DESIGN REPORT FOR CHANNEL 7 AND CHANNEL 8 MELIADINE PROJECT, NUNAVUT

PRESENTED TO
Agnico Eagle Mines Ltd.

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ACRONYMS & ABBREVIATIONS

Acronyms/Abbreviations	Definition
CP	Collection Pond
km	Kilometres
masl	Meters above Sea Level
NAG	Non-Acid Generating
OP	Ore Stockpile
TDS	Total Dissolved Solids
TSF	Tailings Storage Facility
TSS	Total Suspended Solids
WRSF	Waste Rock Storage Facility
WTP	Water Treatment Plant

1.0 INTRODUCTION

Agnico Eagle Mines Limited (Agnico Eagle) retained the services of Tetra Tech to carry out the planning and design works associated with the Water and Environment and the Civil Works components of the Meliadine Project, a gold mine located approximately 25 km north from Rankin Inlet, and 80 km southwest from Chesterfield Inlet in the Kivalliq Region of Nunavut. The project site is located on the peninsula between the east south and west basins of Meliadine Lake (63°01'23.8"N, 92°13'6.42"W). A general location plan for the project is shown in Figure 1.

The project focuses on the development of the Tiriganiaq gold deposit which will be mined using conventional open-pit and underground mining operations. Proposed site facilities will include: plant site and accommodation complex buildings, ore stockpiles, waste rock storage facilities, a dry stack tailings storage facility, and water management systems including collection ponds, water retention dikes, water diversion berms, channels, culverts, an effluent water treatment plant, and many pipelines.

The Nunavut Water Board (NWB) has issued a type A Water licences to Agnico Eagle Mines Limited, (Agnico Eagle) for the Meliadine Gold Project site authorizing the use of water and the disposal of waste required by mining and milling and associated uses.

As part of the scope of work, Agnico Eagle asked Tetra Tech to:

- Conduct the design of Channel 7 and Channel 8;
- Produce construction drawings and specifications for Channel 7 and Channel 8;
- Prepare design and construction summary reports of these water management infrastructures.

This report summarizes the site conditions, design basis and considerations including the final design and constructions drawings for the Channel 7 and Channel 8, as specified under water licence 2AM-MEL 1631, Part D, Item 1.

Figure 2 illustrates the General Site Layout Plan for Proposed Infrastructure during Mine Operation (Year 7).

2.0 GENERAL SITE CONDITIONS

2.1 Climate and Meteorology

The project site lies within the Southern Arctic Climatic Region where daylight reaches a minimum of 4 hours per day in winter and a maximum of 20 hours per day in summer. The nearest weather station is Rankin Inlet A (Station 2303401), located approximately 25 km south of the project site. The closest long-term regional evaporation station operated by Environment Canada is in Churchill, Manitoba.

The monthly mean air temperature is typically above 0°C for the months of June to September, and is below 0°C between October and May. July is typically the warmest month and January the coldest. Winters are typically long and cold, while summers are short and cool. Spring and autumn are short. The mean annual temperature for the period of record from 1981 to 2009 was -10.4°C.

The annual average total precipitation at the project site is 405 mm/year and falls almost equally as snow and rainfall (Golder, 2013a). Average annual evaporation for small waterbodies in the project area is estimated to be 323 mm between June and September. The average annual loss of snowpack to sublimation and snow redistribution is estimated to vary between 46% and 52% of the total precipitation for the winter period and occurs between October and May (Golder, 2013a).

Table 2.1 presents the estimated mean monthly precipitation, evaporation, and temperature characteristics of the site (Agnico Eagle, 2015).

Table 2.1: Estimated Mine Site Mean Monthly Climate Characteristics (Agnico Eagle, 2015)

Month	Monthly Air Temperature (°C)			Mean Monthly Precipitation (mm)			Lake Evaporation (mm)
	Minimum	Average	Maximum	Rainfall	Snowfall	Total	
January	-37.2	-30.9	-19.8	0.0	12.9	11.1	0
February	-35.3	-30.1	-24	0.0	13.1	11.1	0
March	-30.8	-25.1	-18.8	0.0	18.6	16.1	0
April	-20.2	-15.7	-10.4	1.4	28.8	26.4	0
May	-10.8	-5.9	-1.2	7.7	19.2	25.2	0
June	0.1	4.1	6.7	26.4	7.1	37.0	60.4
July	6.9	10.5	14.9	43.7	0.2	51.2	124.4
August	7.7	9.7	11.2	63.7	0.3	74.6	95.6
September	1.3	3.8	6.8	45.2	5.7	57.8	42.7
October	-9.9	-4.6	1.7	15.5	36.9	50.0	0
November	-23.6	-17.2	-10.2	0.3	33.3	28.5	0
December	-33.3	-25.9	-19.4	0.0	18.9	15.8	0
Annual	**-37.2**	**-10.4**	**14.9**	**203.9**	**195.0**	**404.8**	**323.1**

The region is known for high winds, which are due in part to the broad, flat, uninterrupted expanses offered to moving air masses. The wind blows from the north and north-northwest direction more than 30% of the time. The mean values for wind speed show that the north-northwest, together with north and northwest winds, have the highest speeds and tend to be the strongest. Mean monthly wind speeds are typically between 19 km/hour and 27 km/hour.

The climate in the project region is projected to be warmer for the 2020s, 2050s, and 2080s time horizons when compared to the observed historic values (Agnico Eagle and Golder, 2014). Precipitation shows an increase compared to historical values, but the majority of projections are not significantly different from the annual recorded precipitation values.

2.2 Topography and lakes

The dominant terrain in the project area comprises glacial landforms such as drumlins (glacial till), eskers (gravel and sand), and lakes. A series of low relief ridges are composed of glacial deposits, oriented in a northwest-southeast direction, which control the regional surface drainage patterns. The property is about 60 metres above sea level (masl) in low-lying topography with numerous lakes. Surface waters are usually frozen by early October and remain frozen until early June.

The surveyed lake surface elevations in the project area range from about 51 masl at Meliadine Lake to about 74 masl for local small perched lakes. Lakes formed by glaciofluvial processes or glacial processes, are common throughout the project area. Most of the perched lakes at the project site are relatively shallow (less than 2 m water depth). Late-winter ice thicknesses on freshwater lakes in the project area range between 1.0 m and 2.3 m with an average thickness of 1.7 m. Ice cover usually appears by the end of October and is completely formed in early November. The spring freshet typically begins in mid-June and is complete by early July (Golder, 2012a).

2.3 Subsurface Conditions

A number of site investigation programs were carried out at the project site in 1998, 1999, 2007, 2009, 2011, 2012, 2013, 2014, 2015, and 2016.

In general, the near surface stratigraphy comprises a veneer of organic material, underlain by non-cohesive soils (i.e. silty sand and sandy silt) with cobbles and boulders. The overburden thickness ranges between 1.5 m and 17.8 m and is underlain by greywacke, medium to strong with some fracturing and frost jacking of the upper bedrock surface. A layer of ice-rich overburden (silt or sand) has been observed in some of the boreholes drilled. Overburden soils with excess ice (Vc, Vs, Vx, and Vr) were observed in most of the boreholes. Massive icy beds up to 1.25 m thick were also encountered. The estimated percentage (by volume) of the excess visible ice ranged from 2% to more than 50% in the overburden soils. Limited soil porewater salinity tests (EBA, 2013) indicated that the overburden soils may have a porewater salinity of 4 parts per thousand (ppt) for shallow sandy soils and up to 12 ppt for deep silty soils.

2.4 Other relevant data

The raw land survey data, a 1-m contour digital map of the ground surface and 0.5 m contour lake bathymetric data for selected lakes at the project site were provided to Tetra Tech by Agnico Eagle. Survey data for selected areas were provided to Tetra Tech and were incorporated into the original digital map for the design of the channel 7 and channel 8 in this study.

3.0 DESIGN BASIS

3.1 Precipitation, surface Runoff, and Lake Surface Evaporation

Various parameters for surface runoff estimation for a mean precipitation year are presented in Table 3.1. Similar parameters for a wet precipitation year runoff values are presented in Table 3.2. The values in Tables 3.1 and 3.2 were adopted from the feasibility study (Tetra Tech EBA, 2014) and also presented in Appendix B of the Water Management Plan (Agnico Eagle, 2015). Some of the parameters in these tables were used in estimating the volumes of the runoff/run-on water from natural precipitation for water balance and management.

Table 3.1: Various Parameters for Surface Runoff Estimation for a Mean Precipitation Year and 1 in 2 Return Rainfall

Item	Value	Source or Comment
Total adjusted annual precipitation for a mean precipitation year	412 mm	Golder (2013a)
Total adjusted annual rainfall for a mean precipitation year	210 mm	Golder (2013a)
Total adjusted annual water equivalent snowfall for a mean precipitation year	202 mm	Golder (2013a)
Total estimated snow sublimation	99 mm	Golder (2013a)
Estimated snow melt water equivalent in spring freshet	103 mm	Calculated based on values above
Monthly rainfall distribution	16% in June, 21.2% in July 30.8% in August, 24.5% in September 7.5% in October	Golder (2013a)
Annual net runoff on natural on-land surface fora mean precipitation year	215 mm (127 mm in June, 22 mm in July, 32 mm in August, 26 mm in September, and 8 mm in October)	Calculated based on values above
Estimated monthly lake (non-saline water) surface evaporation	60 mm in June, 125 mm in July 96 mm in August, 42 mm in September	Golder (2013a)
Annual net runoff on lake surface for a mean precipitation year	-10 mm (76 mm in June, -80 mm in July, -31 mm in August, 9 mm in September, and 16 mm in October)	Calculated based on values above
Estimated monthly natural land surface evapotranspiration	6 mm in June, 14 mm in July 11 mm in August, 5 mm in September	Golder (2013a)
Annual net runoff on disturbed land surface fora mean precipitation year	251 mm (133 mm in June, 36 mm in July, 43 mm in August, 31 mm in September, and 8 mm in October)	Calculated based on values above
Average start date for spring freshet	June 11	Based on Golder (2013a)
Average date for spring runoff peak	June 13	Based on Golder (2013a)
24-hour duration rainfall for 1 in 2 years of return period	33 mm	Golder (2013a)
5-minute duration rainfall for 1 in 2 years of return period	3.2 mm	Golder (2012d)
1-hour duration rainfall for 1 in 2 years of return period	9.8 mm	Golder (2012d)

Table 3.2: Various Parameters for Surface Runoff Estimation for a 1 in 100 Extreme Wet Year and Extreme Rainfall

Item	Value	Source or Comment
Total adjusted annual precipitation for a 1 in 100 wet precipitation year	594 mm	Golder (2013a)
Total adjusted annual rainfall for a 1 in 100 wet precipitation year	324 mm	Golder (2013a)
Total adjusted annual water equivalent snowfall for a 1 in 100 wet precipitation year	270 mm	Calculated based on values above
Total estimated snow sublimation	99 mm	Golder (2013a)
Estimated snow melt water equivalent in spring freshet for a 1 in 100 wet precipitation year	171 mm	Calculated based on values above
Assumed natural on-land runoff coefficient for the incremental net rainfall between those for a 1 in 100 wet precipitation year and a mean precipitation year	0.8 in June to October	Assumed
Monthly rainfall distribution	16% in June, 21.2% in July 30.8% in August, 24.5% in September 7.5% in October	Golder (2013a)
Annual net runoff on natural on-land surface for a 1 in 100 wet precipitation year	430 mm (213 mm in June, 55 mm in July, 80 mm in August, 63 mm in September, and 19 mm in October)	Calculated based on values above
Estimated monthly lake surface evaporation	60 mm in June, 125 mm in July 96 mm in August, 42 mm in September	Golder (2013a)
Annual net runoff on lake surface for a 1 in 100 wet precipitation year	172 mm (163 mm in June, -56 mm in July, 4 mm in August, 37 mm in September, and 24 mm in October)	Calculated based on values above
Estimated monthly natural land surface evapotranspiration	6 mm in June, 14 mm in July 11 mm in August, 5 mm in September	Golder (2013a)
Annual net runoff on disturbed land surface for a 1 in 100 wet precipitation year	466 mm (219 mm in June, 69 mm in July, 91 mm in August, 68 mm in September, and 19 mm in October)	Calculated based on values above
24-hour duration extreme rainfall with a 1 in 100 years of return period	65 mm	Golder (2013a)
24-hour duration extreme rainfall with a 1 in 1000 years of return period	77 mm	Golder (2013e)
24-hour duration PMP (probable maximum precipitation)	259 mm	Golder (2013e)
5-minute duration rainfall for 1 in 100 years of return period	9.2 mm	Golder (2012d)
1-hour duration rainfall for 1 in 100 years of return period	27.4 mm	Golder (2012d)
Runoff coefficient for extreme rainfall	1.0	Assumed

3.2 Hydraulic analyses and peak flow calculation

Hydrologic and hydraulic analyses were carried out to determine channel capacities to accommodate a 25-year peak design flow.

The Rational Method was used to determine peak flows. The Intensity-Duration-Frequency (IDF) curve developed by Environment Canada for Rankin Inlet Station was used (Environment Canada 2014). A 1 in 25 year rainfall intensity for a duration equivalent to the time of concentration of the catchment area was considered to determine the design peak flow for each channel.

4.0 DESIGN OF CHANNEL 7

Channel 7 is a water collection channel that collect flow from Culvert 11 and part of the runoff from the Waste Rock Storage Facility area 2 (WRSF2) to drain into Channel 1. Drawings 65-695-230-233 and 65-695-230-234 show the layout, profile and typical design sections for this channel.

Channel 7 is an internal channel where any water overflowing from the channel will temporarily flow over the existing drainage channel and remain within the catchment area of the Collection Pond 1 (CP1).

As shown in Figure 4.1, the typical section has a bottom width of 3.0m, and rip-rap protection is required for this channel.

Figure 4.1: Channel 7 Section

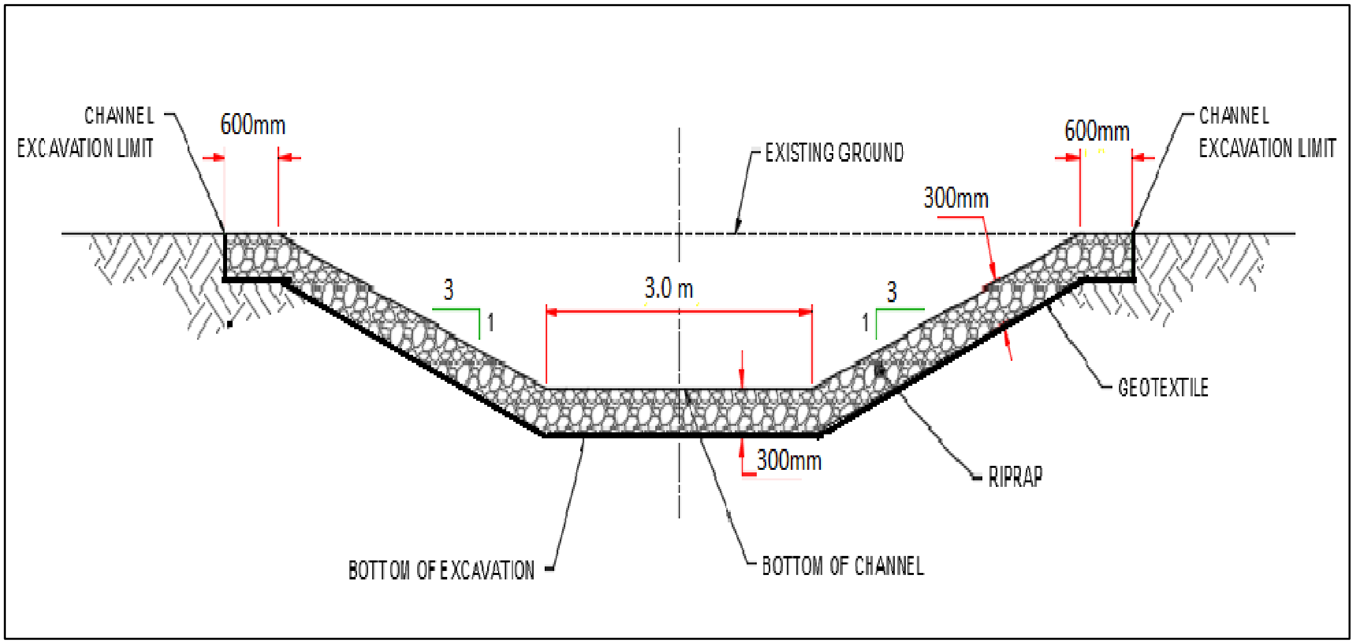


Table 4.1 below presents the design parameters for Channel 7.

Table 4.1: Design Parameters for Channel 7

Item	Channel 7
Approximately total length (m)	240
Channel bottom width (m)	3.0 typical
Slide Slopes	3(H):1(V)
Rip-rap thickness (m)	0.3
Minimum bottom slope gradient (%)	0.85

5.0 DESIGN OF CHANNEL 8

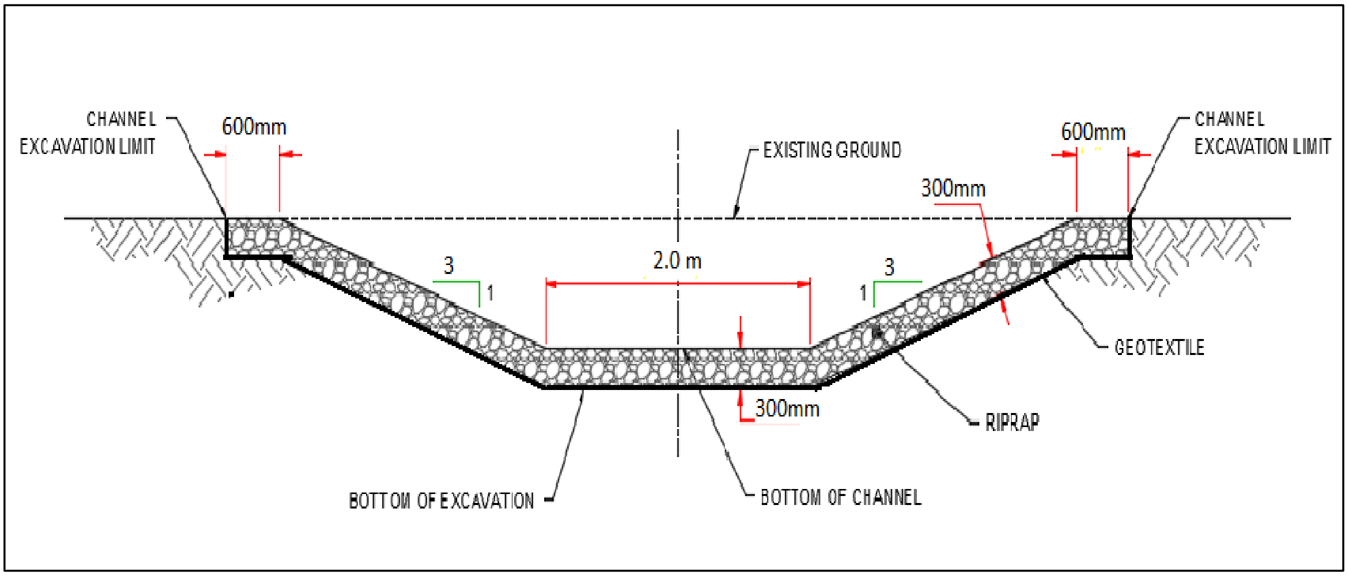
Channel 8 is a water collection channel located on the West side of portal # 2 to collect part of the surface flow of the Waste Rock Storage Facility 1 (WRSF1) and facilitate flow of site drainage through Culvert 2 and Channel 1.

During the construction of the haul road section to reach the WRSF1 sector, culvert 7 has to be installed in the bottom of channel 8. The section of channel is large enough to allow the accommodation of culvert 7.

Channel 8 is an internal channel where any water overflowing from the channel will temporarily flow over the existing drainage channel and remain within the catchment area of the Collection Pond 1 (CP1).

As shown in Figure 5.1, the typical section has a bottom width of 2.0 m and rip-rap protection is required for this channel.

Figure 5.1: Channel 8 Section



Drawings 65-695-230-235 and 65-695-230-236 show the layout, profile and typical design section for Channel 8.

The table below presents the design parameters for the channel.

Table 5.1: Design Parameters for Channel 8

Item	Channel 8
Approximately total length (m)	256
Channel bottom width (m)	2.0 typical
Slide Slopes	3(H):1(V)
Rip-rap thickness (m)	0.3
Minimum bottom slope gradient (%)	0.5

6.0 CONSTRUCTION

6.1 Construction Material Quantities

The Table 6.1 present the material quantities for construction of the water management infrastructures. The quantities presented are estimated in-place quantities and do not include any extras for overlaps, excess or losses.

Table 6.1: Material Quantities for Construction

Material	Channel 7	Channel 8
Rip-rap Fill (m^3)	498	757
* Geotextile (m^2)	1660	1920
Excavation (m^3)	1150	848
* Materials quantities for geotextiles does not include overlaps or excess		

6.2 Construction Material Specifications

The general requirements for the materials are specified below. The requirements for each of the materials can vary slightly for a specific earth structure to meet specific design intents.

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6.2.1 Rip-rap

Rip-rap shall be used as erosion protection materials for various dikes, berms, channels, culverts and ponds. Several types of rip-rap materials are planned to be used in project. The particle size specifications for the graded rip-rap materials required for Channels 7 and 8 are presented in Table 6.3.

Table 6.3: Particle Size Specifications for Rip-rap Materials

Rip-rap Types for Earth Structures	Minimum Particle Size (mm)	Median Particle Size (mm)	Maximum Particle Size (mm)
Rip-rap for Channel	50	150	300

6.2.2 Geotextile

Nonwoven geotextile is proposed to be placed under the rip-rap material for Channels to separate the rip-rap material from the excavated overburden surface and to protect the overburden soils from potential loss into the rip-rap material. Nonwoven, needle-punched geotextile is selected for cost estimating purposes at this stage of design. Table 6.4 presents the preliminary geotextile specifications.

Table 6.4: Preliminary Specifications for Geotextile for Various Earth Structures

Earth Structure	Channel
Nominal Thickness of Geotextile (ASTM D5199) (mm)	1.7
Typical Unit Weight (ASTM D5261) (g/m^2)	203
Puncture Resistance (ASTM D4833) (N)	400

6.3 Estimated Construction Schedule

The construction of Channel 7 and Channel 8 is scheduled for fall 2017.

6.4 TSS Management

Any water containing total suspended solids (TSS), generated by the construction of Channel 7 and Channel 8, will be managed within the watershed of CP1 and be treated prior to discharge to the environment.

6.5 Quality control/assurance program

A quality control/assurance program is required during construction of each of the infrastructures to ensure that construction-sensitive features of the design are achieved. The specific requirements and testing frequencies for the quality control/assurance program will be developed before the construction of the structures.

6.6 Instrumentation and Monitoring

The performance of channel 7 and channel 8 will be monitored throughout their construction and operating life. The monitoring activities may include, but not be limited to, visual inspection for any deformations, surface cracks, surface erosion, and seepage.

An annual site inspection may be required to document the performance of each of the earth structures.

7.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Agnico Eagle Mines Ltd. and their agents. Tetra Tech does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Agnico Eagle Mines Ltd., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech's Services Agreement.

8.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech

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TETRA TECH INDUSTRIES, INC.
O/A TETRA TECH
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