APPENDIX 2-J

Project Design Considerations

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Report No. 1541520

AGNICO EAGLE

Golder Associates

2.J-1 INTRODUCTION

The following is a consolidated document of key engineering and environmental design considerations. For the purpose of the Application, consistent with the Nunavut Water Board (NWB or the Board) Guide "final drawings must be considered complete and include the statement "*issued for construction" or other similar statement.*" Agnico Eagle has submitted drawings, signed, stamped, and dated by the appropriate engineer registered with NAPEG as "issued for permitting". See Volume 1, Appendix 1-C for list of engineered design drawings for Project infrastructure.

If the Project is approved, final design and construction drawings, accompanied with a detailed report, will be provided to the NWB in accordance with the schedule in the Type A Water Licence for infrastructure stipulated in the licence, including water works and waste disposal facilities. Agnico Eagle will submit to the Board for review and acceptance, in a timeframe set by the Board, final design and for-construction drawings, stamped and signed by a Professional Engineer, for all infrastructure and/or facilities designed to contain, withhold, divert, or retain water and/or waste.

Agnico Eagle is committed to compliance with appropriate territorial and federal legislative requirements for the provision of design details recognizing that facility infrastructure design information may be required by multiple regulators. Agnico Eagle will construct and operate the proposed Mine and associated infrastructure and facilities in accordance with all applicable legislation and industry standards. Agnico Eagle will submit a final design and construction drawings as per Type A Water License 2AM MEA1525 Part D and a construction Summary Report to the Board, within ninety (90) days following the completion of any structure designed to contain, withhold, divert or retain Waters or Wastes.

2.J-2 ENVIRONMENTAL CONSIDERATIONS

2.J-2.1 Climate

The Project infrastructure will require special cold climate and permafrost design considerations. The climate data used for this study were based on the values specified in the National Building Code of Canada (NRC 2010; summarized in Table 2-J-1) and on experience building Agnico Eagle's Meadowbank Mine.

Table 2-J-1: Climate Design Criteria

Temperature	**Value**
January-2.5% design	-40°C Extreme
Low	-48.8°C July-2.5 % design
20°C Extreme high	31.4°C
Precipitations	
Average annual total precipitation	250 mm
Snow Load	
Ground snow load, S_s	3.0kPa Rain load,
S_r	0.2 kPa **Hourly Wind**
Pressures	
1/10 year probability	0.47 kPa
1/30 year probsbility	0.60 kPa

Note: All data from NRC (2010), for Rankin Inlet location.

As deemed possible based on scheduling, infrastructure pads, diversion ditches, onland saddle dams and crossings of water courses will be constructed during the winter to reduce permafrost degradation and susceptibility. The Arctic design of the buildings will be reflected notably in heavy insulation and special foundation requirements, use of heated utilidors (insulated, enclosed utilities corridors) to connect the buildings and extreme space-heating requirements. To reduce heating needs, waste heat from the process plant at Meadowbank Mine will continue to be used. Space-heating requirements will be met through recovery of exhaust waste heat from the diesel engines driving the power generators. Auxiliary glycol/water-heating boilers will be provided for heating requirements in extreme conditions and emergencies. Another climate-driven feature will be heat-tracing of fuel and water lines, as deemed necessary.

2.J-2.2 Permafrost

The Project area is in a zone of continuous permafrost, the thickness of the permanently frozen permafrost was estimated to be 425 m (Knight Piésold 2015). The active layer thickness at the end of the summer season is expected to range from 1 to 3 m of the ground surface. Where the bedrock is less than 2 m below surface, the foundations of buildings and heavy equipment will rest directly on bedrock without the need for piles or extensive structural fill. For concrete foundations, experience at the Meadowbank Mine has shown that bedrock tends to shatter when excavated in Arctic climates. Therefore, allowances will be made for pouring lean concrete and using rock dowels to stabilize these foundations. Where the bedrock is deeper than 3 m, the foundations will be supported by pilings, as deemed necessary.

Knight Piésold (2015) characterized the talik under Whale Tail Lake. A talik is expected below the central portions of Whale Tail Lake; however, the talik is likely underlain by permafrost in the shallower and narrower parts of Whale Tail Lake. The talik is thought to connect vertically with the sub-permafrost aquifer in the deeper and wider parts of the lake.

2.J-2.3 Overburden

Overburden thickness data provided by Agnico Eagle (Frenette 2015, pers. comm.) indicates that in the Whale Tail Lake area the overburden can be up to 10 m thick overlying bedrock. Thinner blankets (1 to 3 m thick), veneers (<1 m thick) and thin veneers (< 20 cm thick) of till are found in the northern part of the satellite deposit and for much of the haul road south of Esker #3. Use of overburden during closure is provided in the Interim Closure and Reclamation Plan.

2.J-2.4 Geothermal and Hydrogeological Considerations

Hydrogeological investigations were carried out around the periphery of the proposed Whale Tail Pit and Whale Tail Lake (Knight Piésold 2015). A freezing point depression curve was developed to estimate permafrost depth for the Project. The developed relationship defines a freezing point of -0.35 °C at 150 m and a freezing point of -1.0 °C at 500 m. The intersection of the geothermal gradient with the 0°C isotherm suggests that the basal cryopeg is at a depth of approximately 425 metres below ground surface (Knight Piésold 2015). Agnico Eagle's design basis taking into account hydrogeological considerations is detailed in the next section.

2.J-3 WATER MANAGEMENT AND GEOTECHNICAL CONSIDERATIONS

The design basis for geotechnical and water management infrastructure is as follows:

- the minimum distance between the pits and proposed Water Treatment Plan location shall be 600 m;
- based on the guidelines provided in the Canadian Dam Association (CDA) Dam Safety Guidelines (CDA 2014),, the return period of the design earthquake is 1:2,500;
- seepage control installations will be designed to take into account the risk of piping;
- the minimum dike setback from the pit rim shall be 100 m;
- safety factors (SF) for specific loading conditions are specified in CDA (2013 and 2014) Guidelines:
  - end of construction = 1.3;
  - steady state conditions = 1.5;
  - rapid drawdown = 1.3;
  - Pseudo-static = 1.0; and
- based on the guidelines provided in the Canadian Dam Association (CDA) Dam Safety Guidelines (CDA 2014), the consequence of failure classification for the Project dikes is:
  - Whale Tail Dike and the North-East Dike are rated as “High” consequence of failure structures;
  - Mammoth Dike is rated as “Significant” consequence of failure structure, and;
  - Whale Tail WRSF Dike is classified as “Low” consequence of failure structure.

Table 2-J-2 through Table 2-J-5 provide a summary of water management considerations.

Table 2-J-2: Various Parameters for Surface Runoff Estimation for a Mean Precipitation Year and 1 in 2 Return Rainfall

Item	Value
Total annual precipitation for a mean precipitation year	249 mm
Total annual rainfall for a mean precipitation year	146 mm
Total annual water equivalent snowfall for a mean precipitation year	103 mm
Total estimated snow sublimation	72 mm
Monthly rainfall distribution	21% in June, 26% in July 29% in August, 24% in September
Estimated monthly lake surface evaporation	9 mm in June, 99 mm in July 100 mm in August, 40 mm in September
Estimated monthly natural land surface evapotranspiration	3 mm in June, 32 mm in July 32 mm in August, 13 mm in September
24-hour duration rainfall for 1 in 2 years of return period	27 mm
5-minute duration rainfall for 1 in 2 years of return period	2 mm
1-hour duration rainfall for 1 in 2 years return period	6 mm

Source: SNC (2015).
mm = millimetres; % = percent.

Table 2-J-3: Annual Freshwater Requirements during Operations for Mean Year

Item	Volume (m^3)
Freshwater for road dust control	7,300
Freshwater for operation camp	18,250
Freshwater for main camp	8,030
Freshwater for truck shop	11,498
Freshwater for exploration camp	8,395
Freshwater for open pit	20,440

Source: SNC (2015).
m^3 = cubic metres.

Table 2-J-4: Predicted Groundwater Inflow and Groundwater Quality Over the Mine Life - Whale Tail Pit (EA Conservative Scenario)

Phase	Period	Groundwater Inflow (m^3/day)
Dewatering	Mar 2019 to Oct 2019	-
Mining	Q4 2019 to 2020	275
	2021	100
Filling	2022	65
	2023	55
	2024	30
	Jan to Oct 2025	15
	Nov 2025 to Oct 2028	1

Note: Mining prior to Q4 2019 is within permafrost and groundwater inflow will be negligible.
TDS = total dissolved solids; m^3/day = cubic metres per day; mg/L = milligrams per litre; % = percent.

Table 2-J-5: Water Drainage Areas of Various Site Sectors

Facility	Final Footprint Area (ha)
Waste Rock Storage Facility	99.6
Waste Rock Storage Facility Watershed	109.6
Main Camp Watershed	23.6
Open Pit Footprint	43.5
Open Pit Watershed	111.1
Attenuation Pond Watershed	91.9
North-East Sector watershed	202.4
South Whale Tail Lake Watershed	2,420.5
Mammoth Lake Watershed	948.2

ha = hectares.

2.J-3.1 Dewatering

Based on SNC (2015), the design criteria for minimum freeboard for the dikes are presented in Table 2-J-6. The freeboard may change due to fluctuations in Whale Tail Lake and Ponds, or due to settlement in the dikes. Maintenance may be required to restore loss of freeboard due to settlement. The freeboard may also change during further advanced engineering phases.

Table 2-J-6: Design Minimum Freeboard

	Minimum Freeboard	
	Rockfill Structure (Dike Crest) (m)	**Low Permeability Element (Cutoff Wall or Liner) (m)**
Whale Tail Dike	3.0	2.0
Mammoth Dike	2.6	2.0
Waste Rock Storage Facility Dike	4.0	2.2
Northeast Dike	2.5	2.0

Source: SNC (2015).
m = metres.

2.J-3.2 Operations

The following outlines the key criteria and constraints that will need to be observed and followed to operate the dewatering dikes in accordance with the design objectives, concepts, and assumptions.

Based on SNC (2015), the design criteria for minimum freeboard for the dikes are presented in Table 2-J-6. The freeboard may change due to fluctuations in Whale Tail Lake and ponds, or due to settlement in the dikes. Maintenance may be required to restore loss of freeboard due to settlement. The freeboard may also change during further advanced engineering phases.

2.J-4 RECOMMENDED OPEN PIT SLOPE GEOMETRY

A summary of the recommendations is provided below, full details are provided in Volume 1, Appendix 1-D:

- Design BFA: 65 to 75°
- Design Bench Width: 10 to 14.4 m
- Bench Height: 21 m
- IRA: 4 1 to 53°

2.J-5 WASTE ROCK STORAGE FACILITY CONSIDERATIONS

The design basis and criteria for the development of the waste rock storage facilities assumed, the maximum height of the Waste Rock Storage Facility is 80 m and a storage capacity of 51.7 Mt (Table 2-J-7).

Table 2-J-7: Design Criteria for the Waste Rock Storage Facilities

Parameters	Value
Side Slope	37° (angle of repose)
Bench Height	20.0 m
Bench Setback S	20.0 m
Lift Placement	5.0 m
Factor of Safety during operation (static)	1.3
Factor of Safety during operation (pseudo-static)	1.0
Factor of Safety during closure (static)	1.5
Factor of Safety during closure (pseudo-static)	1
Swell factor	40.0%
Loose Density	2.0t/m^3

Source: SNC (2015).

2.J-6 TAILINGS EXPANSIONS

The design basis set the following general criteria to be maintained as defined by O'Kane (2016) for the expansion of the tailings facility at the Meadowbank Mine to accommodate the tailings from the Whale Tail Pit.

- Meet or exceed required factors of safety (FS).
- Accommodate additional tailings.
- Feasibility of the construction approach (based on cost and effort).
- When the dike is used as a haul road, mine health and safety regulations, NWT/Nunavut will be followed.
- CDA 207 Dam Safety Guidelines will be followed.
- Maintain adequate setback to facilitate other works.

Calculated FS values will then be compared to the minimum required values (i.e., the slope stability criteria). The minimum FS values are summarized in Table 2-J-8.

Table 2-J-8: Summary of Minimum Factor of Safety Values Utilized for Slope Stability Criteria

Condition	FS	Value Basis for Factor of Safety Value
End of Construction	1.3	During or immediately after construction
Operation	1.5	Steady seepage with maximum tailings deposit
Closure	1.5	Long term seepage with cover system
Pseudostatic	1.0	Earthquake Loading

Source: O'Kane (2016).

2.J-7 REFERENCES

Frenette, D. 2015. Environmental Coordinator. Agnico Eagle Mines Limited. Email: 27 August 2015.

Knight Piésold (Knight Piésold Consulting). 2015. Whale Tail Pit – Permafrost and Hydrogeological Characterization. Prepared for Agnico Eagle Mines Limited – Meadowbank Division. November 2015.

NRC (National Research Council Canada). 2010. National Building Code of Canada.

O'Kane (O'Kane Consultants Inc.). 2016. Meadowbank North Cell TSF Expansion-Design of Internal Structures. Prepared for Agnico Eagle. March 2016.

SNC (SNC Lavalin Inc.). 2015. Whale Tail Pit Project Permitting Level Engineering, Geotechnical and Water Management Infrastructure. Prepared for Agnico Eagle Mines Limited. December 2015.