	Filtered tailings (D)	Mohr-Coulomb	19.4	0	30	1
Red	GCL	Mohr-Coulomb	18	0	15	1
Orange	Gravelly till (D)	Mohr-Coulomb	18.5	0	36	1
Cyan	Lake bed sediments (D)	Mohr-Coulomb	17	0	26	1
Blue	Marine silt and clay (D)	Mohr-Coulomb	17	0	30	1
Pink	Rock drain (D)	Mohr-Coulomb	21	0	40	1
Dark Green	Slurry tailings (D)-Non frozen	Mohr-Coulomb	16	0	28	1
Light Grey	Waste Rock (D)	Mohr-Coulomb	21	0	40	1



Factor of Safety vs. Lambda



Distance



Notes:

- Moment equilibrium (figure on the left) - Shear resistance (figure on the right)
- Horizontal force equilibrium (figure on the left) - Mobilized shear resistance (figure on the right)



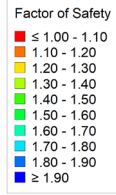
Hope Bay – Filtered Tailings
 Conceptual Design
 Project N#: CAPR003823

Title: Stability Analysis Runs
 Date: June 2025
 Figure: 10

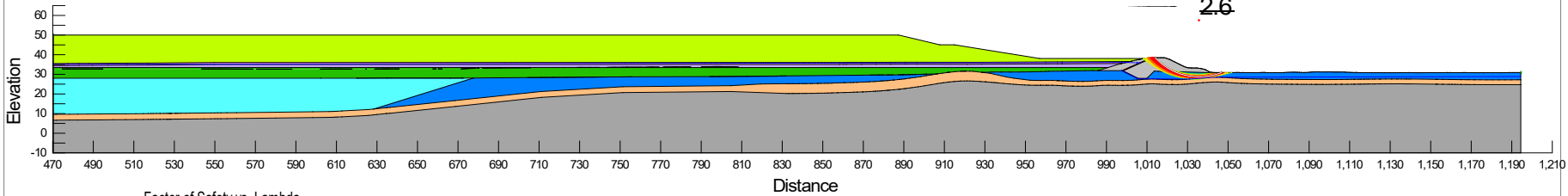
South Section: Stability results

Loading condition
 Tailings state:
 Search method
 Surface geometry
 Minimum slip surface depth

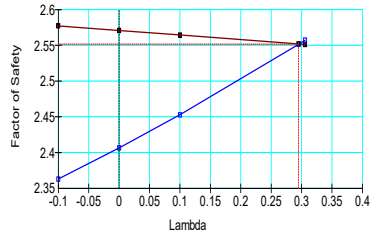
Static - Drained
 Partially frozen (first 2 m frozen)
 Entry-Exit
 Semi-circular (non optimized)
 5,0 m



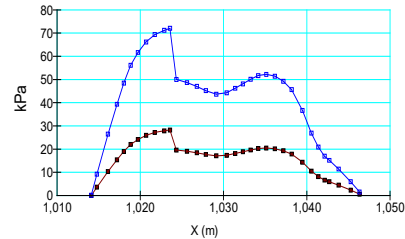
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
Grey	Bedrock	High Strength	22			1
Light Green	Filtered tailings (D)	Mohr-Coulomb	19.4	0	30	1
Red	GCL	Mohr-Coulomb	18	0	15	1
Orange	Gravelly till (D)	Mohr-Coulomb	18.5	0	36	1
Cyan	Lake bed sediments (D)	Mohr-Coulomb	17	0	26	1
Blue	Marine silt and clay (D)	Mohr-Coulomb	17	0	30	1
Pink	Rock drain (D)	Mohr-Coulomb	21	0	40	1
Purple	Slurry tailings (D)-Frozen	Mohr-Coulomb	16	112	28	1
Green	Slurry tailings (D)-Non frozen	Mohr-Coulomb	16	0	28	1
Grey	Waste Rock (D)	Mohr-Coulomb	21	0	40	1



Factor of Safety vs. Lambda



Distance



Notes:

- Moment equilibrium (figure on the left) - Shear resistance (figure on the right)
- Horizontal force equilibrium (figure on the left) - Mobilized shear resistance (figure on the right)



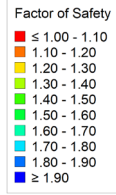
Hope Bay – Filtered Tailings
 Conceptual Design
 Project N#: CAPR003823

Title : Stability Analysis Runs
 Date : June 2025
 Figure: 11

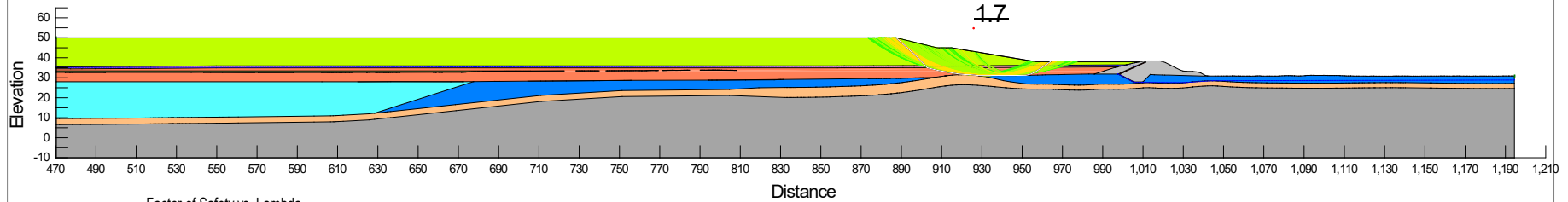
South Section: Stability results

Loading condition
 Tailings state:
 Search method
 Surface geometry
 Minimum slip surface depth

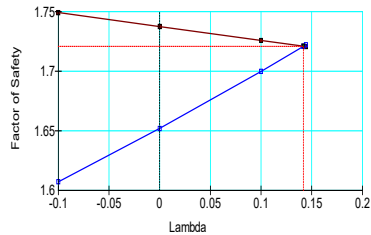
Static – Undrained Peak
 Non frozen (fully thawed)
 Entry-Exit
 Semi-circular (non optimized)
 5,0 m



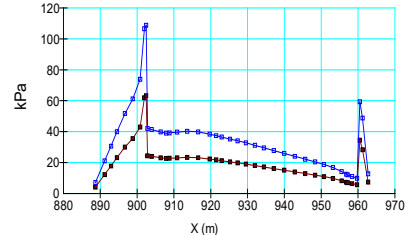
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Grey	Bedrock	High Strength	22			1		
Yellow	Filtered tailings (D)	Mohr-Coulomb	19.4	0	30	1		
Red	GCL	Mohr-Coulomb	18	0	15	1		
Orange	Gravelly till (D)	Mohr-Coulomb	18.5	0	36	1		
Cyan	Lake bed sediments (D)	Mohr-Coulomb	17	0	26	1		
Blue	Marine silt and clay (D)	Mohr-Coulomb	17	0	30	1		
Pink	Rock drain (D)	Mohr-Coulomb	21	0	40	1		
Green	Slurry tailings (D)-Non frozen	Mohr-Coulomb	16	0	28	1		
Orange	Slurry tailings (UD Peak)	SHANSEP	16			1	0.2	0
Grey	Waste Rock (D)	Mohr-Coulomb	21	0	40	1		



Factor of Safety vs. Lambda



Distance



Notes:

- Moment equilibrium (figure on the left) - Shear resistance (figure on the right)
- Horizontal force equilibrium (figure on the left) - Mobilized shear resistance (figure on the right)



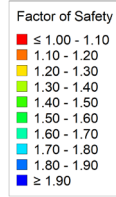
Hope Bay – Filtered Tailings
 Conceptual Design
 Project N#: CAPR003823

Title : Stability Analysis Runs
 Date : June 2025
 Figure: 12

South Section: Stability results

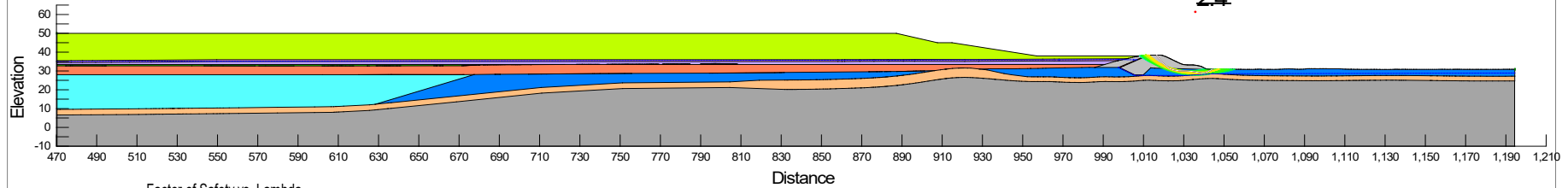
Loading condition
 Tailings state:
 Search method
 Surface geometry
 Minimum slip surface depth

Static – Undrained Peak
 Partially frozen (first 2 m frozen)
 Entry-Exit
 Semi-circular (non optimized)
 5,0 m

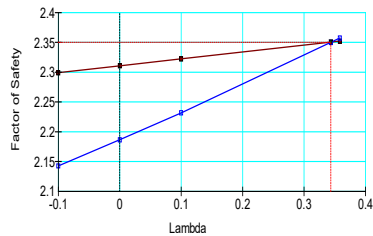


Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Tau/Sigma Ratio	Minimum Shear Strength (kPa)
Grey	Bedrock	High Strength	22			1		
Yellow	Filtered tailings (D)	Mohr-Coulomb	19.4	0	30	1		
Red	GCL	Mohr-Coulomb	18	0	15	1		
Orange	Gravelly till (D)	Mohr-Coulomb	18.5	0	36	1		
Cyan	Lake bed sediments (D)	Mohr-Coulomb	17	0	26	1		
Blue	Marine silt and clay (D)	Mohr-Coulomb	17	0	30	1		
Pink	Rock drain (D)	Mohr-Coulomb	21	0	40	1		
Purple	Slurry tailings (D)-Frozen	Mohr-Coulomb	16	112	28	1		
Green	Slurry tailings (D)-Non frozen	Mohr-Coulomb	16	0	28	1		
Light Orange	Slurry tailings (UD Peak)	SHANSEP	16			1	0.2	0
Grey	Waste Rock (D)	Mohr-Coulomb	21	0	40	1		

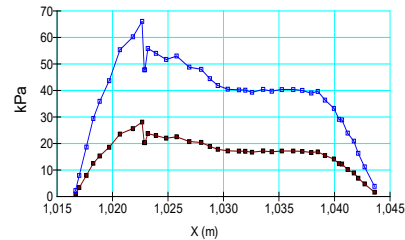
2.4



Factor of Safety vs. Lambda



Distance



Notes:

- Moment equilibrium (figure on the left) - Shear resistance (figure on the right)
- Horizontal force equilibrium (figure on the left) - Mobilized shear resistance (figure on the right)



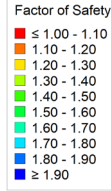
Hope Bay – Filtered Tailings
 Conceptual Design
 Project N#: CAPR003823

Title: Stability Analysis Runs
 Date: June 2025
 Figure: 13

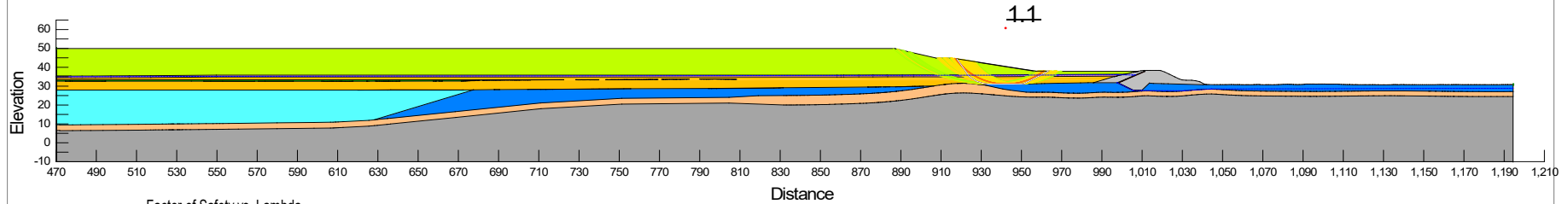
South Section: Stability results

Loading condition
 Tailings state:
 Search method
 Surface geometry
 Minimum slip surface depth

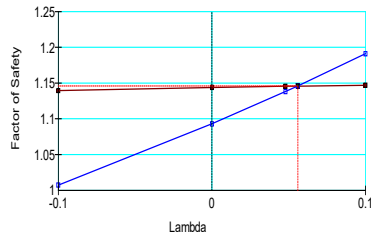
Static – Undrained Residual
 Non frozen (fully thawed)
 Entry-Exit
 Semi-circular (non optimized)
 5,0 m



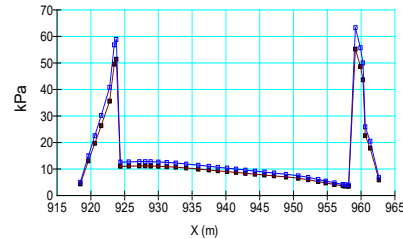
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Tau/Sigma Ratio	Minimum Shear Strength (kPa)
Grey	Bedrock	High Strength	22			1		
Light Green	Filtered tailings (D)	Mohr-Coulomb	19.4	0	30	1		
Red	GCL	Mohr-Coulomb	18	0	15	1		
Orange	Gravelly till (D)	Mohr-Coulomb	18.5	0	36	1		
Cyan	Lake bed sediments (D)	Mohr-Coulomb	17	0	26	1		
Blue	Marine silt and clay (D)	Mohr-Coulomb	17	0	30	1		
Pink	Rock drain (D)	Mohr-Coulomb	21	0	40	1		
Dark Green	Slurry tailings (D)-Non frozen	Mohr-Coulomb	16	0	28	1		
Yellow	Slurry tailings (UD Residual)	SHANSEP	16			1	0.08	0
Grey	Waste Rock (D)	Mohr-Coulomb	21	0	40	1		



Factor of Safety vs. Lambda



Distance



Notes:

- Moment equilibrium (figure on the left) - Shear resistance (figure on the right)
- Horizontal force equilibrium (figure on the left) - Mobilized shear resistance (figure on the right)



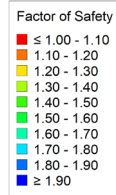
Hope Bay – Filtered Tailings
 Conceptual Design
 Project N#: CAPR003823

Title: Stability Analysis Runs
 Date: June 2025
 Figure: 14

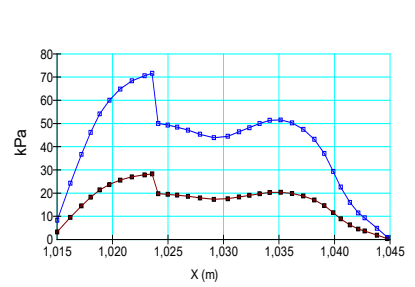
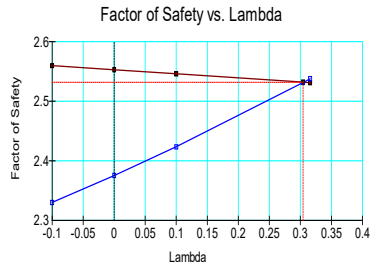
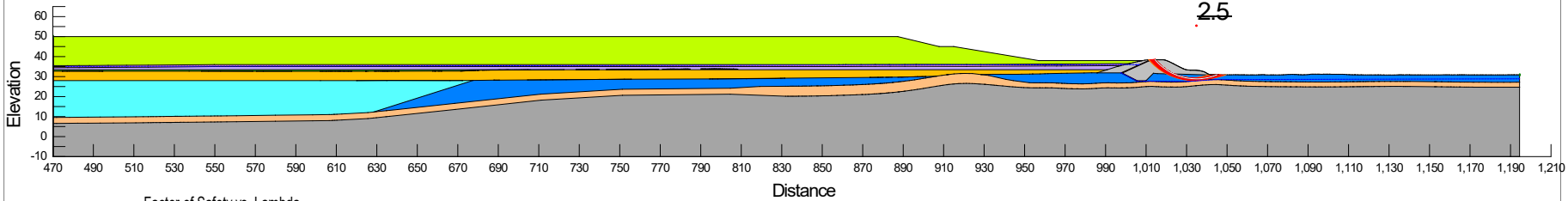
South Section: Stability results

Loading condition
 Tailings state:
 Search method
 Surface geometry
 Minimum slip surface depth

Static – Undrained Residual
 Partially frozen (first 2 m frozen)
 Entry-Exit
 Semi-circular (non optimized)
 5,0 m



Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Tau/Sigma Ratio	Minimum Shear Strength (kPa)
Grey	Bedrock	High Strength	22			1		
Light Green	Filtered tailings (D)	Mohr-Coulomb	19.4	0	30	1		
Red	GCL	Mohr-Coulomb	18	0	15	1		
Orange	Gravelly till (D)	Mohr-Coulomb	18.5	0	36	1		
Cyan	Lake bed sediments (D)	Mohr-Coulomb	17	0	26	1		
Blue	Marine silt and clay (D)	Mohr-Coulomb	17	0	30	1		
Pink	Rock drain (D)	Mohr-Coulomb	21	0	40	1		
Purple	Slurry tailings (D)-Frozen	Mohr-Coulomb	16	112	28	1		
Green	Slurry tailings (D)-Non frozen	Mohr-Coulomb	16	0	28	1		
Yellow	Slurry tailings (UD Residual)	SHANSEP	16			1	0.08	0
Grey	Waste Rock (D)	Mohr-Coulomb	21	0	40	1		



Notes:
 □ Moment equilibrium (figure on the left) - Shear resistance (figure on the right)
 ■ Horizontal force equilibrium (figure on the left) - Mobilized shear resistance (figure on the right)



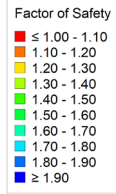
Hope Bay – Filtered Tailings
 Conceptual Design
 Project N#: CAPR003823

Title: Stability Analysis Runs
 Date: June 2025
 Figure: 15

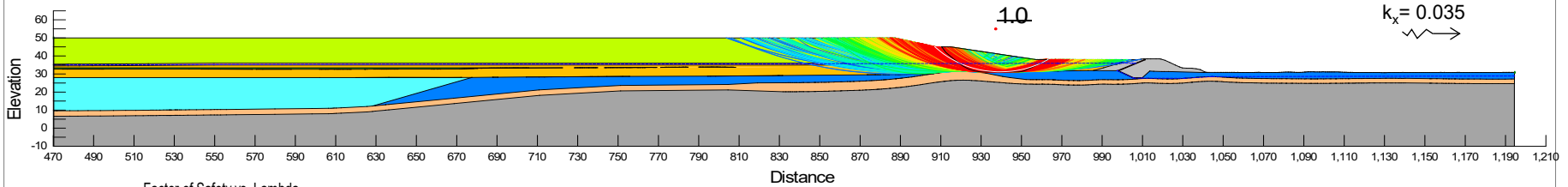
South Section: Stability results

Loading condition
Tailings state:
Search method
Surface geometry
Minimum slip surface depth

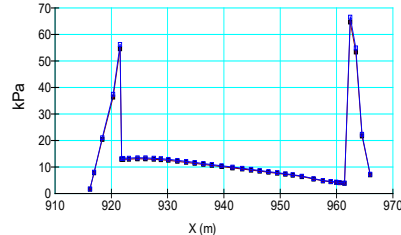
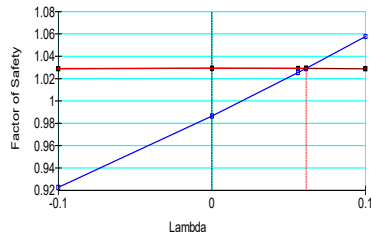
Pseudostatic – Undrained Residual
Non frozen (fully thawed)
Entry-Exit
Semi-circular (non optimized)
5,0 m



Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Tau/Sigma Ratio	Minimum Shear Strength (kPa)
Grey	Bedrock	High Strength	22			1		
Light Green	Filtered tailings (D)	Mohr-Coulomb	19.4	0	30	1		
Red	GCL	Mohr-Coulomb	18	0	15	1		
Orange	Gravelly till (D)	Mohr-Coulomb	18.5	0	36	1		
Cyan	Lake bed sediments (D)	Mohr-Coulomb	17	0	26	1		
Blue	Marine silt and clay (D)	Mohr-Coulomb	17	0	30	1		
Pink	Rock drain (D)	Mohr-Coulomb	21	0	40	1		
Green	Slurry tailings (D)-Non frozen	Mohr-Coulomb	16	0	28	1		
Yellow	Slurry tailings (UD Residual)	SHANSEP	16			1	0.08	0
Grey	Waste Rock (D)	Mohr-Coulomb	21	0	40	1		



Factor of Safety vs. Lambda



Notes:

- Moment equilibrium (figure on the left) - Shear resistance (figure on the right)
- Horizontal force equilibrium (figure on the left) - Mobilized shear resistance (figure on the right)



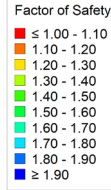
Hope Bay – Filtered Tailings
Conceptual Design
Project N#: CAPR003823

Title: Stability Analysis Runs
Date: June 2025
Figure: 16

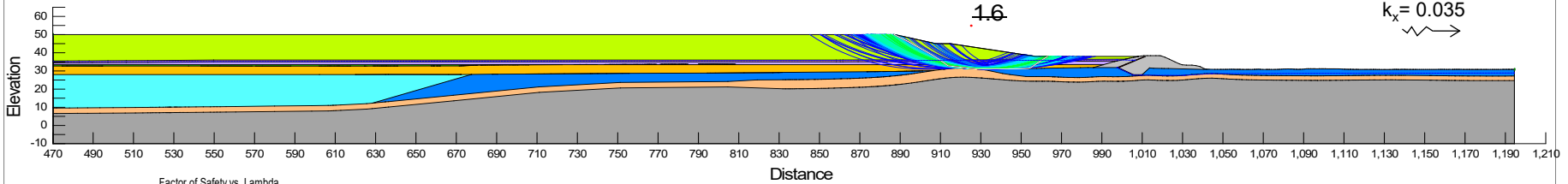
South Section: Stability results

Loading condition
 Tailings state:
 Search method
 Surface geometry
 Minimum slip surface depth

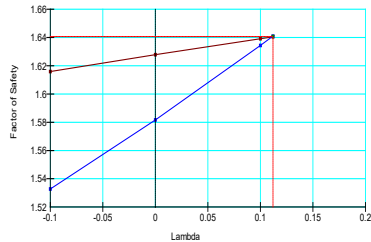
Pseudostatic – Undrained Residual
 Partially frozen (first 2 m frozen)
 Entry-Exit
 Semi-circular (non optimized)
 5,0 m



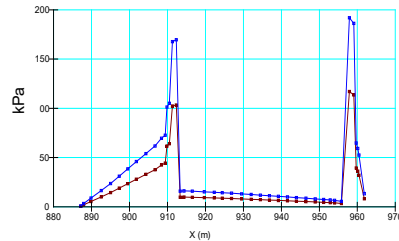
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Tau/Sigma Ratio	Minimum Shear Strength (kPa)
Grey	Bedrock	High Strength	22			1		
Light Green	Filtered tailings (D)	Mohr-Coulomb	19.4	0	30	1		
Red	GCL	Mohr-Coulomb	18	0	15	1		
Orange	Gravelly till (D)	Mohr-Coulomb	18.5	0	36	1		
Cyan	Lake bed sediments (D)	Mohr-Coulomb	17	0	26	1		
Blue	Marine silt and clay (D)	Mohr-Coulomb	17	0	30	1		
Pink	Rock drain (D)	Mohr-Coulomb	21	0	40	1		
Purple	Slurry tailings (D)-Frozen	Mohr-Coulomb	16	112	28	1		
Green	Slurry tailings (D)-Non frozen	Mohr-Coulomb	16	0	28	1		
Yellow	Slurry tailings (UD Residual)	SHANSEP	16			1	0.08	0
Grey	Waste Rock (D)	Mohr-Coulomb	21	0	40	1		



Factor of Safety vs. Lambda



Distance



Notes:

- Moment equilibrium (figure on the left) - Shear resistance (figure on the right)
- Horizontal force equilibrium (figure on the left) - Mobilized shear resistance (figure on the right)



Hope Bay – Filtered Tailings
 Conceptual Design
 Project N#: CAPR003823

Title: Stability Analysis Runs
 Date: June 2025
 Figure: 17

Appendix C Sensitivity Analysis

Sensitivity Analysis Runs

Hope Bay, Nunavut, Canada

Notes:



Hope Bay – Filtered Tailings
Conceptual Design
Project N#: CAPR003823

Title : Sensitivity analysis runs
Date : June 2025
Figure: 1

During, or at End of Construction - Undrained Peak Condition – Non frozen

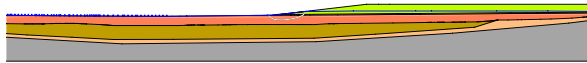
Variation in groundwater table

Changes in slurry tailings thickness

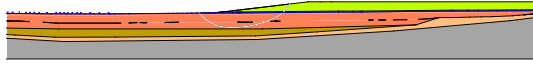
Variations in undrained resistance parameters

Case 1

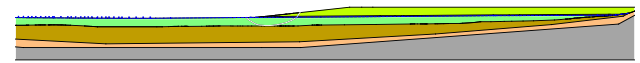
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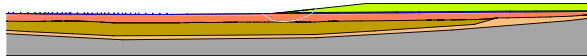


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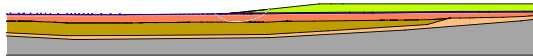


Case 2

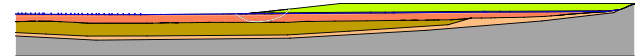
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1.3

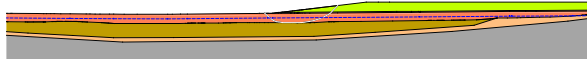


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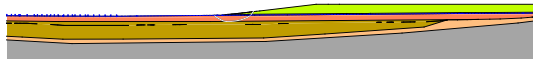


Case 3

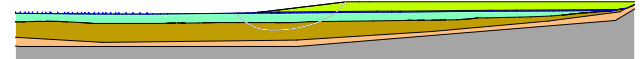
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1.3



1.5



Notes:

During, or at End of Construction - Undrained Peak Condition – Partially frozen

Variation in groundwater table

Changes in slurry tailings thickness

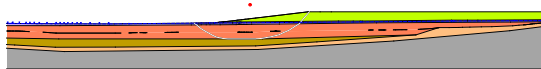
Variations in undrained resistance parameters

Case 1

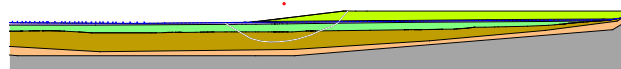
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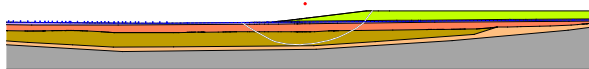


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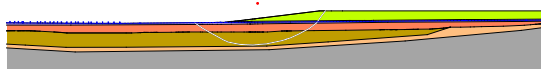


Case 2

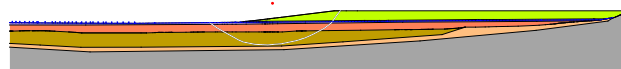
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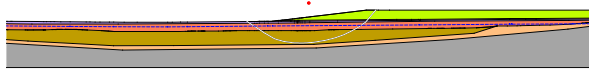


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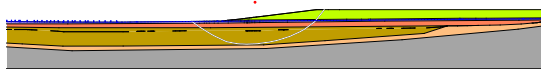


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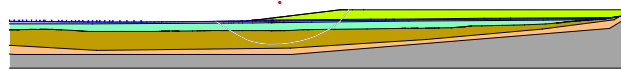
2.0



1.7



1.7



Notes:

During, or at End of Construction - Undrained Residual Condition – Non frozen

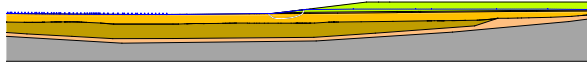
Variation in groundwater table

Changes in slurry tailings thickness

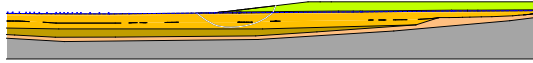
Variations in undrained resistance parameters

Case 1

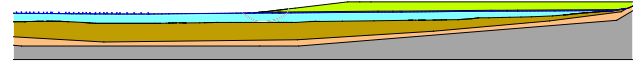
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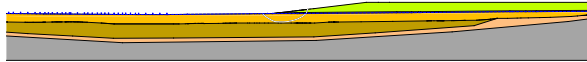


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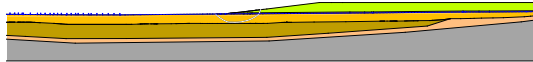


Case 2

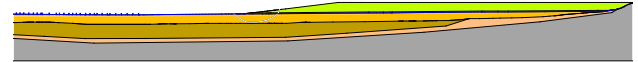
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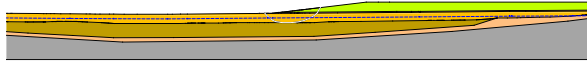


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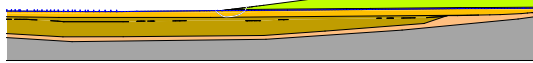


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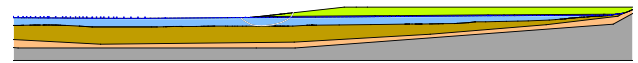
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0.5



0.8



Notes:

During, or at End of Construction - Undrained Residual Condition – Partially frozen

Variation in groundwater table

Changes in slurry tailings thickness

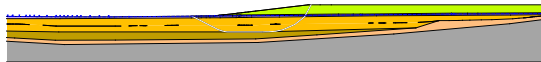
Variations in undrained resistance parameters

Case 1

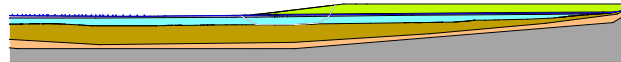
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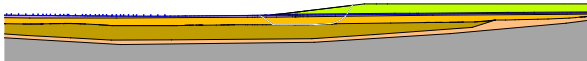


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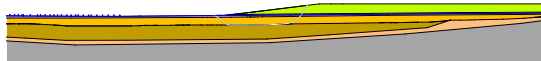


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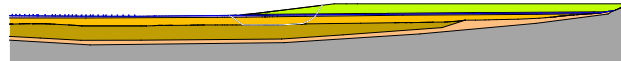
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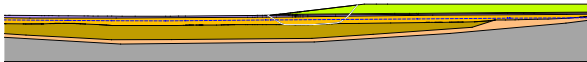


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Case 3

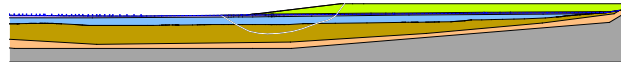
1.2



1.6



1.6



Notes:

Appendix D Mitigation Runs



Mitigation Runs

Hope Bay, Nunavut, Canada

Notes:



Hope Bay – Filtered Tailings
Conceptual Design
Project N#: CAPR003823

Title : Mitigation Measures
Date : June 2025
Figure: 1

North Section Foundation improvement dimensions would increase the FOS to 1.1

Densified tailings (phi = 35 deg)

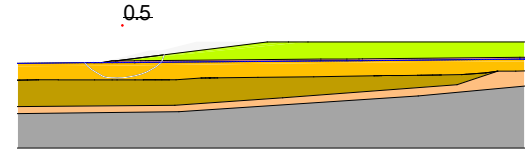
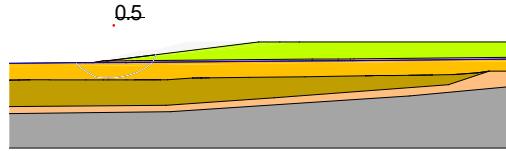
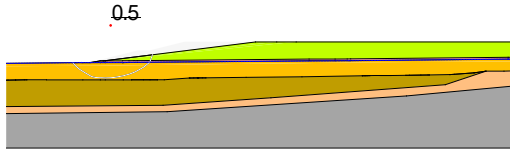
Stone columns (phi = 40 deg)

Densified tailings plus buttress (phi = 35 deg)

Base case

Base case

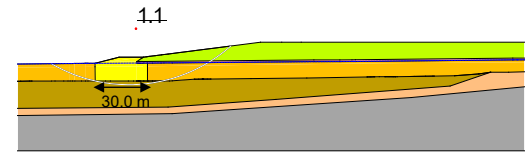
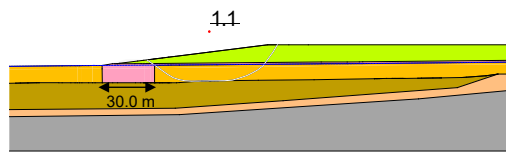
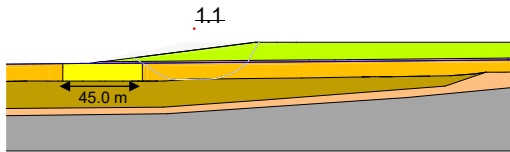
Base case



45 m wide

30 m wide

30 m long + buttress



Notes:

The stability runs correspond to the undrained residual loading condition for both tailings and foundation soils. **FS target = 1.1**

The runs were based on the geometry (1V:8H)

Appendix E Convergence Criteria

Appendix E - Convergence and Optimization Criteria

For Project File

From Barbara Amar, M. Sc., Civil Eng. SAIG, ISSMGE

Reviewed by Peter Luedke, PEng (NU).

Subject Convergence and Optimization Criteria Used for the Stability Analysis of the Filtered Tailings Stack at Hope Bay

File Name: Appendix E Convergence Criteria.docx

1 Objectives

The objective of this document is to present the convergence criteria used for the stability analysis of the filtered tailings stack modelled using Geostudio v. 2024.2.0 software.

2 Convergence criteria

2.1 Flow modeling

Due to the conceptual stage of the project and the limited information about the construction details and groundwater regime, the pore pressure distribution was calculated by considering the phreatic surface and applying Phreatic Correction to the proposed piezometric line.

2.2 Stability analysis

The convergence criteria for the assessment of slope stability using the Slope/W module are summarized in the Table 2-1. The parameters presented are adjusted according to the convergence needs of the stability model and the precision required in the estimation of the FoS. Modeling is initiated using the default convergence values proposed by the software and the criteria values are varied as needed.

As for the minimum depth of the failure surface, it varies depending on the project and the geometry of the model. In this case, the value was fixed at 5.0 m for deep failure surfaces.

In order to improve the solution, the number of slices subdividing the sliding surface can be adjusted according to the configuration of the project and the extension of the sliding surface: the larger the

failure surface, increased number of slices are required to obtain an adequate solution (Arai, K., & Tagyo, K., 1985). Due to the size of the sliding surfaces, 60 columns were chosen.

The maximum number of iterations has been adjusted so that the tolerable difference in the FoS is respected. For example, when the calculations stop because the maximum number of iterations is reached but the tolerable difference in the FoS is still greater than the applicable difference criteria, the maximum number of iterations is increased. It is important that the stop of the calculations is defined by the tolerable difference in the FoS and not by the maximum number of iterations. However, to limit the computation time, it is important to limit the maximum number of iterations

Table 2-1: Slope/W Model Convergence Criteria

Criterion	Value
Minimum Depth of Sliding Surface	5.0 m
Maximum number of iterations	100
Tolerable difference in FS	0,001
Research method	Root Finder
Number of slices	60
Underrelaxation allowed	Checked
Minimum rate of sub-relaxation	0,1
Sub-relaxation rate reduction factor	0,65
Frequency of reduction of sub-relaxation	50 iterations
Tolerable difference between starting and converged MSDS	3
Maximum iterations to compute the convergent value of Lambda	20
Lambda absolute maximum	2

3 Criteria for Optimizing the Factor of Safety

Table 3-1 shows the parameters chosen for optimizing the sliding surfaces and are used primarily in the following cases: (i) Adjust the optimized slip surface to obtain a realistic geometry and (ii) in the case of complex stratigraphy, to avoid unrealistic concavity in the optimization process.

In the first case, the number of points on the sliding surface can be added, while to change the concavity of the sliding surface it is necessary to change the value of the maximum concave angle. As described by Greco V.R. (1996), in laminated soils, the ascending concavity condition can lead to errors, because, due to stratigraphic conditions, part of the slip surface could be convex. Finally, the particular method used for stability analysis may require additional constraints on the variables to obtain inclinations of the bases of the slices within the failure surfaces.

The failure surface must not deviate significantly from its original (semi-circular) shape and the FS after optimization must not be much different: the difference must not be more than 15%, according to Seequent (2023). A difference in safety factor of more than 15% between optimized and non-optimized sliding surfaces should be carefully examined.

Finally, the optimization procedure is only a mathematical method for finding weaker FoS without much control over the shape of the final failure surface and should not be considered as a single search method.

Table 3-1: Optimization settings

Criterion	Parameter	Value / Interval
Maximum number of iterations		2,000
Number of points on the sliding surface	Starting	8
	Ending	16
Angle concave maximal	Driving side	5°
	Resisting side	1°

References

- Arai, K., & Tagyo, K. (1985). Determination of noncircular slip surface giving the minimum factor of safety in slope stability analysis. *Soils and Foundations*, 25(1), 43-51.
- Greco, V. R. (1996). Efficient Monte Carlo technique for locating critical slip surface. *Journal of Geotechnical Engineering*, 122(7), 517-525.
- Seequent (2023). Stability Modeling with Geostudio, Geostudio, Seequent. Copyright © 2023 Seequent Limited, The Bentley Subsurface Company.

Appendix F Hydrotechnical Design

DRAFT

Memo

To	Lisa Mah (AEM)	Client	Agnico Eagle Mines Limited
From	Federico Giurich (SRK), Charles Veilleux (SRK)	Project	CAPR003823
Cc	Peter Luedke (SRK)	Date	June 6, 2025
Reviewed by	Brandon Smith (SRK)		
Subject	Conceptual Analysis of Runoff Conveyance - Hope Bay TIA Filtered Tailings Stack Facility		

File name: TIA_Dry_Stack_Runoff_Conveyance_Conceptual_Analysis_CAPR03823_20250606_DRAFT.docx

1 Introduction

1.1 Overview

Agnico Eagle Mines Limited (AEM) is evaluating a potential transition from thickened slurry to filtered tailings stack, or dry stack, for the Hope Bay Tailings Impoundment Area (TIA). SRK Consulting (Canada) Inc. was retained by AEM to advance the conceptual design of the filtered tailings stack and develop a conveyance system to manage surface runoff within the TIA. The filtered tailings stack design was developed as part of the Multiple Accounts Analysis process conducted in 2024, by AEM and SRK (SRK 2024). The preferred conceptual alternative design is advanced as part of this scope.

This memo summarizes SRK's conceptual hydrotechnical design for both the operational and closure phases of the filtered tailings stack within the TIA at the Hope Bay Project. The analysis is focused on the surface water conveyance of the filtered tailings stack and management of runoff reporting to the TIA Reclaim Pond, within the facility. Water management and discharge from the Reclaim Pond will be managed through active water discharge, treatment and overflow via the Emergency Overflow Channel (EOC) once constructed. The EOC and overall water management strategy of the TIA is excluded from this scope.

2 TIA Catchment Areas

Figure 2-1 shows a Digital Elevation Model (DEM) of the proposed TIA filtered tailings stack at the end of tailings placement (SRK 2024). During operations, the requirement for these channels will be determined based on operational tailings placement staging details, however, they are indicative of the conceptual channel dimensions once implemented. Figure 2-2 shows:

- The filtered tailings stack will have a total catchment area of 3.0 km².

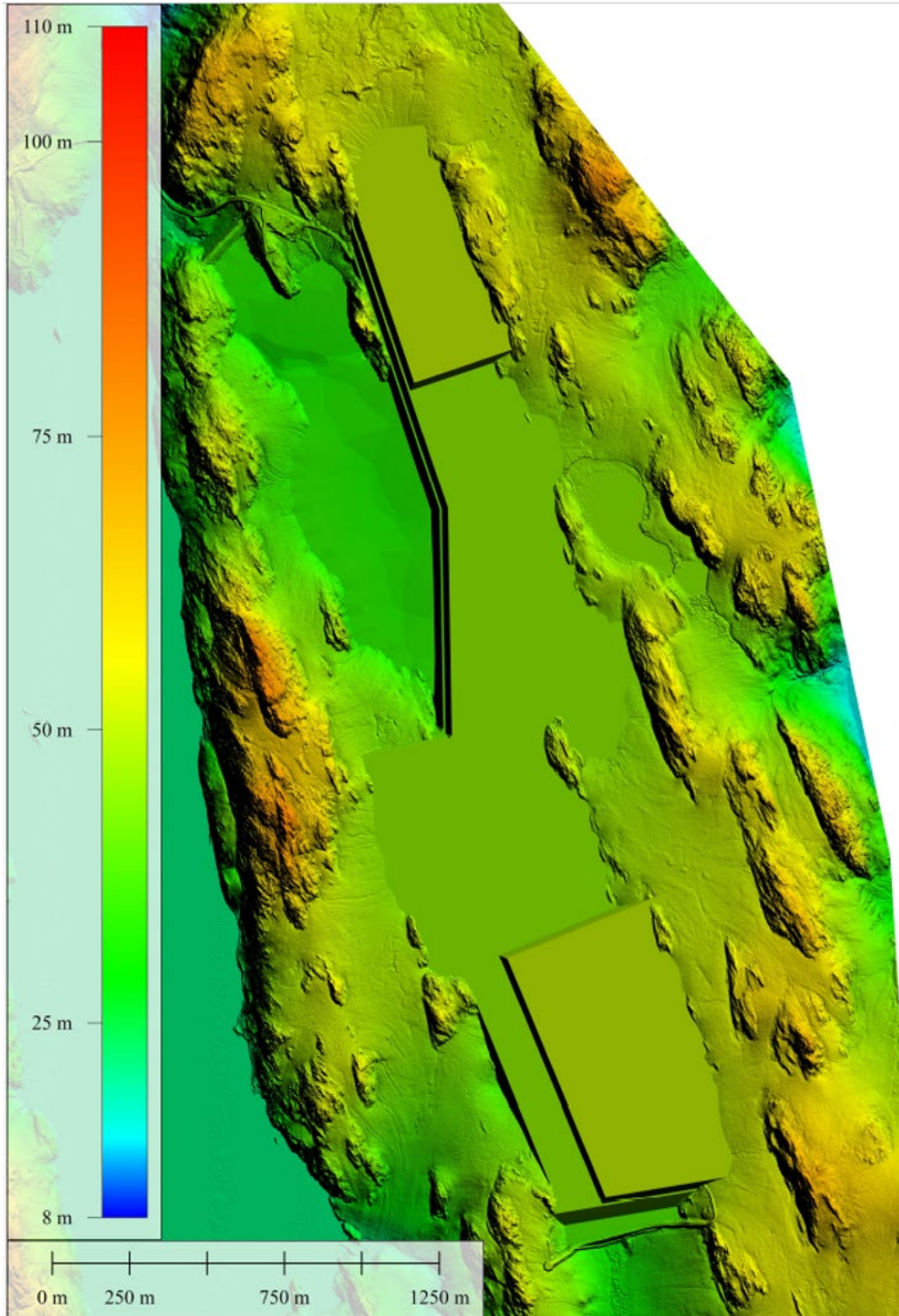
- SRK subdivided this surface into 11 sub-catchments (colored areas C1 through C11) for the purpose of this analysis.
- Flow directions for each sub-catchment are denoted as blue arrows.
- Alignments of proposed drainage channels for conveying surface runoff towards the TIA Reclaim Pond are denoted as white solid lines for main channels and white dashed lines for secondary channels.
- The location of chutes, conveying flows from one bench to another in a short distance, are denoted as black circles.
- Potential locations of diversion ditches, not analyzed in this study, are shown as black dashed lines.

Table 2-1 indicates the contributing sub-catchment to each drainage channel, the channel type and the corresponding chutes.

Table 2-1: Drainage Sub-catchments, Channel Type, and Chutes.

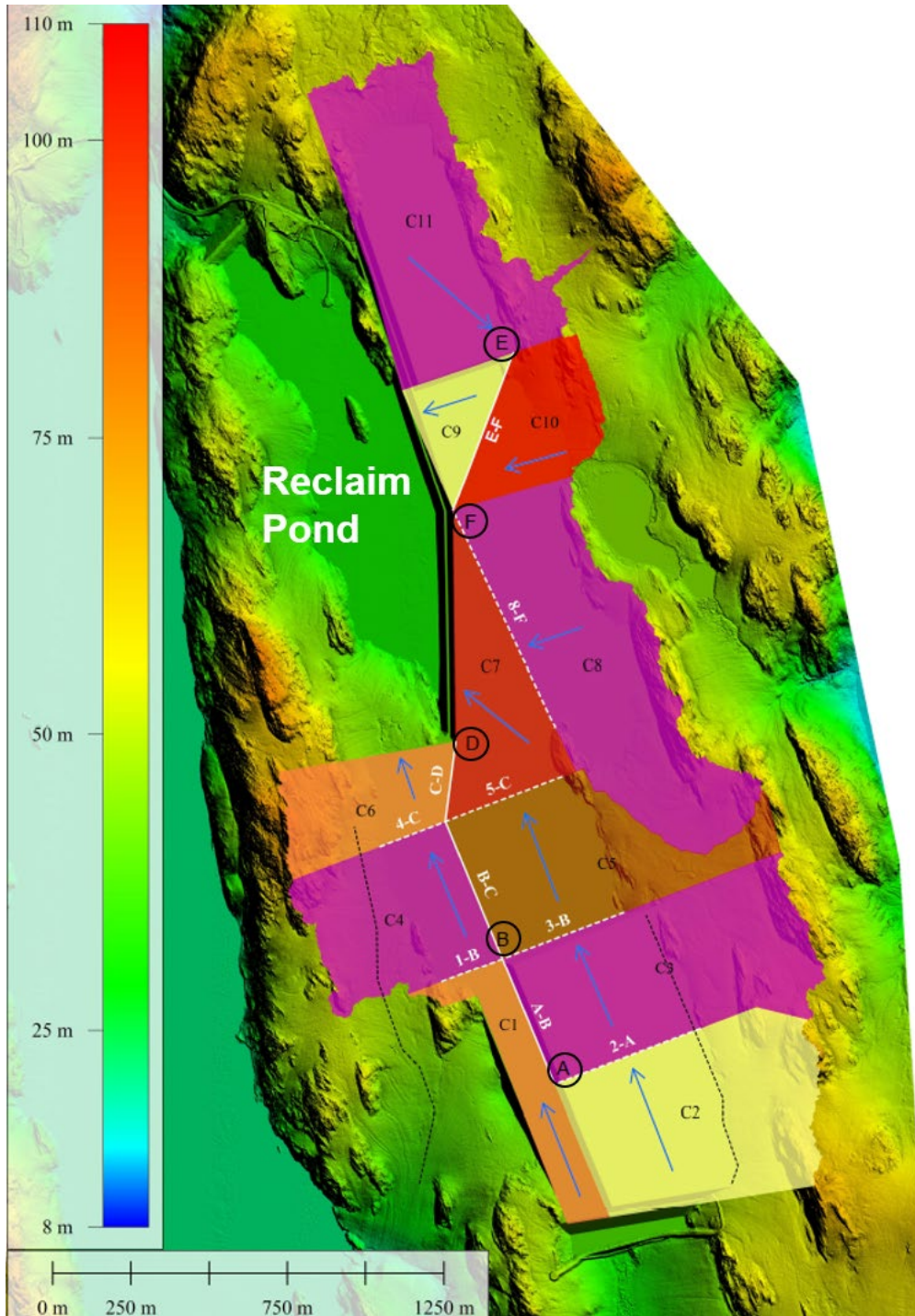
Channel	Draining Sub-catchment	Channel Type	Chute at Channel Inlet	Chute at Channel Outlet
2-A	C2	Secondary	-	A
A-B	C2	Main	-	-
1-B	C1	Secondary	-	-
3-B	C3	Secondary	-	B
B-C	C1 to C3	Main	-	-
4-C	C4	Secondary	-	-
5-C	C5	Secondary	-	-
C-D	C1 to C5	Main	-	D
8-F	C8	Secondary	-	F
E-F	C10 and C11	Main	E	F

Sources: NA CAPR003823 HOPE BAY TIA Filtered Tailings Permitting - Internal\Task300-Hydro_Analysis\Rational_method.xlsx



Source: NA CAPR003823 HOPE BAY TIA Filtered Tailings Permitting - Internal\030_AutoCAD\Global mapper\TIA - Dry stack.gmw

Figure 2-1: DEM of the proposed TIA.



Source: NA CAPR003823 HOPE BAY TIA Filtered Tailings Permitting - Internal\030_AutoCAD\Global mapper\TIA - Dry stack.gmw

Figure 2-2: DEM of the proposed TIA with sub-catchments configuration and preliminary conveyance system.

3 Design Events

For the design of this proposed conveyance system, the following storm design events were considered, in accordance with AEM Water Management Guidelines (AEM, 2021):

- Design Event 1: 100-year, 24-h rainfall event plus median 30-day snowmelt (AEM requirement for operational conditions)
- Design Event 2: 1,000-year, 24-h rainfall event plus median 30-day snowmelt (AEM requirement for closure conditions).

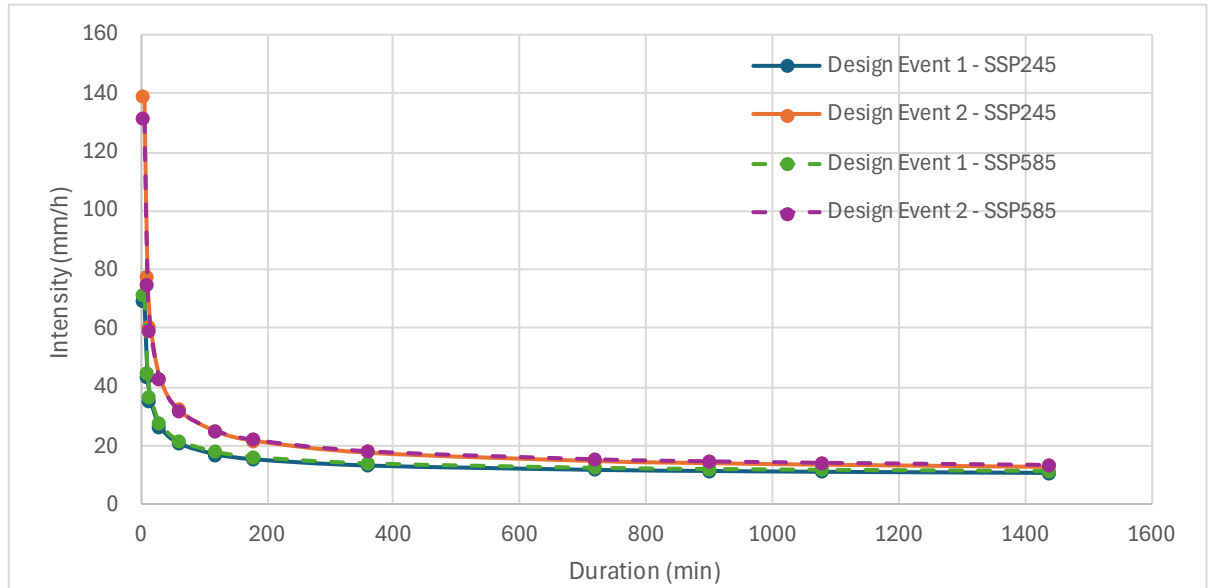
In both design events, the effects of climate change were accounted for, and the snowmelt component was assumed to melt completely during the 24-h rainfall event. Table 3-1 summarizes total storm depths, sourced from (SRK, 2024) for the projected period of 2040 – 2079, and for radiative forcing scenarios SSP2-4.5 and SSP5-8.5. Scenario SSP2-4.5 is adopted for the preliminary design, while scenario SSP5-8.5 is included to perform a sensitivity analysis.

Table 3-1: 24-h Design Event Precipitation

Design Event	Radiative Forcing Scenario	Rainfall (mm)	30-day Snowmelt (mm)	Total Precipitation (mm)
1	SSP2-4.5	58.5	194	252.5
2	SSP2-4.5	115.1	194	309.1
1	SSP5-8.5	59.8	210	269.8
2	SSP5-8.5	110.9	210	320.9

Source: SRK, 2024. Hope Bay Climate Change Update to AR6. CAPR003278.

Figure 3-1 illustrates the intensity-duration-frequency (IDF) curves for the two design events. As the figure shows, there is expected to be only a small difference in storm intensity between the two evaluated climate change scenarios.



Source: NA CAPR003823 HOPE BAY TIA Filtered Tailings Permitting - Internal\Task300-Hydro_Analysis\Rational_method.xlsx

Figure 3-1: IDF curves for the design events

4 Hydraulic Analysis

The Rational Method (Chow, Maidment, & Mays, 1988) was used to size the channels that will make up the filtered tailings stack runoff conveyance system. The following assumptions were applied to this analysis:

- The surface of the TIA filtered tailings stack would correspond to that of the final configuration in both operational and closure stage (Figure 2-1).
- All TIA filtered tailings stack surface runoff will be conveyed towards the existing Reclaim Pond located at the northwest of the TIA.
 - Runoff from sub-catchments C6, C7, and C9 will be conveyed to the Reclaim Pond via sheet flow or operational surface water ditches.
 - Runoff from the remaining sub-catchments will be conveyed via channels and chutes down the slope of the filtered tailings stack.
- Drainage channels will be lined with riprap and non-woven geotextile, and conform to a trapezoidal cross-section with the following dimensions:
 - Base width = 1 m (min)
 - Side slope = 2H:1V
 - Manning's roughness coefficient = 0.033 (Chow V. T., 1959)
 - Longitudinal slope = 0.5% (min).

- The required depth of each drainage channel considered the following:
 - Main channels (white solid line, Figure 2-2) will convey a constant steady state flow along the entire alignment (i.e., inflows enter the channel at the inlet only).
 - Secondary channels (white dashed line, Figure 2-2) will convey a variable steady state flow along the alignment (i.e., inflows enter the channel both at the inlet and along the length).
 The design depth of secondary channels will conform to the depth of flow at the outlet of each channel (i.e., the maximum required depth).
- Chutes will also be designed as trapezoidal cross-sections and be lined with riprap, sharing the following characteristics:
 - Base width = 3 m (for A, B and E); 7 m (for D and F)
 - Side slope = 2H:1V
 - Manning's coefficient = 0.039 (corresponding to a 20% increase relative to the roughness coefficient of the upstream channel, to account for increased turbidity).
 - Longitudinal slope = 13%, per dry stack design

Concentration times were calculated as the mean of 20 different methods (after removing the methods that yield the minimum and maximum values). Table 4-1 summarizes the area and concentration time of each sub-catchment.

Table 4-1: Sub-catchments Area and Concentration Time.

Sub-catchment	Area (km ²)	Concentration Time (min)
C1	0.123	59
C2	0.401	21
C3	0.416	26
C4	0.250	27
C5	0.311	30
C6	0.160	14
C7	0.192	14
C8	0.469	25
C9	0.079	15
C10	0.158	8
C11	0.442	44

Sources: NA CAPR003823 HOPE BAY TIA Filtered Tailings Permitting - Internal\Task300-Hydro_Analysis\Rational_method.xlsx

- IDF curves correspond to those shown in Figure 3-1:
 - Scenario SSP2-4.5 is used for the preliminary design
 - Scenario SSP5-8.5 is used to perform a sensitivity analysis of the preliminary design

- A runoff coefficient of 1.0 for all sub-catchments, per (AEM, 2021).

For all channels, preliminary riprap dimensions (i.e., D_{50} grading and thickness) were calculated using the Isbach equation (USACE, 1994).

5 Results

5.1 Base Case (SSP2-4.5)

Table 5-1 summarizes the estimated dimensions of each drainage channel under SSP2-4.5 conditions. For both design events, it is feasible to convey the surface runoff of the TIA filtered tailings stack by gravity towards the Reclaim Pond within riprap-lined channels using riprap with a D_{50} of 0.05 m to 0.1 m.

Channel depths shown do not include additional freeboard, a minimum of 0.3 m should be added to the required depth, and adjusted at a later stage of design.

Table 5-1: Drainage channel dimensions (SSP2-4.5).

Channel	Length (m)	Longitudinal slope	Base width (m)	Side slope (H:1V)	Design Event 1			Design Event 2		
					Required depth (m)	D_{50} (m)	Thickness (m)	Required depth (m)	D_{50} (m)	Thickness (m)
2-A	497	0.5%	1	2	1.0	0.1	0.2	1.2	0.1	0.2
A-B	436	0.5%	1	2	1.0	0.1	0.2	1.2	0.1	0.2
1-B	207	0.5%	1	2	0.5	0.05	0.1	0.6	0.05	0.1
3-B	414	0.5%	1	2	0.9	0.1	0.2	1.2	0.1	0.2
B-C	476	0.5%	1	2	1.2	0.1	0.2	1.4	0.1	0.2
4-C	223	0.5%	1	2	0.7	0.05	0.1	0.9	0.05	0.1
5-C	399	0.5%	1	2	0.8	0.05	0.1	1	0.1	0.2
C-D	258	0.5%	1	2	1.4	0.1	0.2	1.7	0.1	0.2
8-F	766	0.5%	1	2	1.0	0.1	0.2	1.2	0.1	0.2
E-F	542	0.5%	1	2	1.0	0.1	0.2	1.2	0.1	0.2

Sources: NA CAPR003823 HOPE BAY TIA Filtered Tailings Permitting - Internal\Task300-Hydro_Analysis\Rational_method.xlsx

The planned configuration of the tailings facility includes several lifts, with an overall slope of 8H:1V (13%). Benches may be constructed if required, up to 5-m high. Chutes are proposed to be built to allow surface water to drain from the top surface of the stack to the toe of the slope, towards the Reclaim Pond.

Table 5-2 summarizes the required dimensions of the chutes for the two design events. To reduce the size of the required D50 size, the chute base width is larger than that of the channels.

Table 5-2: Dimensions of Chutes (SSP2-4.5).

Chute	Length (m)	Longitudinal slope	Base width (m)	Side slope (H:1V)	Design Event 1			Design Event 2		
					Required depth (m)	D ₅₀ (m)	Thickness (m)	Required depth (m)	D ₅₀ (m)	Thickness (m)
A	38	13.0%	3	2	0.3	0.59	1.18	0.4	0.83	1.66
B	38	13.0%	3	2	0.3	0.56	1.13	0.4	0.78	1.57
D	38	13.0%	7	2	0.3	0.69	1.39	0.4	0.95	1.91
E	38	13.0%	3	2	0.4	0.63	1.26	0.4	0.85	1.71
F	38	13.0%	7	2	0.3	0.65	1.30	0.4	0.92	1.85

Sources: NA CAPR003823 HOPE BAY TIA Filtered Tailings Permitting - Internal\Task300-Hydro_Analysis\Rational_method.xlsx

5.2 Sensitivity Case (SSP5-8.5)

Channel and chute dimension estimates corresponding to the SSP5-8.5 climate change scenario is summarized in Table 5-3 and Table 5-4.

Table 5-3: Drainage channel dimensions (SSP5-8.5).

Channel	Length (m)	Longitudinal slope	Base width (m)	Side slope (H:1V)	Design Event 1			Design Event 2		
					Required depth (m)	D ₅₀ (m)	Thickness (m)	Required depth (m)	D ₅₀ (m)	Thickness (m)
2-A	497	0.5%	1	2	1.0	0.1	0.2	1.2	0.1	0.2
A-B	436	0.5%	1	2	1.0	0.1	0.2	1.2	0.1	0.2
1-B	207	0.5%	1	2	0.5	0.05	0.1	0.6	0.05	0.1
3-B	414	0.5%	1	2	1.0	0.1	0.2	1.2	0.1	0.2
B-C	476	0.5%	1	2	1.2	0.07	0.2	1.4	0.1	0.2
4-C	223	0.5%	1	2	0.8	0.05	0.1	0.9	0.05	0.1
5-C	399	0.5%	1	2	0.8	0.05	0.1	1	0.1	0.2
C-D	258	0.5%	1	2	1.4	0.1	0.2	1.7	0.1	0.2
8-F	766	0.5%	1	2	1.0	0.1	0.2	1.2	0.1	0.2
E-F	542	0.5%	1	2	1.0	0.1	0.2	1.2	0.1	0.2

Sources: NA CAPR003823 HOPE BAY TIA Filtered Tailings Permitting - Internal\Task300-Hydro_Analysis\Rational_method.xlsx

Results of the sensitivity case indicate that the change in minimum channel dimensions are negligible, compared to the base case (SSP2-4.5). This is because the IDF curves under climate change, as analyzed in (SRK, 2024), are very similar for the two scenarios considered.

Table 5-4: Dimensions of Chutes (SSP5-8.5).

Chute	Length (m)	Longitudinal slope	Base width (m)	Side slope (H:1V)	Design Event 1			Design Event 2		
					Required depth (m)	D ₅₀ (m)	Thickness (m)	Required depth (m)	D ₅₀ (m)	Thickness (m)
A	38	13.0%	3	2	0.3	0.61	1.2	0.4	0.82	1.6
B	38	13.0%	3	2	0.3	0.58	1.2	0.4	0.78	1.6
D	38	13.0%	7	2	0.4	0.72	1.4	0.4	0.95	1.9
E	38	13.0%	3	2	0.4	0.65	1.3	0.4	0.85	1.7
F	38	13.0%	7	2	0.3	0.67	1.3	0.4	0.92	1.8

Sources: NA CAPR003823 HOPE BAY TIA Filtered Tailings Permitting - Internal\Task300-Hydro_Analysis\Rational_method.xlsx

Regards,
SRK Consulting (Canada) Inc.

DRAFT

Federico Giurich
Consultant

DRAFT

Charles Veilleux, ing.
Senior Consultant

Reviewed by:

DRAFT

Brandon Smith, PEng
Principal Consultant

DRAFT

Peter Luedke, PEng
Senior Consultant

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