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RE: BAY-GOOSE DIKE AND SOUTH CAMP DIKE DESIGNS
MEADOWBANK GOLD PROJECT, NUNAVUT

Dear Dr. Eric Lamontagne:

1.0 INTRODUCTION

Agnico-Eagle Mines Limited (AEM), Meadowbank Division has authorized Golder Associates Ltd. (Golder) to provide a design for the proposed Bay-Goose Dike and South Camp Dike at the Meadowbank Gold Project site. This combined network of dikes will be constructed to isolate a portion of Third Portage Lake in order to permit dewatering and enable mining of the southern portion of the Portage Pit and the Goose Island Pit, as shown on Figure 1.1. The proposed Bay-Goose Dike is approximately 2,265 m in length and the South Camp Dike is approximately 60 m in length.

The Bay-Goose Dike will replace the former Bay Zone Dike and the former Goose Island Dike that were presented in the March 13, 2007 Golder report *Detailed Design of Dewatering Dikes*, Doc. No. 342, Ver. 0 (Golder, 2007a), and in the July 12, 2007 *Report Addendum*, Doc. No. 492 (Golder, 2007c). AEM has revised the following mining concepts which have resulted in the revised dike alignment:

- Mining of north Portage Pit during the first two years of operation, requiring only the East and West Channel Dikes;
- Revised Goose Island Pit has eliminated the need for a deep water portion (depth to bedrock in excess of 16 m) of the dike south east of Goose Island thus reducing risk, construction time and costs; and
- Revised construction schedule to complete the proposed Bay-Goose Dike over two years (2009 and 2010), followed by dewatering to allow mining operation in southern portion of the Portage Pit and the Goose Island Pit to start in the 3rd Quarter of 2011.

Replacement of the Bay Zone Dike and Goose Island Dike with a single Bay-Goose Dike has the advantage of eliminating approximately 800 m of dike.

The 70 m setback from pit crest to the toe of the dike has been maintained (Golder, 2007b).

AEM plans to construct the South Camp Dike followed by the southern portion of the Bay-Goose Dike in 2009. During the later part of the 2009 construction season, rockfill placement for the northern portion of the

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Bay-Goose Dike may be advanced depending on equipment and material availability. The north portion of the Bay-Goose Dike is expected to be completed in 2010.

The South Camp Dike design is similar to that used for construction of the West Channel Dike.

The Bay-Goose Dike alignment shown on Figure 1.1 was subdivided into two components based on the depth to bedrock from Third Portage Lake surface. The shallow portion has a depth to bedrock of less than 8 m and the medium depth portion has a depth to bedrock between 8 and 16m. The yellow highlighted areas of Figure 1.1 indicate where the water depth is greater than 6 m, which with an estimated 2 m thickness of lakebed soils indicates sections with an estimated depth to bedrock greater than 8 m. Golder has assessed conceptual design options, and selected a preferred option, for the medium depth portions (Golder, 2008d). Detailed design for the shallow section of the dike has been completed. This design follows the general design used to construct the East Dike (Golder, 2008d).

The following letter, referenced drawings, and specifications present the design for the Bay-Goose Dike and South Camp Dike. A geotechnical investigation program to characterize the lakebed soils and bedrock is planned for March 2009 to obtain additional geotechnical information along the proposed alignment of the Bay-Goose Dike and South Camp Dike. Details of the proposed program are outlined in the draft letter dated January 23, 2009 (Golder, 2009).

Golder recognizes that based on the results of the investigation program, the alignment and designs described in this letter and drawings will be optimized. It is further recognized that the design information provided as part of this letter are based on limited geotechnical information and therefore, construction methods, expected efforts, quantity estimates, schedules, and associated costs will need to be adjusted and revised following the completion of the geotechnical investigation and any redesign work that may be required.

1.1 Letter Outline

Section 2 of this letter presents background information regarding the Meadowbank site climate, geologic conditions, existing geotechnical data and planned geotechnical investigation program. Section 3 outlines the design criteria and assumptions used for the Bay-Goose Dike and South Camp Dike. Section 4 presents the design for the shallow section of the Bay-Goose Dike and the conceptual preferred design and alternative designs for the medium depth section of the dike. Section 5 presents the design for the South Camp Dike. Finally, Section 6 discusses the importance of turbidity control measures for dike construction.

2.0 BACKGROUND

The following sections provide information regarding the climate and geologic conditions at the site.

2.1 Climate

The project site is located along the southern boundary of the Northern Artic Ecozone in the District of Keewatin, Nunavut. The climate in the Northern Arctic Ecozone is dry and cold, and is described as a polar desert, generally with mean annual precipitation ranging from 100 mm to 200 mm per year. The closest climate station to the Meadowbank site is at Baker Lake, at 64.3^{o}N Latitude and 96.1^{o}W Longitude, approximately 70 km to the south.

Meteorological data has been collected at Meadowbank since 1997. Longer term climate data are available from the regional climate station at Baker Lake. Tables 2.1 and 2.2 summarize the monthly climate data (AMEC, 2005a).

Table 2.1: Summary of Monthly Climate Data

Month	Mean Monthly					
	Maximum[1] Air Temperature (°C)	Minimum[1] Air Temperature (°C)	Minimum Relative Humidity (%)	Maximum Relative Humidity (%)	Wind Speed (km/h)	Soil Temperature[1] (°C)
January	-29.1	-35.5	67.1	75.9	16.3	-25.5
February	-27.8	-35.2	66.6	76.5	16.0	-28.1
March	-22.3	-30.5	68.4	81.4	16.9	-24.9
April	-13.3	-22.5	71.3	90.1	17.3	-18.1
May	-3.1	-9.9	75.7	97.2	18.9	-8.0
June	7.6	0.0	62.6	97.2	16.4	2.0
July	16.8	7.2	47.5	94.3	15.1	10.5
August	13.3	6.4	59.2	97.7	18.4	9.3
September	5.7	0.9	70.8	98.6	19.3	3.6
October	-5.0	-10.6	83.1	97.4	21.4	-2.8
November	-14.8	-22.0	80.6	91.1	17.9	-11.7
December	-23.3	-29.9	73.3	82.7	17.7	-19.9

Note: Mean soil temperature is reported by AMEC to be measured at a depth between 0.2 m and 0.3 m below ground surface, but should be confirmed. Installation details such as slope aspect, surficial cover, site drainage, and annual snow cover are not available.
[1] Sources: AMEC (2003, 2005a).

Table 2.2: Estimated Average Monthly Temperature and Precipitation Meadowbank Site

Month	Mean [1] Temperature (°C)	Average Precipitation (mm)			Lake Evaporation (mm)
		Rainfall [1]	Snowfall	Total	
January	-32.4	0	11.2	11.2	0
February	-31.7	0	10.5	10.5	0
March	-26.3	0.1	14.6	14.6	0
April	-17.7	2.3	16.7	19.0	0
May	-6.3	9.8	11.3	21.1	0
June	3.7	14.5	3.9	18.4	8.8
July	12.1	36.7	0.0	36.7	99.2
August	9.7	45.5	0.9	46.4	100.4
September	3.4	30.1	8.8	38.9	39.5
October	-7.4	3.5	30.3	33.8	0.1
November	-17.9	0	23.6	23.6	0
December	-25.8	0	15.0	15.0	0
Annual Average	-11	139	145	285	248

Note: Monthly averages have been rounded. Mean temperatures and rainfall are based on site data (1997 to 2004). Snowfall is based on adjusted Baker Lake data (1946 to 2004) and reported as water equivalent. Adjusted small lake evaporation was estimated from pan evaporation data (2002 to 2004).
[1]Source: AMEC (2003, 2005a, 2005b).

The prevailing winds at Meadowbank (1997 to 2004 data) for both the winter and summer months are from the northwest. A daily maximum wind gust of 83 km/h was recorded on May 21, 2002 (AMEC, 2005a). Estimates of

wave heights on Third Portage Lake during such an event were reportedly on the order of 0.6 m to 0.9 m based on communications with site personnel during 2002.

The estimated annual rainfall, snowfall, and precipitation for Meadowbank are 139, 145 and 285 mm, respectively. Estimates of extreme annual rainfall, snowfall and total precipitation at the site are shown in Table 2.3.

Table 2.3: Estimates of Extreme Rainfall, Snowfall, and Total Precipitation at Meadowbank Camp

Return Period (Years)	Condition	Rainfall (mm)	Snowfall (cm)	Total Precipitation (mm)
100	Wet	245	265	452
50	Wet	232	252	433
25	Wet	218	237	411
10	Wet	195	212	376
5	Wet	175	189	343
2	Average	139	145	285
5	Dry	108	104	233
10	Dry	93.6	84.4	208
25	Dry	79.2	64.6	183
50	Dry	70.4	52.4	168
100	Dry	62.9	41.8	155

Source: AMEC (2003, 2005a)

The annual precipitation at the site generally falls as rain between June and September while snow falls generally between October and May. However, snowfall may occur at any time of the year. A comparison of annual total precipitation data at Baker Lake and the Meadowbank site (AMEC, 2003) showed that Meadowbank total annual rainfall averaged 85% of the Baker Lake total over common periods of record.

A mean daily wind rose for the Meadowbank Camp Station from May to October, between 1997 and 2004 was presented within the baseline hydrology report (AMEC, 2005a). The wind rose shows that the predominant wind direction is from the northwest and north northwest, with the wind blowing from these directions approximately 20% of the time. Wind speeds range between 0 and 83 km/h.

There is a long-term Environment Canada meteorological site at Baker Lake, referred to as “Baker Lake A”. A mean hourly wind rose using the Baker Lake data from 1963 to 2004 was presented in the 2004 hydrologic monitoring data report (AMEC, 2005a). This wind rose included year round data. Due to winter freeze-up and icing over of the lakes, it is appropriate to use summer open water winds only for prediction of wave data.

A mean hourly wind rose from May to October, between 1963 and 2004 is also presented within AMEC, 2005a. The wind rose shows that the predominant wind direction is from the northwest and north, with the wind blowing from these directions approximately 37% of the time. Wind speeds were found to range between 0 and 177 km/h.

When comparing the wind roses, the Meadowbank Camp Station shows a higher frequency of winds coming from the southwest and northeast than the Baker Lake station.

The maximum wind gust recorded at the Baker Lake climate station was 177 km/h on June 6th, 1970 (AMEC, 2005a).

2.2 Existing Geotechnical Information

2.2.1 Permafrost

The Meadowbank Gold Project site is located within a zone of continuous permafrost. The land surface in the project area is underlain by continuous permafrost, while lakes that are deeper than about 2 m are typically underlain by a talik, or zone of permanently unfrozen ground. Based on thermal studies carried out to date, the depth of permafrost is estimated to be on the order of 450 m to 550 m. The depth of the active layer ranges from about 1.3 m in areas with soils, up to about 4 m adjacent to lakes. The depth of permafrost and of the active layer varies based on proximity to lakes, soils thickness, vegetation, climate conditions, and slope direction.

Based on ground conductivity surveys and compilation of regional data, the ground ice content is generally low (0% to 10%). Locally on land, ice lenses and ice wedges are present, as indicated by ground conductivity, and by permafrost features such as peat palsas. These areas of local ground ice are generally associated with low lying areas with poor drainage.

Lake ice thicknesses of between 1.5 m and 2.5 m have been encountered during geotechnical investigations in mid to late spring. It is possible that mid-winter ice thickness is greater; however, no data relating to ice thickness currently exists for the mid-winter period.

Ground temperatures have been monitored at Baker Lake since 1997 as part of the Circumpolar Active Layer Monitoring (CALM) program. Table 2.4 presents ranges in the recorded mean annual ground temperature at an estimated depth of 2 m for the Baker Lake CALM station.

Table 2.4: Range in Mean Annual Ground Temperature – Baker Lake CALM Site (1998 to 2001)

Site Number	Latitude	Longitude	Elevation (m)	Location (km)	Mean Annual Ground Temperature (2 m depth) (ºC)
C20	64º 19.6'N	96º 2.5'W	50	70 km South of Meadowbank	-6.6 to -8.4

The mean annual ground temperatures recorded at the station in Baker Lake are comparable to those estimated at the Meadowbank site (see below). Annual thaw depths at the CALM site are reported in Table 2.5.

Table 2.5: Annual Thaw Depth at the Baker Lake CALM Site

Thaw Depth in Centimetres (Baker Lake CALM Site)						
Station	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Baker Lake C20	120	170	174	189	193	207

Thermal studies at the Meadowbank site were initiated during the 1996 summer exploration drilling program, with the installation of two (2) thermistor cables in exploration boreholes drilled on the Third Portage Peninsula. These studies have continued with the installation of additional thermistor cables during field investigations in 1997, 1998, 2002, 2003 and 2006.

Between about 1997 and 2003, some twenty three (23) thermistor cables were installed to characterize and monitor the thermal conditions and permafrost at the project site. The thermistors were located to characterize the thermal regime at the project site both inland (away from the influence of deep lakes), as well as adjacent to lakes. The thermistors were monitored during periods of time that the camp was open. Generally, data were collected from March through to September. Based on available information the active layer varies between 1.3 m and 3.8 m, depending on location.

Thermistor cables were installed at the north and south abutment areas of the Bay-Goose Dike in boreholes 03GT-BZ-1 and 03GT-GI-7, respectively, however they are currently not functioning.

More recently, Five (5) thermistors were installed as part of the East Dike construction work in 2008.

2.2.2 Hydrological Conditions

Maximum and minimum expected lake water elevations are shown in Table 2.6.

Table 2.6: Maximum Water Levels[1]

Return Period	Third Portage Lake
100 yr wet	134.19
10 yr wet	134.14
Average	134.09
10 yr dry	134.03
100 yr dry	133.99

[1] Source: AMEC 2005a p.7 and p.11

It should be noted that these are **natural** lake levels, and are expected to change with the construction of the West Channel Dike and during dewatering. (Golder, 2008a and Golder, 2008b).

2.2.3 Topography and Bathymetry

The general site area consists of low, rolling hills with numerous small lakes. The topography in the immediate vicinity of the main deposits (Third Portage, North Portage, and Goose Island Deposits) is of generally low relief with a range in elevation of about 70 m. The natural average water elevation of Third Portage Lake is about 134.1 masl.

Bathymetric surveys were conducted by Golder in 2002, 2003, 2006, and 2008 for lake areas adjacent to and over the main deposits at Meadowbank. The lake bottom has a similar topography to the adjacent land. Water depths reach a maximum of about 28 m in Third Portage Lake.

Detailed bathymetry in the proposed area of the Bay-Goose Dike was conducted by Golder in October 2008. Results of the survey are incorporated in the Drawings and on Figure 1.1, and indicate a maximum water depth beneath the centerline of the Bay-Goose Dike cutoff wall alignment of 9 m.

No bathymetry could be performed along the proposed alignment of South Camp Dike, given the shallow water depth and large boulders on the surface at this location, however the water depth was observed to be about 1m.

2.2.4 Quaternary Geology

The project area is covered by laterally extensive deposits of glacial till. Glaciofluvial sand and gravel deposits reportedly occur on the north shore of Second Portage Lake. Crysolic soils dominate on land, and lakebed sediment overlies till in the lakes. Lakebed sediments are relatively thin and loose, consisting of sand, silt and clay sized particles.

Geotechnical investigations conducted on land have found varied glacial till thicknesses from 0 to 5 m. Drilling observations for lakebed soils indicate thicknesses between 0 and 18 m. Based on limited available information along the Bay-Goose Dike alignment (Golder, 2003), soil thicknesses are between 1.25 m to 5.9 m (Figure 2.1). Grain size distributions from till samples obtained from the Meadowbank site are shown on Figure 2.2. The glacial till is variable but generally consist of sand and gravel with cobbles and boulders and a fines content (passing 0.074 mm sieve size) between 15% and 40%. The percentage of silt sized particles exceeds that of clay. Boulders have been encountered in approximately 40% of the boreholes.

2.2.5 Bedrock Geology

Regional geology is illustrated in Figure 2.3. The Meadowbank Project site is underlain by a sequence of Archaean greenstone (ultramafic and mafic flow sequences) and metasedimentary rocks that have undergone polyphase deformation resulting in the superposition of at least two major structural events. Enclosed within the greenstone are volcaniclastic sediments, felsic-to-intermediate flows and tuffs, sediments (greywackes), and oxide iron formations. The sequence also contains sericite schists, which are believed to be altered felsic flows or dikes. The ultramafic rocks are variably altered, containing serpentinite, chlorite, actinolite, and talc. The ore in the Portage and Goose deposits are hosted in iron formation rocks.

From the geotechnical boreholes used to define the open pits, there are four main rock types including iron formation (IF), intermediate volcanic (IV), and ultramafic volcanic (UM) (serpentinized and non-serpentinized), and quartzite (QTZ).

2.2.6 Faults

Figure 2.3 includes faults in the area of the Bay-Goose Dike. The Third Portage Peninsula is flanked on the west by the north-south trending Bay Zone Fault, which roughly parallels the western shoreline of Third Portage Peninsula and extends northward along the western flank of the North Portage Deposit and south-southeastward between the eastern shore of the Bay Zone Island and the Third Portage Peninsula. A splay trending off the Bay Zone Fault begins south of the narrows separating the Third Portage peninsula from the mainland and trends south along the western side of the Bay Zone Island. Whether one or both faults pass beneath the Bay-Goose Dike is unknown. The Bay Zone Fault is interpreted as a ductile shear, across which stratigraphic continuity is transposed but maintained.

The potential for fault reactivation is considered to be very low. The project area is in a zone of low seismic activity, Seismic Zone ‘0 ’. The Second Portage Fault is on the order of 1.7 to 1.9 billion years in age (Pehrsson, 2001; Rainbird et al., 2005). Pehrsson et al. (2005) reports that the structures in the deposit area have not been demonstrably reactivated by orogenic events in the area. McMartin and Dredge (2005) report that these structures do not localize post-glacial rebound. The potential for fault reactivation is low due to the type, or character, of the faults, the absence of evidence for reactivation despite known tectonism, and the low seismic activity of the area. Consequently, there is a very low risk for potential damage to the dewatering dikes associated with reactivation of the faults.

2.2.7 Borehole Information

A geotechnical and hydrogeologic investigation was carried out in 2003 to investigate the proposed Bay Zone Dike and Goose Island Dike alignments (Golder, 2003). During this investigation, ten (10) boreholes were drilled in the general area of the proposed Bay-Goose Dike. The location of these boreholes is shown on Figure 1.1 and a summary of information from this program is presented on Table 2.7.

Table 2.7: Summary of Water Depth, Overburden Thickness and Hydraulic Conductivity Testing Results for Boreholes in Vicinity of the Proposed Bay-Goose Dike

Borehole	Vertical Depth from Ice Surface to Lakebed (m)	Overburden Thickness (Vertical, m)	Interval Tested (Below Ice Surface)		Bedrock Hydraulic Conductivity (m/s)
			From (m)	To (m)	
03GT-GI-1	1.61	3.31	7.61	12.11	$2.5 X10^{-8}$
03GT-GI-2	0.91	3.60	7.51	12.01	$3.7X10^{-9}$
03GT-GI-3	10.55	1.25	15.35	18.35	$1.3X10^{-6}$
03GT-GI-4	0.61	1.81	Not performed		
03GT-GI-5	2.42	1.83	7.61	12.11	$3.3X10^{-5}$
03GT-GI-6	7.10	5.90	15.0	18.75	$4.7X10^{-7}$
03GT-GI-7	0.00	3.93	Not performed		
03GT-GI-8	5.08	3.52	Not performed		
03GT-BZ-2	5.50	2.16	10.86	15.36	$1.3X10^{-6}$
03GT-BZ-6	4.17	4.43	11.60	16.10	$1.3X10^{-7}$

2.3 Planned Geotechnical Investigations

AEM is planning to undertake a geotechnical investigation program at the Bay-Goose Dike and South Camp Dike areas starting in March 2009. Golder has prepared a recommended geotechnical investigation program which would include drilling boreholes, logging lakebed soils and bedrock, collecting lakebed soil samples for laboratory testing, and performing insitu testing. Details of the proposed investigation plan can be found in Golder, 2009.

The final investigation program will be determined following selection and scheduling of the drilling equipment. A phased investigation approached is proposed. This would include an initial phase which would include drilling to characterize the lakebed soil in terms of geotechnical properties, as well as permit the collection and analysis of samples to support the Total Suspended Solids (TSS) management plan. Insitu packer testing to measure the hydraulic conductivity of the lakebed soils and bedrock would be undertaken at select locations.

Following completion of the first phase of the investigation program, geotechnical data collected will be used to re-assess the proposed alignment and the final design concepts selected for the medium depth sections. This will be followed by an updated drawings and specifications package. The information will also be used in the preparation of a final TSS management plan for dike construction.

In a second phase of the geotechnical investigation program, additional boreholes along the cutoff wall alignment will be undertaken in areas of the Bay-Goose dike to be constructed in areas identified as medium depth to further define foundation conditions. The goal of this phase is to further characterize the lakebed soils and determine if continuity and integrity of the lakebed soils and their hydraulic conductivity is maintained. In particular to determine if high permeability lenses exist within the lakebed soils and if so, assess their continuity.

A minimum of one borehole will be drilled along the South Camp Dike alignment to assess overburden thicknesses and ice content in permafrost.

3.0 DESIGN CRITERIA AND ASSUMPTIONS

Table 3.1 presents a summary of design criteria for the Bay-Goose Dike and South Camp Dike.

Table 3.1: Design Criteria for Bay-Goose and South Camp Dikes

Design Criteria	Value and/or Description	Source and/or Comment
Dam Classification	High – Bay-Goose Dike Significant – South Camp Dike	Canadian Dam Association (CDA) Dam Safety Guidelines (2007).
Minimum Setback from Portage and Goose Island Pits to Downstream Toe of Dike	70 m	Golder 2007b, pit slope design.
Minimum Freeboard	2 m minimum between traffic way/rockfill embankment crest and lake water surface; and 1 m minimum between top of cutoff wall and lake water surface.	Settlement and overtopping CDA (2007).
Maximum Size of Haul Trucks on Dike	Caterpillar 777D (Bay-Goose Dike) Caterpillar 785D (South Camp Dike)	Dike Crest to serve as haul road. To confirm with AEM based on their operation activities.
Cat 777D Width	6.05 m	Caterpillar website http://www.cat.com
Tire Diameter (27.00-R549 Tire)	2.5 m	
Cat 785D Width	6.64 m	
Tire Diameter (33.00-R51 Tire)	3.06 m	
Minimum Crest Width (Including Safety Berms)	29.1 m (two way traffic) – South Camp Dike 19.7 m (one way traffic) – Bay-Goose Dike	NU Mine Health and Safety Regulation.
Design Earthquake (1 in 2500 year return period)	Peak horizontal ground acceleration = 0.06g	2005 National Building Code of Canada, CDA Dam Safety Guidelines (2007) based on high consequence category.
Minimum Factor of Safety for Slope Stability	End of construction prior to dewatering – 1.3; Steady state seepage during operation – 1.5; and Pseudostatic conditions – 1.0.	CDA (2007).
Internal Erosion Seepage and Drainage Control	Granular filter design criteria and low hydraulic conductivity cutoff wall	CDA (2007) Fell and al (2005) U. S. Army Corps (2004) Eldridge and Gilmer (2002).
Grouting	Grout curtain in bedrock below	Target grout curtain hydraulic

Design Criteria	Value and/or Description	Source and/or Comment
	cutoff wall Contact grouting at base of cutoff wall	conductivity of 4 Lugeons
Construction Schedule	Bay-Goose Dike will be constructed over two seasons (2009 and 2010); and South Camp Dike will be constructed in one season (2009).	AEM
Dewatering	Commence by March 2011	AEM To allow open pit mining to start in the south end of Portage Pit and in Goose Island Pit by 3rd Quarter 2011.
Rockfill	Non-Potentially Acid Generating (NPAG)	AEM

The following subsections provide additional information regarding the design criteria.

3.1 Dam Classification

The Canadian Dam Association (CDA, 2007) classification considers the risk to populations, financial and environmental losses. According to the CDA guidelines the Bay-Goose Dike would be classified as "High" due to risk to workers, and classified as "High" due to economic loss. Therefore the Bay-Goose Dike is classified as a "High" consequence structure. The South Camp Dike is classified as "Significant" for temporary risk to workers, and classified as "Low" due to economic loss. Therefore the South Camp Dike's overall classification is "Significant".

3.2 Setback

The distance from the downstream toe of the dike to the open pit crest is the "setback." The purpose of the setback is to isolate the dike from potential failures occurring through the pit wall at ultimate mining depth, to isolate the dike and lake from the effects of blasting, to provide a working area between the pit and the dike, and to allow for seepage water collection works.

A minimum design setback criterion is 70 m for the Bay-Goose Dike based on a review of pit wall stability (Golder, 2007b).

3.3 Freeboard

Freeboard is the minimal vertical distance between the still water surface elevation in the lake and the top of the containment structure. This safety margin is to be maintained at all times in order to restrict overtopping of the containing structure by flood or large waves, considering wind and wave setup and wave run up (CDA, 2007).

For the Bay-Goose Dike, the freeboard between the final crest of the rockfill overlying the cutoff wall and the lake surface is a minimum of 3 m during operation. Freeboard between the top of the low permeability cutoff wall and the lake surface is a minimum of 1 m during operations and following closure.

For the South Camp Dike, the freeboard between the top of the cutoff wall and the lake surface is a minimum of 1 m during operation. The freeboard between the final crest of the rockfill overlying the cutoff wall and the lake surface is a minimum of 3 m during operation.

In addition to freeboard, the upstream slopes and abutments of the dike should have adequate protection against erosion and possible breaching due to wave and ice action. The downstream slopes should be protected where necessary against the erosive action of runoff, seepage, flows, traffic, frost, and burrowing animals (CDA, 2007 - Section 6.6, p. 71).

3.4 Crest Width

The dike crest width will depend on:

- Height and hazard category of the dam;
- Roadway requirements; and
- Constructability.

Where dike crests are used as haul roads, the crest width should comply with NWT Mine Health and Safety Act and Regulations, or equivalent regulations for Nunavut, for minimum width of haul roads (NWT and Nunavut, 1995). For single lane traffic the minimum width is twice the width of the widest haulage vehicle used on the road; for double lane traffic the minimum width is three times the width of the widest haulage vehicle. A shoulder barrier of at least three-quarters the height of the largest tire on any vehicle using the road is also required.

The South Camp Dike will be used as a two way traffic haul road. The upstream crest of the rockfill embankments of the Bay-Goose Dike will be used as a one way traffic haul road.

For the South Camp Dike, the vehicle used as a design basis for sizing the road is a Caterpillar 785D with a width of 6.64 m and a tire diameter of 3.06 m (Caterpillar 33.00-R51 tire). The required width for two way traffic, including width for safety berms each 2.3 m high, is 29.1 m. The initial rockfill width will be at least 47.3 m wide to allow for excavation of soil to bedrock and construction of the low permeability core zone, and to allow for a final rockfill embankment, downstream of the core zone, with a crest width to allow for two way haul traffic.

For the Bay-Goose Dike, the vehicle used as a design basis for sizing the road is a Caterpillar 777D with a width of 6.05 m and a tire diameter of 2.5 m (Caterpillar 27.00R49 tire). The initial rockfill embankment crest width for this dike will vary depending on the depth to bedrock. It is estimated the initial rockfill crest width will be between 50 m and 90 m which will allow for a 12.1 m wide one way haul traffic road on the upstream side of the cutoff wall.

3.5 Design Earthquake

The Meadowbank Project is located in an area of low seismicity. Peak horizontal ground accelerations for the Meadowbank site are summarized in Table 3.2.

Table 3.2: Peak Horizontal Ground Acceleration for the Meadowbank Site

Return Period of Seismic Event (years)	Peak Horizontal Ground Acceleration (g)
100	0.007
475	0.021
1,000	0.035
2,475	0.06[D]

Source: National Building Code of Canada (2005), Appendix IV.
[D] Design event for Bay-Goose Dike.

Canadian Dam Safety Guidelines (CDA, 2007) state that dams shall be designed to withstand an Earthquake Design Ground Motion (EDGM) without release of the reservoir. Selection of the EDGM is based on the consequence of failure of the dam. For a Dike falling in the “High” category (*e.g.,* Bay-Goose Dike) the suggested design earthquake level is 1/2500 or Annual Exceedance Probability (AEP) of one in two thousand five hundreds (2500) years. For a Dike falling in the “Significant” category (*e.g.,* South Camp Dike), the

suggested design earthquake level is 1/1000 or AEP of one in one thousand years (CDA, 2007 - Table 6.1, p.62).

3.6 Slope Stability

Canadian Dam Association Dam Safety Guidelines for static and seismic assessment of slope stability are included in Table 3.3 and Table 3.4 respectively.

Table 3.3: Factors of Safety for Slope Stability, Static Assessment (CDA, 2007 - Section 6.6, p. 70)

Loading Conditions	Minimum Factor-of-Safety	Slope
End of Construction before Reservoir Filling	1.3	Downstream and Upstream
Long-term (Steady-state Seepage, Normal Reservoir Level)	1.5	Downstream
Full or Partial Rapid Drawdown	1.2 to 1.3	Downstream

Table 3.4: Factors of Safety for Slope Stability, Seismic Assessment (CDA, 2007 - Section 6.6, p. 70)

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

CDA (1999 - Section 8.4, p.8-13) states that dams (dikes) on permafrost shall meet the same stability requirements as embankment dams, and shall remain stable in spite of large foundation settlements, which may be applicable to the abutments.

3.7 Seepage and Drainage Control

CDA (2007 - Section 6.6, p. 71) states:

“Seepage exit gradients should be within acceptable limits for the embankment and foundation materials. The usual techniques used to reduce seepage through the pervious units are impermeable upstream blankets, cutoff trenches, grout curtains, sheetpile walls, slurry trench cutoff walls, and other thin cutoffs. Strategically placed granular filter materials can also be used to provide an acceptable exit condition.”

Criteria followed for filter design included those in Fell et al. (2005), and the U.S. Army Corps of Engineers (2004). In addition to using established empirical design criteria such as $D_{15}/d_{85} \leq 5$, laboratory evidence of filter performance was also considered for filter gradation design (Eldridge and Gilmer, 2002).

Note : Seepage reduction is primarily to protect the low permeability elements of the design. It is assumed that AEM will provide appropriate pumping capacity to accommodate seepage under operating conditions. Design of cutoff wall should be sufficiently robust to reduce the risk of rapidly increasing seepage rate.

3.8 Cutoff Wall

The criteria for cutoff wall design include:

- A sufficiently low value of hydraulic conductivity to limit seepage quantities to those that can be handled by the pit dewatering system; and
- Erosion resistance to gradients expected during operation.

Bedrock foundation and contact grouting shall be applied where necessary to control seepage through the bedrock and to control piping of foundation soils and cutoff wall materials into voids in the rock.

3.9 Dewatering

To allow open pit mining in the south end of the Portage Pit and in the Goose Island Pit in the third quarter of 2011, it is understood that dewatering should be initiated by March 2011.

4.0 BAY-GOOSE DIKE DESIGN

Figure 1.1 presents the proposed Bay-Goose Dike alignment, designed to maintain a minimum of 70 m setback from the pit crest limit of each the Goose Island and Portage pits and minimize the water depth to bedrock beneath the cutoff wall. The total length of the dike is approximately 2,265 m and it intersects areas in a range of water depths (0 to 9 m lake level to lakebed surface). Depth to bedrock is estimated to range from 0.5 to 15 m below lake level (to be confirmed by the geotechnical investigation program).

As previously mentioned, the Bay-Goose Dike design has been subdivided into two components based on the depth to bedrock. The design for the shallower sections, less than 8 m depth to bedrock, is based on the design used for construction of the East Dike, while the design of the medium depth sections, between 8 and 15 m depth to bedrock, has been completed at a conceptual level.

An investigation program to determine the depth to bedrock along the dike alignment and to characterize the soils will be completed during March 2009. This investigation will be used to refine the alignment, determine the extent of the shallow and medium depth areas, and finalize the Bay-Goose Dike design.

4.1 Shallow Depth Design

It is estimated that 85% of Bay-Goose Dike cutoff wall falls within the shallow depth category, but a more accurate estimation will be obtained after the 2009 field investigation. The design for the shallow depth area is consistent with the design utilized for the East Dike and the experience gained during the East Dike construction has been applied to the Bay-Goose Dike design.

The general construction phases are outlined as follows:

- Execution of turbidity control and total suspended solid (TSS) mitigation measures;
- Placement of rockfill;
- Excavation of the centre section of the rockfill and lakebed soils to bedrock;
- Placement of Filter on the downstream side of the excavation;
- Backfilling the excavation with granular material and performing dynamic compaction of the backfilled material;
- Excavation of a trench through the backfilled and compacted material and stabilization of the trench with a slurry (water and bentonite) mixture;
- Backfilling trench with Soil Bentonite (SB) or Cement Bentonite (CB), displacing the slurry out of the trench to construct the cutoff wall; and
- Placement of granular cap and complete the surfacing of the dike.

Tube-a-manchette (TAM) grouting of the contact between the cutoff wall and bedrock is required along with grouting of the bedrock. Other approved comparable grouting methods or techniques which could achieve the same results may be considered. It is anticipated that bedrock grouting would be extended approximately 10 to 25 m into bedrock; however, this will be confirmed based on results obtained from the 2009 geotechnical investigation program. Depth of grouting will be adjusted depending on water depth, foundation and thermal conditions.

Drawings of the Bay-Goose Dike design for the shallow section are included in Appendix A and the related Specifications are included in Appendix B.

An alternative design, or design modification may also be considered for a portion of the shallow depth sections that may have sufficiently thick layers of low permeability till above the bedrock (e.g. > 2m), (to be confirmed during the 2009 geotechnical drilling program). The alternative design would involve construction of a SB or CB cutoff wall which would be keyed into low permeability lakebed soil layer (minimum of 1 m key-in). TAM grouting would be performed in the lakebed soils to effectively extend the low permeability cutoff wall to bedrock. A similar option is also being considered for the medium depth section, as discussed later in this letter. This alternate design would need to accommodate potentially localized high hydraulic gradients below the cutoff wall so the risk of piping failure is minimized (*i.e.*, additional width of filter zone).

Detailed stability, seepage, thermal, consolidation and stress-deformation analyses were completed for the East Dike design showing satisfactory results (Golder, 2008c). The results of the analyses apply to the shallow design section for the Bay-Goose Dike. If a modified design is selected, additional detailed analyses would be completed.

4.2 Medium Depth Design

Two locations were identified as medium water depth along the proposed alignment of the Bay-Goose Dike as shown in yellow in Figure 1.1. One of the areas is near the southern abutment and extends for about 225 m, the other is near the northern abutment and extends for about 75 m. There is a third area that may also be classified as medium depth southeast from Goose Island. The general design concept used for the East Dike has been maintained for the medium depth design portions of the Bay-Goose Dike, except for the cutoff wall characteristics.

Six different conceptual design options were considered for the medium depth section of the cutoff wall. Details of the design characteristics, analysis, and comparison of each are included in Golder (2008d).

Following the results of the analysis, and based on information available at the time of writing this letter, it was preliminarily concluded that the preferred cutoff wall option is the construction of a Cement-Bentonite cutoff wall in core backfill of the dike, with limited excavation of lakebed soils (*i.e.* a cutoff wall founded in competent lakebed soils). The cutoff wall trench would be extended through the lakebed soils, using a long-reach excavator or cutter device, until refusal.

This preliminary conclusion will be reviewed and revised, if necessary, after the completion of the geotechnical investigations planned for March 2009.

It is expected that the lakebed till soils are heterogeneous and therefore the potential for variability in the hydraulic conductivity exists owing to the potential presence of layers, lenses and/or pockets of coarse material. These layers could become seepage channels during and after dewatering with the associated risk for erosion and piping, which could jeopardize the integrity of the cutoff wall. The option to found the Bay-Goose Dike on the insitu lakebed soils and not carry out excavation to bedrock requires that a thorough and detailed geotechnical investigation be undertaken during March 2009. Even with a geotechnical investigation, it is expected that risks associated with leaving the lakebed soils in the dike foundation will remain.

Acknowledging the potential for variability in the hydraulic conductivity of lakebed till soils and the fact that the cutoff wall may not reach bedrock in all areas, this option also includes a plan to incorporate additional treatment of the lakebed soils in local areas during dike construction. Treatment options would consider either TAM grouting or other localized treatment of the soils (for example, passive thermosyphons). It is assumed that TAM grouting or other treatments could be scheduled to occur during the winter period.

Given higher gradients expected in these sections, it is understood that if this cutoff option is utilized, proper attention would have to be given to the response of the foundation materials following dewatering in order to reduce the risk of piping failure under the cutoff wall.

A seepage analysis was conducted to further evaluate the option of founding the cutoff wall in the lakebed soils. Figure 4.1 presents the Seep/W model utilized for the analysis (GeoSlope 2004, Version 6.22). A section

through the dike with 6 m of water and 6 m of soils above the bedrock was analyzed. Table 4.1 presents the hydraulic conductivities considered for each material (Golder, 2008d). A range of hydraulic conductivities were considered for the lakebed soils, consistent with previously reported laboratory tests conducted in this material.

Table 4.1: Hydraulic Conductivities Utilized for the Seepage Analysis

Material	Hydraulic Conductivity, k [m/s]
Rockfill	1×10^{-2}
Core Backfill	1×10^{-5}
Lakebed Soil	1×10^{-5} to 1×10^{-7}
Weathered Bedrock	5×10^{-6}
Grouted Bedrock	5×10^{-7}
Soil-Bentonite	1×10^{-9}
Cement-Bentonite	1×10^{-8}

Figures 4.2 and 4.3 present the results of the analysis in terms of profiles of pressure head in the model and hydraulic gradient across the cutoff wall, for the range in lakebed soil hydraulic conductivity. The results of the seepage analysis indicate the gradients across the cutoff wall vary between 5.0 to 5.5 and the flow of water across the dike, considering a 300 m long section, varies from 85 to 1,500 m³/day as a result of the variation of the hydraulic conductivity of the lakebed soils. This analysis assumes uniform conditions of the lakebed soils and does not include the potential for high permeability lenses in the lakebed soils, which could result in much larger seepage volumes and pose significant construction and schedule risks.

As part of the analysis, other cutoff options were also considered, as described in Golder (2008d), such as:

a) Jet Grouting columns from 0.5 m below dike surface to bedrock;

b) Jet Grouting columns in lakebed soils only and construction of a Soil-Bentonite or Cement-Bentonite cutoff wall in core backfill above lakebed soils; and

c) Freeze Wall from dike surface extended 5 m into the bedrock.

5.0 SOUTH CAMP DESIGN

The South Camp Dike will be constructed across an existing lake narrows located in Third Portage Lake. There maybe natural lake currents in this narrows which could impact the mobility of suspended solids, and depending on the time of year of construction, turbidity control may be necessary for construction of this dike. The South Channel Dike is required along with the Bay-Goose Dike to permit dewatering of the southern portion of the Portage Pit and for the Goose Island Pit.

The design concept for the South Camp Dike consists of a rockfill shell with a low permeability core. The general construction sequence for the dike will involve: pushing a rockfill platform out across the channel, excavation through the center portion of the rockfill to bedrock, followed by placement of till or other suitable low permeability material in the excavation, then placing additional rockfill over the till core to load it and promote settlement. The minimum width of the dike core at the base of the excavation is 7.5 m but the actual width will be determined in the field based on foundation conditions encountered, and depth to bedrock. The requirement for filters against the downstream edge of the excavation is governed by head across the dike and the type of foundation materials encountered, and will be determined by the engineer in the field during construction.

Depth of excavation to prepare for till placement will be confirmed as part of the 2009 geotechnical investigation program.

Details of South Camp Dike design are included on Drawings 4200-30 and 4200-31 in Appendix A.

6.0 TURBIDITY CONTROL

Based on East Dike construction experience, the control of turbidity generated in Third Portage Lake around Bay-Goose and South Camp Dikes construction activities will be required to minimize the environmental impact.

Golder undertook analyses of the turbidity generated in Second Portage Lake as a result of East Dike Construction which was carried out in August and September 2008 (Golder, 2008e). This review was used to form the basis of the turbidity control plan for Bay-Goose and South Camp Dikes construction which is planned for 2009 and 2010.

The TSS management plan will consider the use of turbidity barriers to control TSS generated in the construction areas of the Bay-Goose and South Camp Dikes. The control measure(s) used will be determined based upon:

- Potential lake currents induced by watershed runoff and wind stresses at Third Portage;
- The proposed construction sequences for the Bay-Goose and South Camp Dikes; and
- Potentially available construction processes that might reduce the mobilization of suspended solids.

The plan recommends building the South Camp Dike first to limit lake currents during the construction of Bay-Goose Dike. AEM is considering scheduling construction of the South Camp Dike in winter or early spring of 2009, prior to ice break up, to reduce TSS generation.

A field survey for the characterization of fine lakebed sediment at Third Portage Lake is required to support the selection and finalization of the TSS control measures (*i.e.*, turbidity barriers) proposed in the management plan. The survey would be intended to determine sediment thickness at the location of the dike footprint and where sediment pockets would be expected and the grain size distribution, organic content and specific gravity of those sediments. The survey will be conducted as part of the 2009 geotechnical investigation program.

7.0 CLOSURE

The reader is referred to the "Important Information and Limitations of this Letter" which follows the text but forms an integral part of this letter and the accompanying specifications, and drawings.

We trust the above information is sufficient for your current needs. Should you require additional information, or further clarification, please do not hesitate to contact us.

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED BY

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Geotechnical Engineer (BC)

ORIGINAL SIGNED AND SEALED BY

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THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER
P 049
GOLDER ASSOCIATES LTD.

Attachments: Important Information and Limitations
Figures 1.1, 2.1, 2.2, 2.3, 4.1, 4.2, 4.3
Appendix A - Bay-Goose Dike Design Drawings
Appendix B - Bay-Goose Dike Design Specifications

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IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder can not be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, and safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on

adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, *etc.*) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

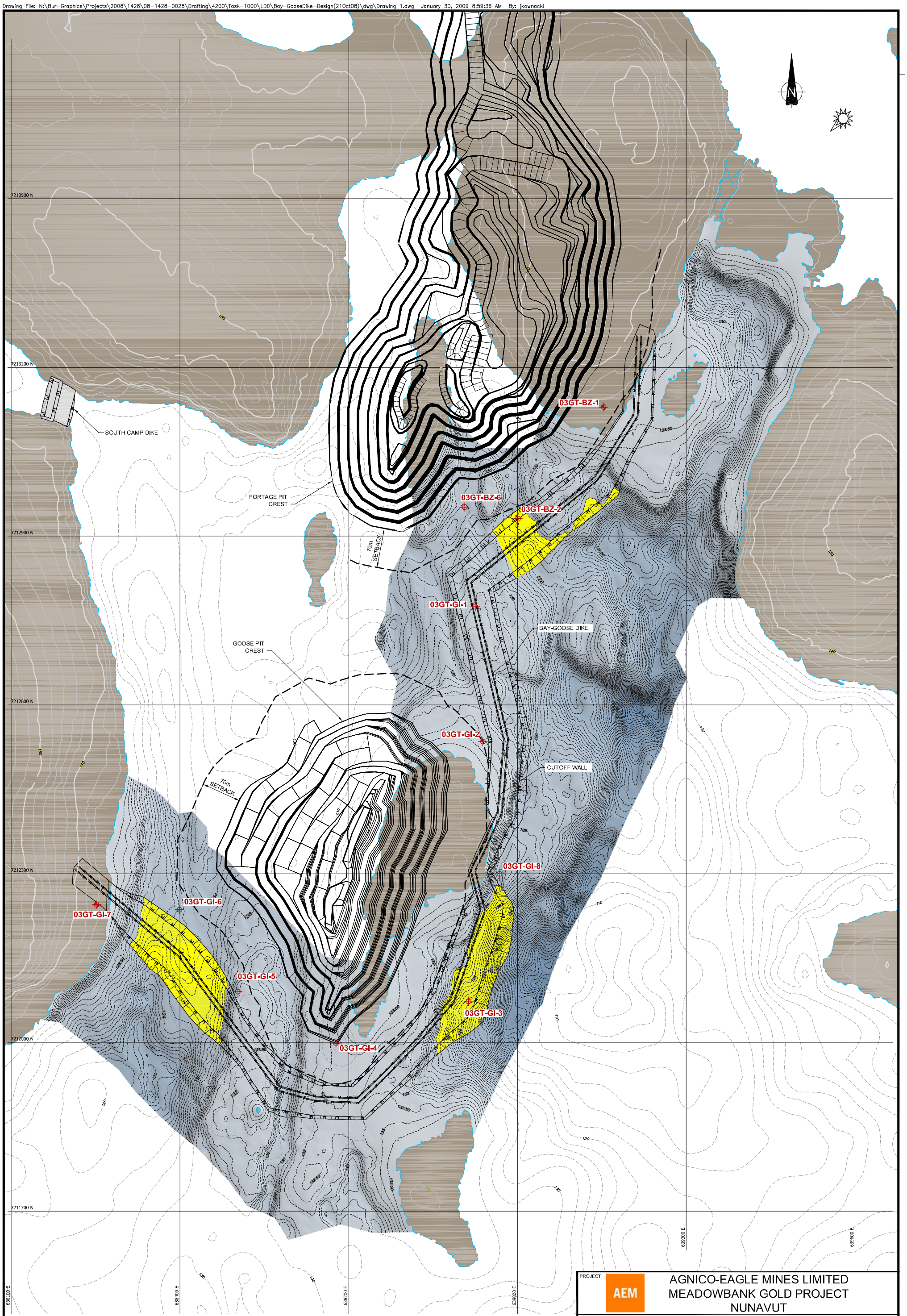
Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.



LEGEND

- LAND-BASED MAJOR CONTOUR
- LAND-BASED MINOR CONTOUR
- BATHYMETRY MAJOR CONTOUR 2006
- BATHYMETRY MINOR CONTOUR 2006
- BATHYMETRY MAJOR CONTOUR 2008
- BATHYMETRY MINOR CONTOUR 2008
- BATHYMETRY CONTOUR BELOW EL. 128m (6m WATER DEPTH UNDER DIKE FOOTPRINT)
- EXISTING BOREHOLE WITH THERMISTOR (2003)
- EXISTING BOREHOLE (2003)

NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3. GRID REFERENCE: NAD 83, UTM ZONE 14.
4. CONTOUR INFORMATION ON LAND SUPPLIED BY AGNICO-EAGLE MINES LIMITED (AEM), MEADOWBANK DIVISION.
5. LAKEBED SURFACE INTERPOLATED FROM 2008 BATHYMETRY DATA.
6. LAKE CONTOURS ARE BASED ON SURVEYED LAKE SURFACE ELEVATIONS: THIRD PORTAGE LAKE = 134.1m.

0 30 60 90 120 150
SCALE IN METRES

NOT FOR CONSTRUCTION

PROJECT

AEM

AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

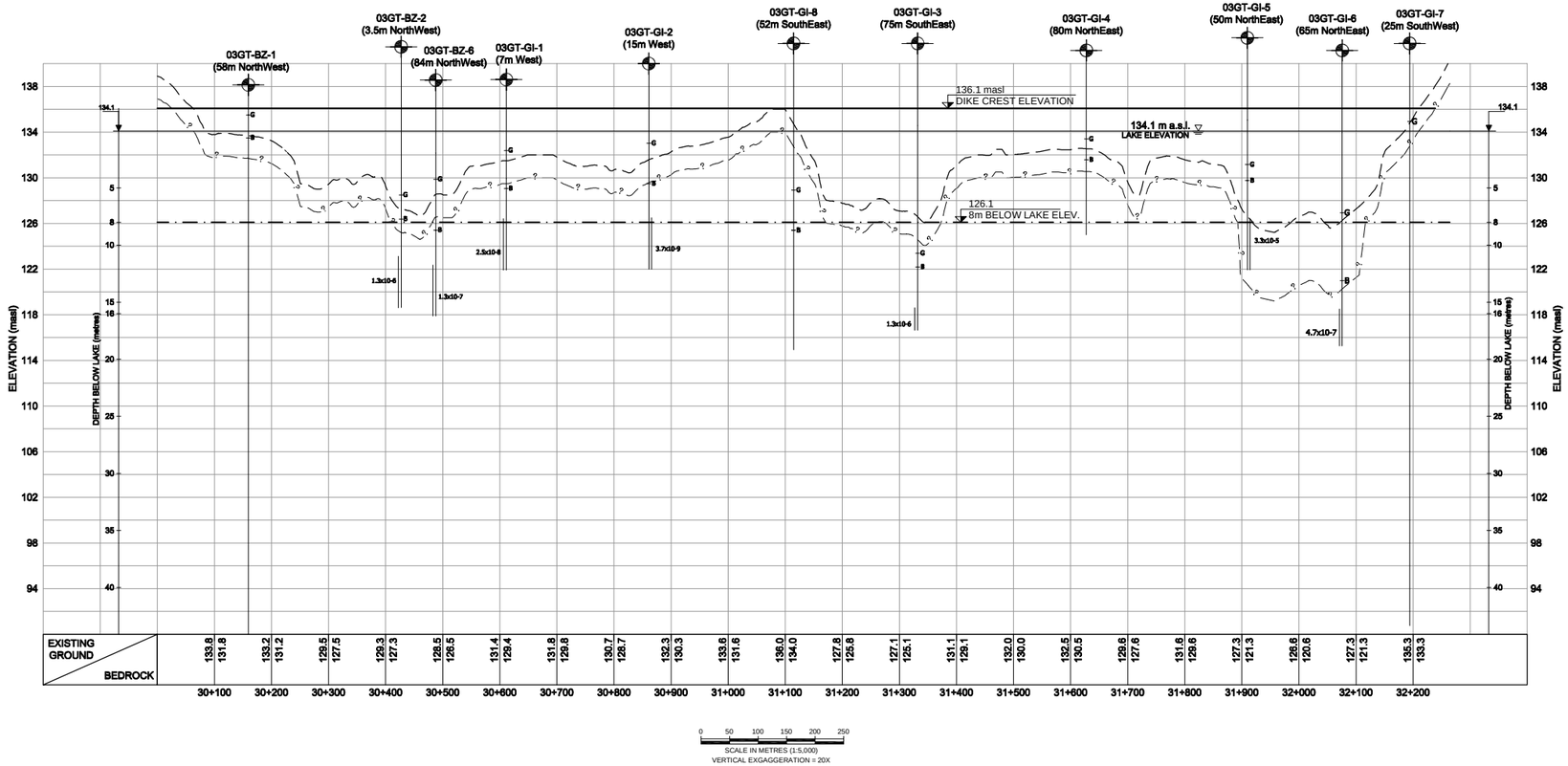
TITLE

BAY GOOSE DIKE AND SOUTH CAMP DIKE PROPOSED ALIGNMENT

Golder Associates

PROJECT No.		07-141374	FILE No.	DRAWING 1
DESIGN	KD	17OCT08	SCALE AS SHOWN	REV. -
CADD	EA	17OCT08		
CHECK	-			
REVIEW				

FIGURE 1.1



LEGEND:

2x10^{-8}	HYDRAULIC CONDUCTIVITY TEST INTERVAL WITH RESULTS IN m/s
03GT-SE-2 (9m WEST)	BOREHOLE NAME (OFFSET TO DIKE CENTRELINE AND DIRECTION)
	EXISTING BOREHOLE (2003)
B	BEDROCK
G	GROUND OR LAKEBED SOILS
– — — –	LAKEBED SURFACE
—— —? ——	INFERRED CONTACT LAKEBED SOIL AND BEDROCK

NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3) CONTOUR INFORMATION ON LAND SUPPLIED BY AGNICO-EAGLE MINES LIMITED (AEM), MEADOWBANK DIVISION.
4) LAKEBED SURFACE BASED ON OCTOBER 2008 INVESTIGATION.
5) LAKE CONTOURS ARE BASED ON SURVEYED LAKE SURFACE ELEVATIONS: THIRD PORTAGE LAKE = 134.1m (2008)
6) CONDITIONS AWAY FROM BOREHOLES ARE ASSUMED AND SHOULD BE CONFIRMED BY THE CONTRACTOR IN THE FIELD.
7) INFERRED FOUNDATION CONDITIONS TO BE UPDATED FOLLOWING 2009 GEOTECHNICAL INVESTIGATION PROGRAM.

NOT FOR CONSTRUCTION

PROJECT

AEM

AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE

BAY-GOOSE DIKE CUTOFF WALL PROFILE

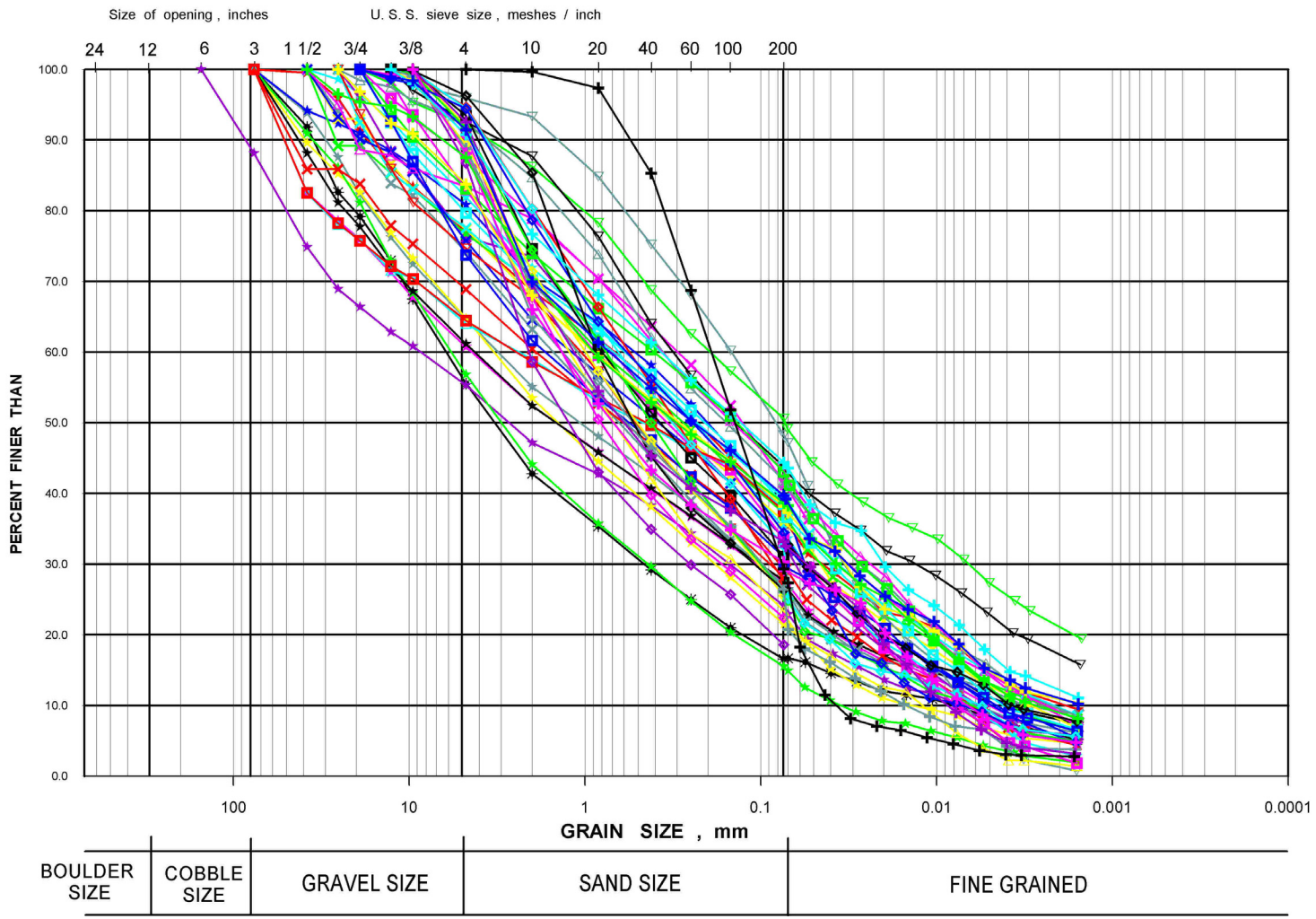
Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No. 0814280028-4200-FIGURE 2.1	
DESIGN	JU	04JUL08	SCALE AS SHOWN	REV. 0
CADD	EA	09DEC08		
CHECK	-	-		
REVIEW	-	-		

FIGURE 2.1

REVISION DATE: 09/01/28 05:37PM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2008\1428\08-1428-0028\Drafting\4200\Task-1000\27JAN09\0814280028-4200-FIGURE 2.1.dwg

REVISION DATE: BY: FILE:



Note: Pre-August 2007 data shown

PROJECT	**AGNICO-EAGLE MINES LIMITED** **MEADOWBANK GOLD PROJECT** **NUNAVUT**
TITLE	RANGE OF GRAIN SIZE DISTRIBUTION FOR TILL SAMPLES

Golder Associates

PROJECT No. 07-1413-0074			FILE No. ----	
DESIGN	--	-	SCALE NTS	REV.
CADD	--	-	**FIGURE 2.2**	
CHECK	--	-		
REVIEW				

630000 635000 640000 645000 650000

7230000 7225000 7220000 7215000

PDF

PIPEDREAM LAKE

FARSIDE LAKE

WALLY LAKE

VAULT DEPOSIT

SECOND PORTAGE FAULT

NORTH PORTAGE

CAMP

THIRD PORTAGE LAKE

THIRD PORTAGE

BAY ZONE

GOOSE ISLAND

BAY ZONE FAULT

N

LEGEND

Lake

Gold Deposit

Fault Line

ROCK TYPE

- Granite, Granodiorite
- Gabbro
- Quartzite, Conglomerate
- Quartz arenite, metasediments
- Ultramafic
- Foliated Diorite, Gabbro
- Intermediate to Felsic Volcaniclastics
- Iron Formation
- Felsic Volcanics
- Mafic Volcanics

REFERENCE

Data provided by Cumberland Resources Ltd.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 14

0 800 1,600 3,200

SCALE 1:80,000 METRE

PROJECT

AEM

AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE

REGIONAL GEOLOGY

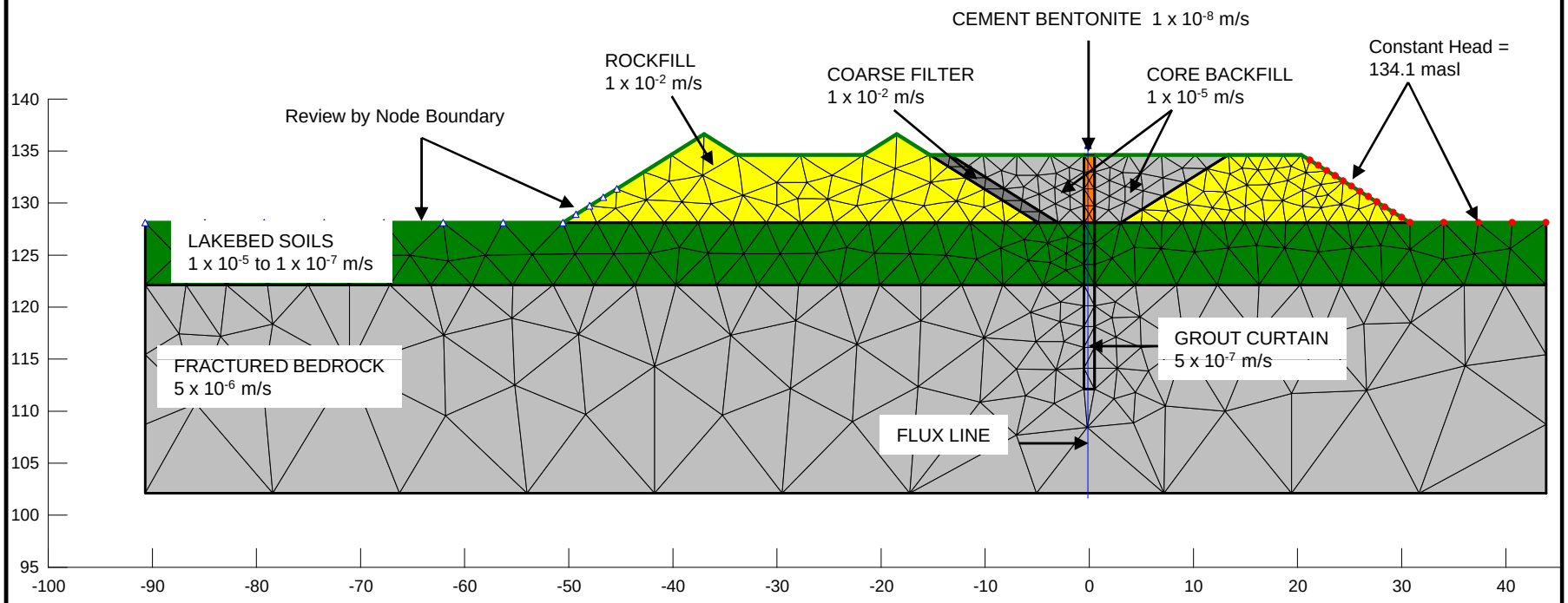
Golder Associates
Burnaby, B.C.

PROJECT No. 06-1413-089			SCALE AS SHOWN	REV. 0
DESIGN	ES	06 Mar. 2007		
GIS	AL	06 Mar. 2007		
CHECK				
REVIEW				

FIGURE 2.3

Project: N:\Bur-Graphics\Projects\2006\1413-06\1413-089\GIS\projects\5000\4000\figure-02-03_regional-geology.mxd

REVISION DATE: November 26,2008 BY: GJ FILE:O:\Active_2008\1428\08-1428-0028 Meadowbank Bay Goose Dike Design\4100 Design Analyses\medium section options\Seepage Analyses\Revised sections - Nov26,08



PROJECT

AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE

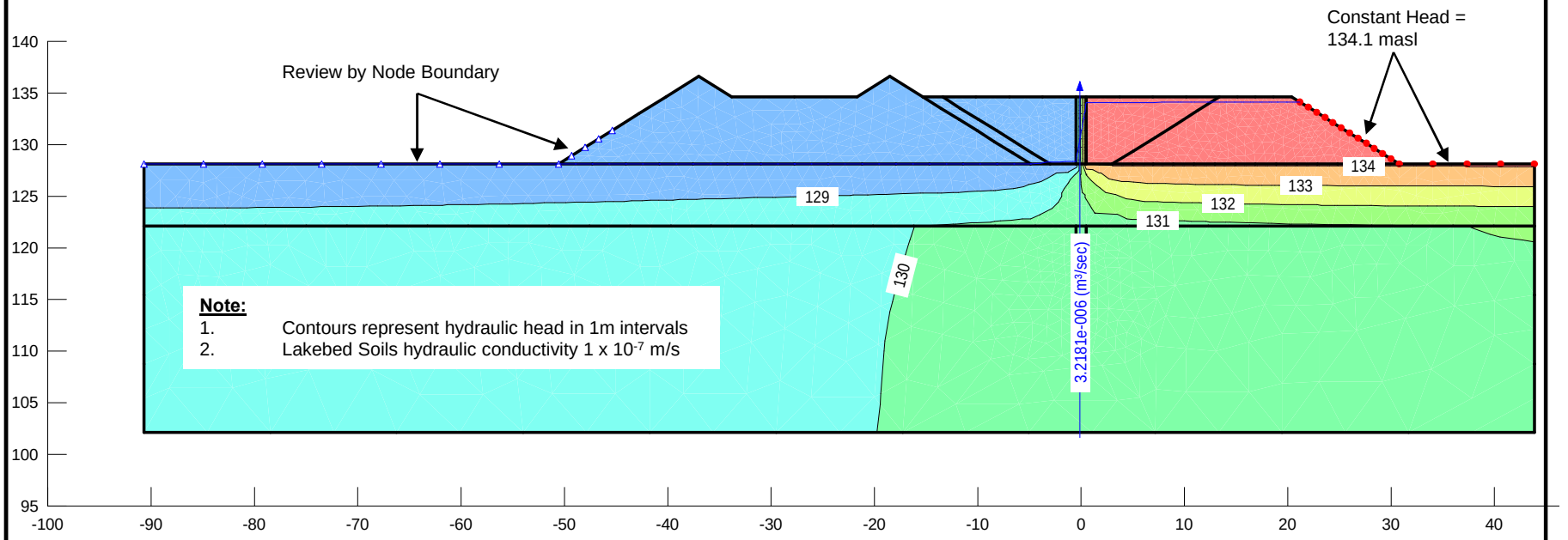
SEEPAGE ANALYSIS MODEL MEDIUM DEPTH SECTION

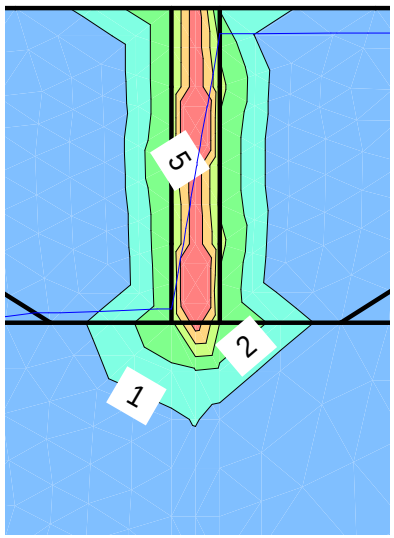
Golder Associates

PROJECT No. 08-1428-0028			FILE No. 4100	
DESIGN	JU	26NOV08	SCALE NTS	REV.
CADD	GJ	28JAN09		
CHECK	--			
REVIEW				

FIGURE 4.1

REVISION DATE: November 26,2008 BY: GJ FILE:O:\Active_2008\1428\08-1428-0028 Meadowbank Bay Goose Dike Design\4100 Design Analyses\medium section options\Seepage Analyses\Revised sections - Nov26,08





HYDRAULIC GRADIENT ALONG CUTOFF WALL

Contours represent XY gradient in 1m intervals

PROJECT

AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE

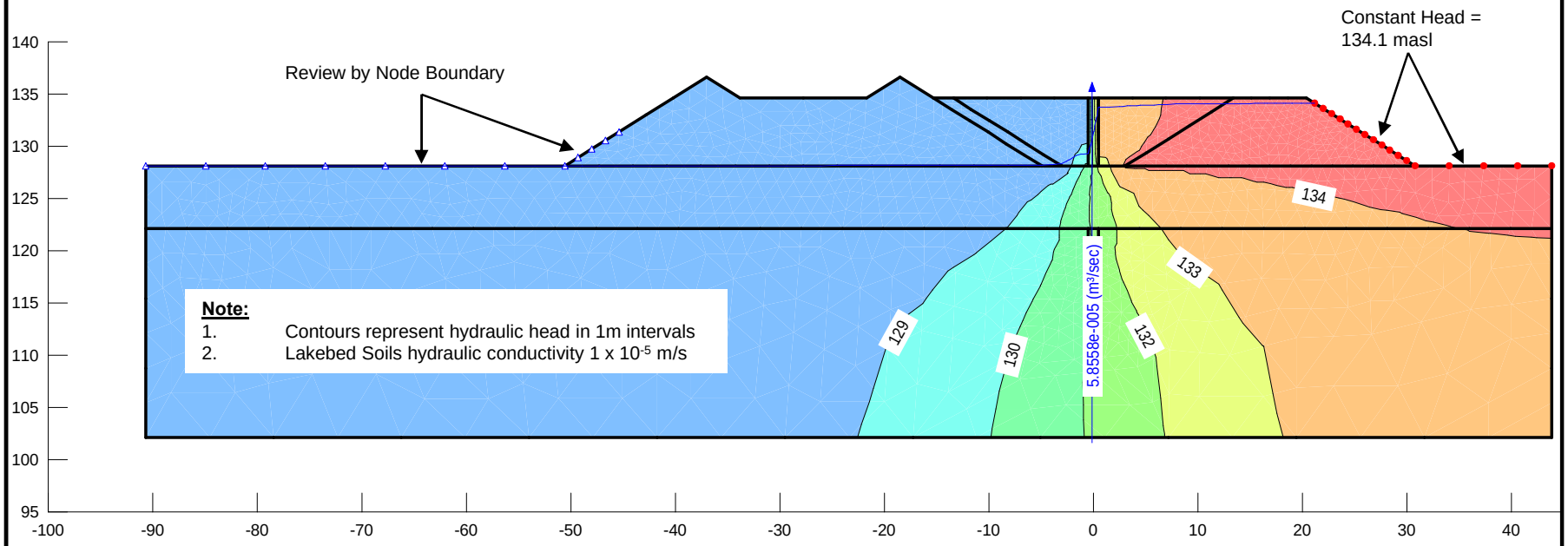
SEEPAGE ANALYSIS RESULTS
LOW LIMIT CONDUCTIVITY LAKEBED SOILS

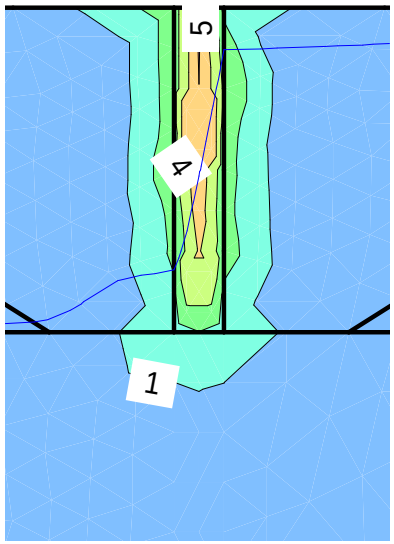
Golder Associates

PROJECT No. 08-1428-0028			FILE No. 4100	
DESIGN	JU	26NOV08	SCALE NTS	REV.
CADD	GJ	28JAN09		
CHECK	--			
REVIEW				

FIGURE 4.2

REVISION DATE: November 26,2008 BY: GJ FILE:O:\Active_2008\1428\08-1428-0028 Meadowbank Bay Goose Dike Design\4100 Design Analyses\medium section options\Seepage Analyses\Revised sections - Nov26,08





HYDRAULIC GRADIENT ALONG CUTOFF WALL

Contours represent XY gradient in 1m intervals

PROJECT
AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE
SEEPAGE ANALYSIS RESULTS
HIGH LIMIT CONDUCTIVITY LAKEBED SOILS

Golder Associates

PROJECT No. 08-1428-0028			FILE No. 4100	
DESIGN	JU	26NOV08	SCALE NTS	REV.
CADD	GJ	28JAN09		
CHECK	--		**FIGURE 4.3**	
REVIEW				

APPENDIX A

Bay-Goose Dike Design Drawings

AGNICO-EAGLE MINES LIMITED
MEADOWBANK DIVISION
MEADOWBANK GOLD PROJECT
BAY-GOOSE DEWATERING DIKE DESIGN

DWG NO.	DRAWING TITLE	REVISION	REVISION TITLE
4200-00	BAY-GOOSE DIKE AND SOUTH CAMP DIKE LOCATION MAP AND DRAWING INDEX	B	ISSUED FOR REVIEW
4200-01	BAY-GOOSE DIKE AND SOUTH CAMP DIKE SITE PLAN	B	ISSUED FOR REVIEW
4200-02	BAY-GOOSE DIKE BOREHOLE LOCATION PLAN	B	ISSUED FOR REVIEW
4200-03	BAY-GOOSE DIKE CUTOFF WALL CENTRELINE SETOUT PLAN	B	ISSUED FOR REVIEW
4200-04	BAY-GOOSE DIKE INITIAL ROCKFILL LAYOUT PLAN	B	ISSUED FOR REVIEW
4200-05	BAY-GOOSE DIKE TYPICAL MATERIAL PLACEMENT PLAN	B	ISSUED FOR REVIEW
4200-06	BAY-GOOSE DIKE TYPICAL MATERIAL PLACEMENT SECTIONS	B	ISSUED FOR REVIEW
4200-07	BAY-GOOSE DIKE TYPICAL CONCEPTUAL MEDIUM DEPTH PLAN AND SECTION	B	ISSUED FOR REVIEW
4200-08	BAY-GOOSE DIKE GOOSE ISLAND ABUTMENT DETAILS	B	ISSUED FOR REVIEW
4200-09	BAY-GOOSE DIKE GOOSE ISLAND ABUTMENT SECTIONS	A	ISSUED FOR REVIEW
4200-10	BAY-GOOSE DIKE NORTH AND SOUTH ABUTMENT PLANS AND DETAILS	B	ISSUED FOR REVIEW
4200-11	BAY-GOOSE DIKE INSTRUMENTATION PLAN	B	ISSUED FOR REVIEW
4200-12	BAY-GOOSE DIKE INSTRUMENTATION SECTION AND GROUTING DETAILS	B	ISSUED FOR REVIEW
4200-13	BAY-GOOSE DIKE INSTRUMENTATION AND GROUTING DETAILS	A	ISSUED FOR REVIEW
4200-14	BAY-GOOSE DIKE CROSS SECTIONS (1 OF 4)	A	HOLD
4200-15	BAY-GOOSE DIKE CROSS SECTIONS (2 OF 4)	A	HOLD
4200-16	BAY-GOOSE DIKE CROSS SECTIONS (3 OF 4)	A	HOLD
4200-17	BAY-GOOSE DIKE CROSS SECTIONS (4 OF 4)	A	HOLD
4200-18	BAY-GOOSE DIKE CUTOFF WALL PROFILE	B	ISSUED FOR REVIEW
4200-19	BAY-GOOSE DIKE GROUTING PROFILE	A	ISSUED FOR REVIEW
4200-20	BAY-GOOSE DIKE SEEPAGE COLLECTION SYSTEM PLAN	A	HOLD
4200-21	BAY-GOOSE DIKE SEEPAGE COLLECTION SYSTEM PROFILE AND DETAILS	A	HOLD
4200-22	BAY-GOOSE DIKE SEEPAGE COLLECTION SYSTEM SECTIONS (1 OF 2)	A	HOLD
4200-23	BAY-GOOSE DIKE SEEPAGE COLLECTION SYSTEM SECTIONS (2 OF 2)	A	HOLD
4200-30	SOUTH CAMP DIKE MATERIAL PLACEMENT PLAN	B	ISSUED FOR REVIEW
4200-31	SOUTH CAMP DIKE PROFILE AND SECTIONS	B	ISSUED FOR REVIEW

LOCATION PLAN

LIST OF SPECIFICATIONS		
SPECIFICATION NO.	TITLE	REVISION
4200-S1	ADMINISTRATION	B
4200-S2	CARE OF WATER	B
4200-S3	TURBIDITY BARRIER	B
4200-S4	FOUNDATION PREPARATION	B
4200-S5	FILL PLACEMENT	B
4200-S6	CUT-OFF WALL	B
4200-S7	DRILLING AND GROUTING	B
4200-S8	INSTRUMENTATION	B
4200-S9	QC AND QA REQUIREMENTS	B

DRAWINGS ON HOLD ARE PENDING CONCLUSION OF 2009 GEOTECHNICAL INVESTIGATION PROGRAM

DRAWING NUMBERS NOT USED:
4200-24, 4200-25, 4200-26, 4200-27, 4200-28, 4200-29

REVISION DATE: 09/02/03 11:56AM By: jkownacki CADD FILE: N:\Bur--Graphics\Projects\2008\1428\08--1428--0028\Drafting\4200\Task--1000\30JAN09--Rev--B\0814280028-4200_B_00.dwg

DRAWING NO.	REFERENCES	REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
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		A	24DEC08	JU	ISSUED FOR REVIEW	EA	JU	JCC

NOT FOR CONSTRUCTION

STAMP

ORIGINAL SIGNED

PROJECT

AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE

BAY-GOOSE DIKE AND SOUTH CAMP DIKE LOCATION MAP AND DRAWING INDEX

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_B_00	
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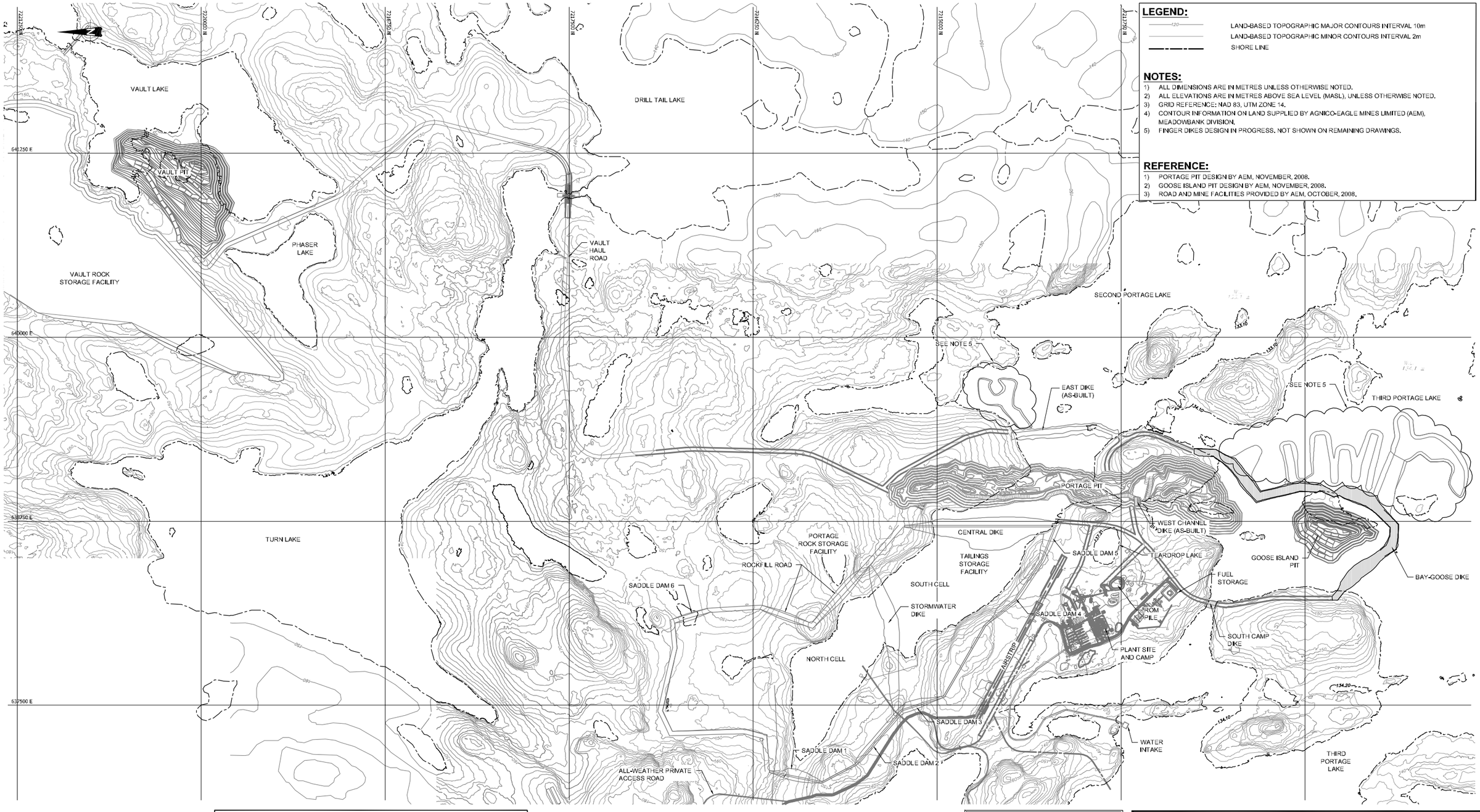
CADD	EA	04DEC08			
CHECK					
REVIEW					

4200-00



LEGEND:

- LAND-BASED TOPOGRAPHIC MAJOR CONTOURS INTERVAL 10m
- LAND-BASED TOPOGRAPHIC MINOR CONTOURS INTERVAL 2m
- SHORE LINE

NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3) GRID REFERENCE: NAD 83, UTM ZONE 14.
4) CONTOUR INFORMATION ON LAND SUPPLIED BY AGNICO-EAGLE MINES LIMITED (AEM), MEADOWBANK DIVISION.
5) FINGER DIKES DESIGN IN PROGRESS. NOT SHOWN ON REMAINING DRAWINGS.

REFERENCE:

1) PORTAGE PIT DESIGN BY AEM, NOVEMBER, 2008.
2) GOOSE ISLAND PIT DESIGN BY AEM, NOVEMBER, 2008.
3) ROAD AND MINE FACILITIES PROVIDED BY AEM, OCTOBER, 2008.

0 125 250 375 500 625
SCALE IN METRES
1 : 12,500

REDUCED DRAWING NOT TO SCALE

PROJECT

AEM

AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE

BAY-GOOSE DIKE AND SOUTH CAMP DIKE SITE PLAN

NOT FOR CONSTRUCTION

STAMP

ORIGINAL SIGNED

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
2	02FEB09	JU	ISSUED FOR REVIEW	SD		
1	24DEC08	JU	ISSUED FOR REVIEW	SD	JU	JCC

DRAWING NO. | REFERENCES

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_B_01	
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REVIEW					

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By: jkownacki
REVISION DATE: 09/02/02 10:37AM

EXISTING BOREHOLE COORDINATES TABLE			
POINT ID	EASTING	NORTHING	COMMENT
03GT-BZ-1	639153.13	7213129.49	SURVEYED
03GT-BZ-2	639000	7212931	APPROX.
03GT-BZ-6	638906	7212952	APPROX.
03GT-GI-1	638924	7212775	APPROX.
03GT-GI-2	638938	7212535	APPROX.
03GT-GI-3	638913	7212073	APPROX.
03GT-GI-4	638676	7211999	APPROX.
03GT-GI-5	638502	7212091	APPROX.
03GT-GI-6	638398	7212236	APPROX.
03GT-GI-7	638251.18	7212245.77	SURVEYED
03GT-GI-8	638967	7212300	APPROX.

NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3) GRID REFERENCE: NAD 83, UTM ZONE 14.
4) CONTOUR INFORMATION ON LAND SUPPLIED BY AGNICO-EAGLE MINES LIMITED (AEM), MEADOWBANK DIVISION.
5) LAKEBED SURFACE BASED ON BATHYMETRIC AND SEISMIC SURVEYS BY GOLDER ASSOCIATES LTD., 2006. DETAILED BATHYMETRY (0.5M CONTOUR INTERVAL) BASED ON 2008 SURVEY.
6) LAKE CONTOURS ARE BASED ON SURVEYED LAKE SURFACE ELEVATIONS: THIRD PORTAGE LAKE = 134.1m (2008)

LEGEND:

- 03GT-BZ-1 — EXISTING BOREHOLE WITH THERMISTOR INSTALLATION (2003)
- 03GT-BZ-6 — EXISTING BOREHOLE (2003)
- SHORELINE
- 70m PIT OFFSET FROM PIT RIM
- PIT RIM
- MINOR BATHYMETRY CONTOUR
- MAJOR BATHYMETRY CONTOUR
- MINOR TOPOGRAPHIC CONTOUR
- MAJOR TOPOGRAPHIC CONTOUR

REFERENCE:

1) PORTAGE PIT DESIGN BY AEM, NOVEMBER, 2008.
2) GOOSE ISLAND PIT DESIGN BY AEM, NOVEMBER, 2008.
3) ROAD AND MINE FACILITIES PROVIDED BY AEM, OCTOBER, 2008.

EAST DIKE (AS-BUILT)
ACCESS ROAD (BY AEM)
WEST CHANNEL DIKE (AS-BUILT)
PORTAGE PIT
PIT RIM (APPROXIMATE)
70m OFFSET FROM PIT RIM
BAY-GOOSE DIKE FOOTPRINT
BAY-GOOSE DIKE CUTOFF WALL CENTRELINE
GOOSE ISLAND PIT
SOUTH CAMP DIKE SEE DWG 4200-30, 31
03GT-BZ-1
03GT-BZ-2
03GT-BZ-6
03GT-GI-1
03GT-GI-2
03GT-GI-3
03GT-GI-4
03GT-GI-5
03GT-GI-6
03GT-GI-7 (INCLINED)
638800 E
639200 E
638400 E
7213600 N
7213200 N
7212800 N
7212400 N
7212000 N
7211600 N
7211200 N
0 40 80 120 160 200
SCALE IN METRES (1:4,000)

REDUCED DRAWING
NOT TO SCALE

NOT FOR CONSTRUCTION

ORIGINAL SIGNED

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
2	02FEB09	JU	ISSUED FOR REVIEW	EA		
1	24DEC08	JU	ISSUED FOR REVIEW	SD	JU	JCC

DRAWING NO. | REFERENCES

PROJECT
AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE
BAY-GOOSE DIKE BOREHOLE LOCATION PLAN

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_B_02	
DESIGN	JU	04JUL08	SCALE	AS SHOWN	REV. B
CADD	EA	05DEC08	4200-02		
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REVIEW					

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REVISION DATE: 09/01/30 11:12AM By: EAbella

BAY-GOOSE CUTOFF WALL CENTRELINE SETOUT			
POINT ID	CHAINAGE	EASTING	NORTHING
BG-CL-01	30+000.00	639216.22	7213256.30
BG-CL-02	30+141.62	639210.10	7213114.81
BG-CL-03	30+274.60	639139.62	7213002.05
BG-CL-04	30+565.52	638913.33	7212819.21
BG-CL-05	30+853.47	638979.42	7212538.95
BG-CL-06	30+983.17	638968.81	7212409.69
BG-CL-07	31+098.03	638920.89	7212305.30
BG-CL-08	31+170.66	638938.07	7212234.73
BG-CL-09	31+341.03	638883.55	7212073.32
BG-CL-10	31+433.09	638823.36	7212003.66
BG-CL-11	31+518.01	638764.29	7211942.65
BG-CL-12	31+584.12	638716.72	7211896.75
BG-CL-13	31,659.32	638641.57	7211899.70
BG-CL-14	31+727.23	638559.49	7211940.09
BG-CL-15	32+024.66	638399.62	7212156.33
BG-CL-16	32+264.36	638215.69	7212310.97

NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3) GRID REFERENCE: NAD 83, UTM ZONE 14.
4) CONTOUR INFORMATION ON LAND SUPPLIED BY AGNICO-EAGLE MINES LIMITED (AEM), MEADOWBANK DIVISION.
5) LAKEBED SURFACE BASED ON BATHYMETRIC AND SEISMIC SURVEYS BY GOLDER ASSOCIATES LTD., 2006. DETAILED BATHYMETRY (0.5M CONTOUR INTERVAL) BASED ON 2008 SURVEY.
6) LAKE CONTOURS ARE BASED ON SURVEYED LAKE SURFACE ELEVATIONS; THIRD PORTAGE LAKE = 134.1m (2008)
7) DIKE ALIGNMENT TO BE REVIEWED FOLLOWING 2009 GEOTECHNICAL INVESTIGATION.

LEGEND:

- BG-CL-12 — BAY-GOOSE CENTRELINE SETOUT POINT
- SHORELINE
- DIKE FOOTPRINT
- 70m PIT OFFSET FROM PIT RIM
- PIT RIM
- MINOR BATHYMETRY CONTOUR
- MAJOR BATHYMETRY CONTOUR
- MINOR TOPOGRAPHIC CONTOUR
- MAJOR TOPOGRAPHIC CONTOUR

REFERENCE:

1) PORTAGE PIT DESIGN BY AEM, NOVEMBER, 2008.
2) GOOSE ISLAND PIT DESIGN BY AEM, NOVEMBER, 2008.
3) ROAD AND MINE FACILITIES PROVIDED BY AEM, OCTOBER, 2008.

SCALE IN METRES (1:4000)

REDUCED DRAWING NOT TO SCALE

NOT FOR CONSTRUCTION

STAMP: ORIGINAL SIGNED

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	02FEB09	JU	ISSUED FOR REVIEW	EA		
A	24DEC08	JU	ISSUED FOR REVIEW	EA	JU	JCC

DRAWING NO. | REFERENCES

PROJECT: AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE: **BAY-GOOSE DIKE CUTOFF WALL CENTRELINE SETOUT PLAN**

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_B_03	
DESIGN	JU	04JUL08	SCALE	AS SHOWN	REV. B
CADD	EA	05DEC08			
CHECK			4200-03		
REVIEW					

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By: jkownacki
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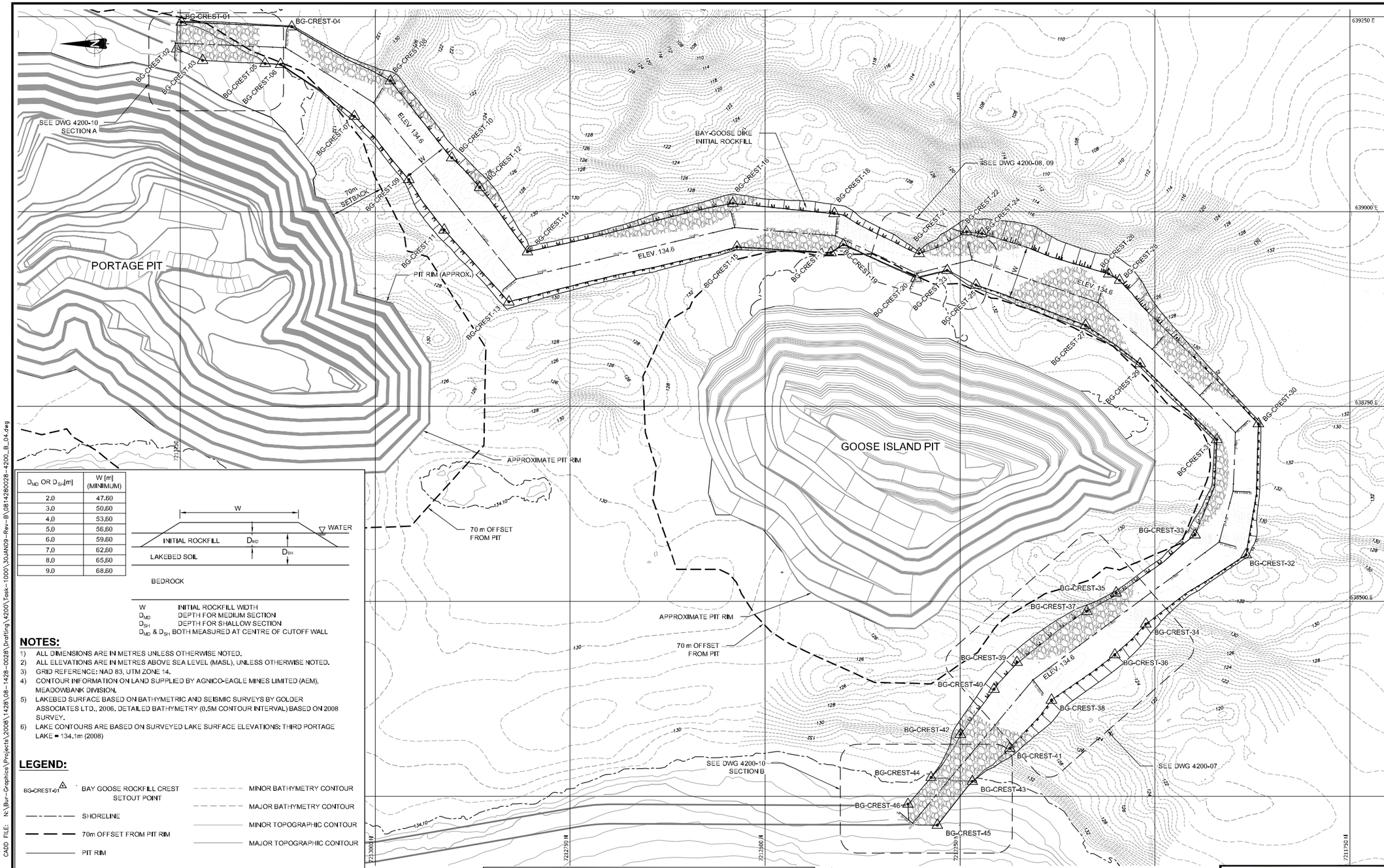

POINT ID	EASTING	NORTHING	ELEV
BG-CREST-01	639243.02	7213248.45	134.60
BG-CREST-02	639208.79	7213254.81	134.60
BG-CREST-03	639193.89	7213221.39	134.60
BG-CREST-04	639236.89	7213106.96	134.60
BG-CREST-05	639189.78	7213141.08	134.60
BG-CREST-06	639188.84	7213121.37	134.60
BG-CREST-07	639122.14	7213026.61	134.60
BG-CREST-08	639167.52	7212980.51	134.60
BG-CREST-09	639041.06	7212956.85	134.60
BG-CREST-10	639069.03	7212901.75	134.60
BG-CREST-11	638976.49	7212911.48	134.60
BG-CREST-12	639031.05	7212866.00	134.60
BG-CREST-13	638884.28	7212828.55	134.60
BG-CREST-14	638948.41	7212804.76	134.60
BG-CREST-15	638954.62	7212536.13	134.60
BG-CREST-16	639010.54	7212541.30	134.60
BG-CREST-17	638947.30	7212415.60	134.60
BG-CREST-18	638997.62	7212411.35	134.60
BG-CREST-19	638957.47	7212399.62	134.60
BG-CREST-20	638914.63	7212306.46	134.60
BG-CREST-21	638946.23	7212302.50	134.60
BG-CREST-22	638974.02	7212241.63	134.60
BG-CREST-23	638924.51	7212266.50	134.60
BG-CREST-24	638971.80	7212221.95	134.60
BG-CREST-25	638905.83	7212229.50	134.60
BG-CREST-26	638920.08	7212059.43	134.60
BG-CREST-27	638854.01	7212088.98	134.60
BG-CREST-28	638911.81	7212045.50	134.60
BG-CREST-29	638804.87	7212019.10	134.60
BG-CREST-30	638727.79	7211867.40	134.60
BG-CREST-31	638707.56	7211920.67	134.60
BG-CREST-32	638559.77	7211883.27	134.60
BG-CREST-33	638585.27	7211948.64	134.60
BG-CREST-34	638470.94	7212011.74	134.60
BG-CREST-35	638511.04	7212049.79	134.60
BG-CREST-36	638431.76	7212051.51	134.60
BG-CREST-37	638487.40	7212087.38	134.60
BG-CREST-38	638373.59	7212132.77	134.60
BG-CREST-39	638422.00	7212176.98	134.60
BG-CREST-40	638387.50	7212206.46	134.60
BG-CREST-41	638311.56	7212186.28	134.60
BG-CREST-42	638329.41	7212249.53	134.60
BG-CREST-43	638269.34	7212234.19	134.60
BG-CREST-44	638274.32	7212287.16	134.60
BG-CREST-45	638213.18	7212279.13	134.60
BG-CREST-46	638240.09	7212316.76	134.60

D_{MD} OR D_{SH} [m]	W [m] (MINIMUM)
2.0	47.60
3.0	50.60
4.0	53.60
5.0	56.60
6.0	59.60
7.0	62.60
8.0	65.60
9.0	68.60

W INITIAL ROCKFILL WIDTH
D_{MD} DEPTH FOR MEDIUM SECTION
D_{SH} DEPTH FOR SHALLOW SECTION
D_{MD} & D_{SH} BOTH MEASURED AT CENTRE OF CUTOFF WALL

NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3) GRID REFERENCE: NAD 83, UTM ZONE 14.
4) CONTOUR INFORMATION ON LAND SUPPLIED BY AGNICO-EAGLE MINES LIMITED (AEM), MEADOWBANK DIVISION.
5) LAKEBED SURFACE BASED ON BATHYMETRIC AND SEISMIC SURVEYS BY GOLDER ASSOCIATES LTD., 2006. DETAILED BATHYMETRY (0.5M CONTOUR INTERVAL) BASED ON 2008 SURVEY.
6) LAKE CONTOURS ARE BASED ON SURVEYED LAKE SURFACE ELEVATIONS: THIRD PORTAGE LAKE = 134.1m (2008)

LEGEND:

BG-CREST-01 BAY GOOSE ROCKFILL CREST SETOUT POINT
SHORELINE
70m OFFSET FROM PIT RIM
PIT RIM
MINOR BATHYMETRY CONTOUR
MAJOR BATHYMETRY CONTOUR
MINOR TOPOGRAPHIC CONTOUR
MAJOR TOPOGRAPHIC CONTOUR

REFERENCE:

1) PORTAGE PIT DESIGN BY AEM, NOVEMBER, 2008.
2) GOOSE ISLAND PIT DESIGN BY AEM, NOVEMBER, 2008.
3) ROAD AND MINE FACILITIES PROVIDED BY AEM, OCTOBER, 2008.

REDUCED DRAWING
NOT TO SCALE

0 25 50 75 100 125
SCALE IN METRES (1:2,500)

PROJECT
AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

NOT FOR CONSTRUCTION

STAMP
ORIGINAL SIGNED

TITLE
BAY-GOOSE DIKE INITIAL ROCKFILL LAYOUT PLAN

REVISION DATE:	By: jkownacki	CADD FILE: N:\Bur-Graphics\Projects\2008\1428\08-1428-0028\Drafting\4200\Task-1000\30JAN09-Rev-B\0814280028-4200_B_04.dwg
09/02/03 11:57AM		

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	02FEB09	JU	ISSUED FOR REVIEW	SD		
A	24DEC08	JU	ISSUED FOR REVIEW	SD	JU	JCC

DRAWING NO.	REFERENCES
4200-06	TYPICAL MATERIAL PLACEMENT SECTIONS
4200-05	TYPICAL MATERIAL PLACEMENT PLAN

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_B_04	
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CADD	EA	05DEC08	4200-04		
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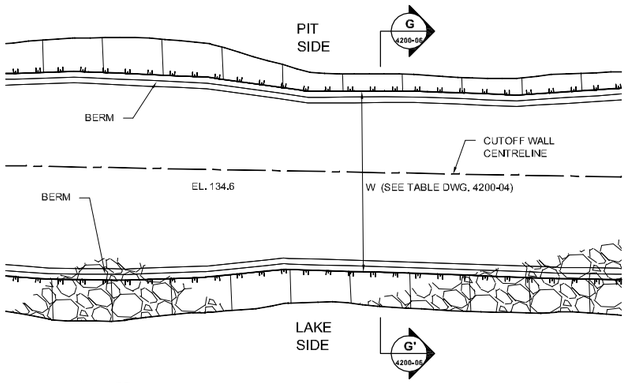
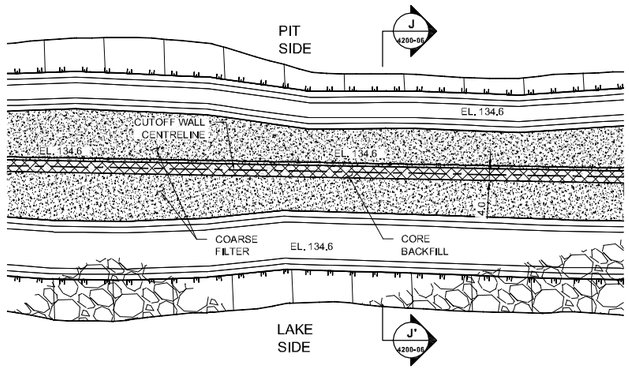
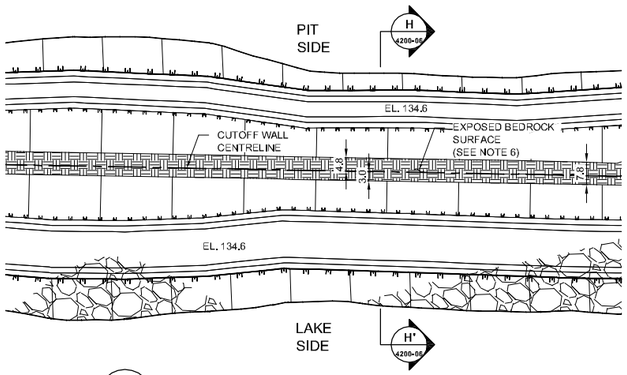
REVIEW					



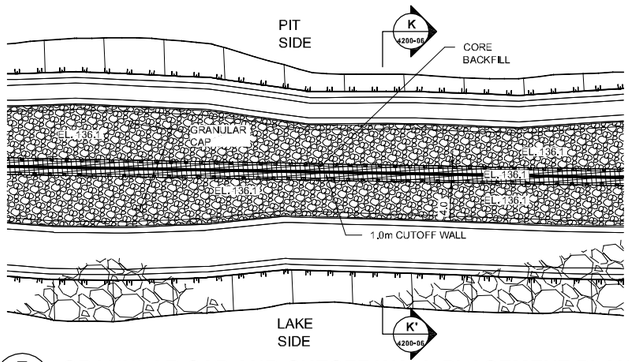
A 4200-04 **INITIAL ROCKFILL PLACEMENT PLAN**



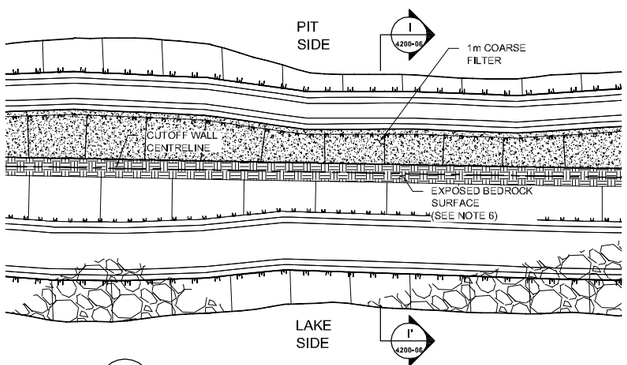
D 4200-04 **CORE BACKFILL AND COARSE FILTER PLACEMENT PLAN**



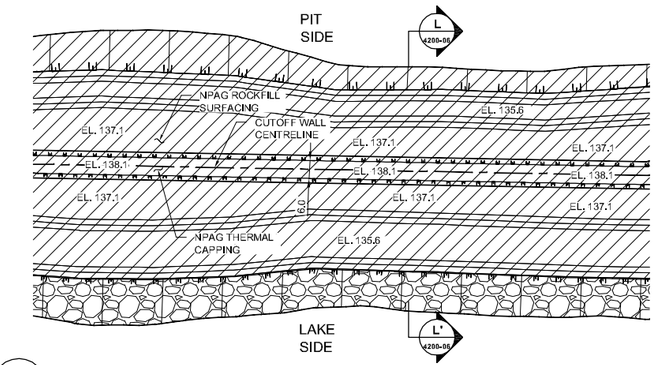
B 4200-04 **EXCAVATION TO BEDROCK PLAN**



E 4200-04 **GRANULAR CAP AND CUTOFF WALL PLACEMENT PLAN**



C 4200-04 **COARSE FILTER PLACEMENT PLAN**



F 4200-04 **ROCKFILL SURFACING AND THERMAL CAP PLACEMENT PLAN**

NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3) LAKE CONTOURS ARE BASED ON SURVEYED LAKE SURFACE ELEVATIONS: THIRD PORTAGE LAKE = 134.1m (2008)
4) ROCKFILL SURFACING TO BE PLACED BY AEM. SURFACING ON DOWNSTREAM SLOPE TO BE PLACED FOLLOWING DEWATERING.
5) GEOCHEMICAL CLASSIFICATION OF NPAG MATERIALS IS THE RESPONSIBILITY OF AEM.
6) BEDROCK OR APPROVED DENSE COMPETENT SURFACE.
7) TYPICAL SHALLOW WATER SECTION APPLIES BETWEEN STA. 30+000 & 31+850.

LEGEND:

- BEDROCK
- COARSE FILTER
- CORE BACKFILL
- GRANULAR CAP
- NPAG ROCKFILL SURFACING AND THERMAL CAP
- ROCKFILL
- CUTOFF WALL

0 10 20 30 40 50
SCALE IN METRES (1:1,000)

REDUCED DRAWING
NOT TO SCALE

DRAWING NO.	REFERENCES
4200-04	INITIAL ROCKFILL LAYOUT PLAN
4200-06	TYPICAL MATERIAL PLACEMENT SECTIONS

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	02FEB09	JU	ISSUED FOR REVIEW	SD		
A	24DEC08	JU	ISSUED FOR REVIEW	SD	JU	JCC

NOT FOR CONSTRUCTION

STAMP

ORIGINAL SIGNED

PROJECT

AEM

AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

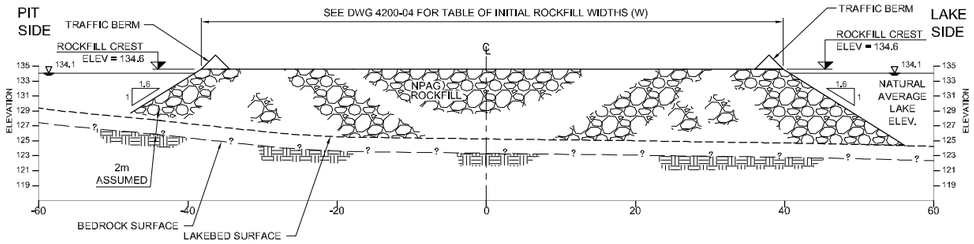
TITLE

BAY-GOOSE DIKE
TYPICAL MATERIAL PLACEMENT PLAN

Golder Associates

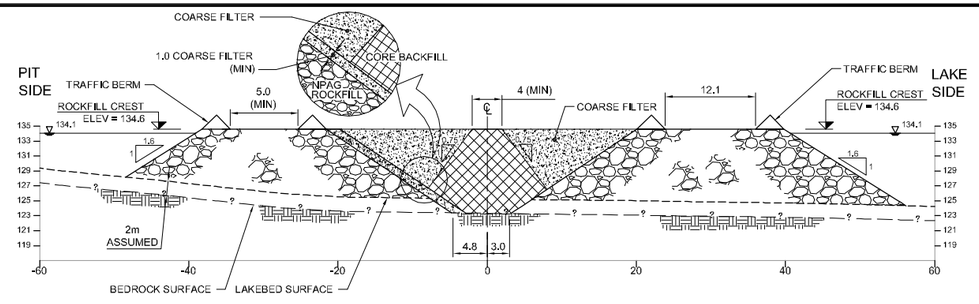
PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_B_05	
DESIGN	JU	04JUL08	SCALE	AS SHOWN	REV. B
CADD	EA	05DEC08	4200-05		
CHECK					
REVIEW					

REVISION DATE:: 09/02/03 08:59AM By: jkownacki CADD FILE: N:\Bur~Graphics\Projects\2008\1428\08~1428~0028\Drafting\4200\Task~1000\30JAN09~Rev~B\0814280028~4200_B_05.dwg



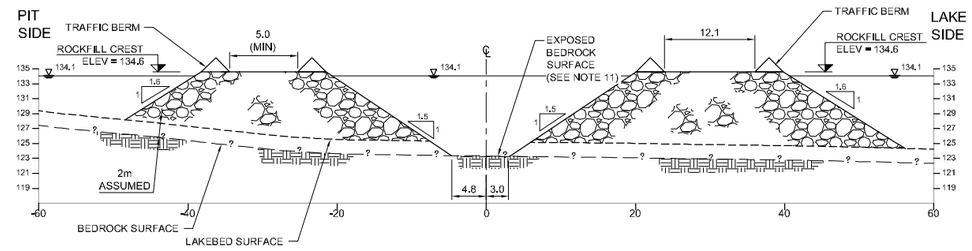
G-G' 4200-05 INITIAL ROCKFILL PLACEMENT SECTION

SCALE IN METRES (1:400)



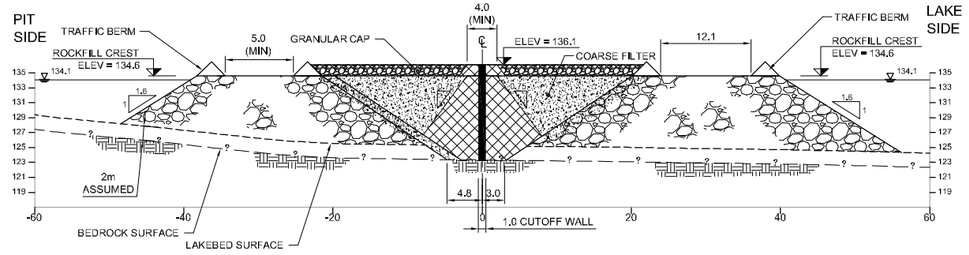
J-J' 4200-05 CORE BACKFILL AND COARSE FILTER PLACEMENT SECTION

SCALE IN METRES (1:400)



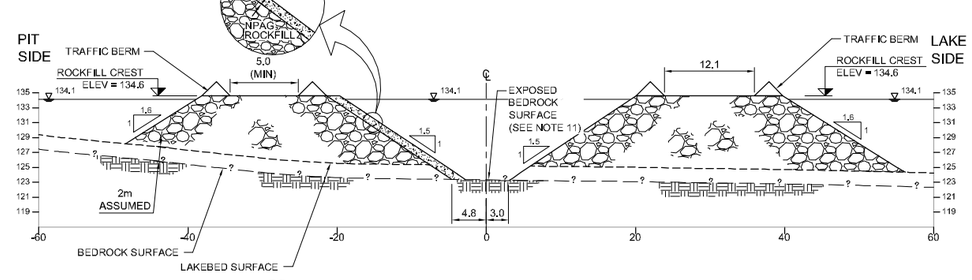
H-H' 4200-05 EXCAVATION TO BEDROCK SECTION

SCALE IN METRES (1:400)



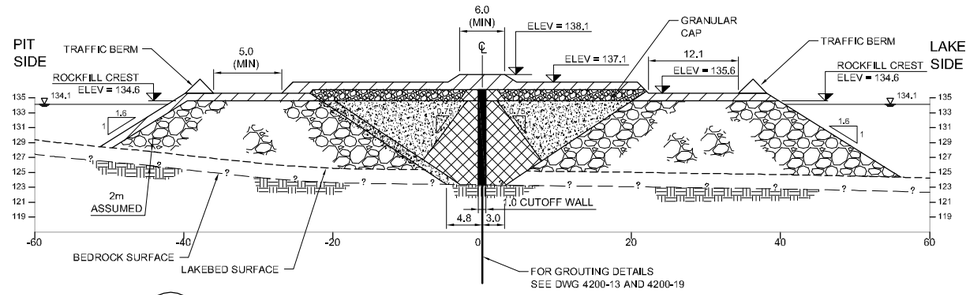
K-K' 4200-05 GRANULAR CAP AND CUTOFF WALL PLACEMENT SECTION

SCALE IN METRES (1:400)



I-I' 4200-05 COARSE FILTER PLACEMENT SECTION

SCALE IN METRES (1:400)



L-L' 4200-05 ROCKFILL SURFACING AND THERMAL CAP PLACEMENT SECTION

SCALE IN METRES (1:400)

NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3) LAKEBED SURFACE BASED ON BATHYMETRIC AND SEISMIC SURVEYS BY GOLDER ASSOCIATES LTD., 2006 AND 2008. DEPTH TO LAKEBED AND BEDROCK AT EXCAVATION CENTRELINE ASSUMED BASED ON APRIL/MAY 2008 AND 2003 INVESTIGATIONS. ADDITIONAL INVESTIGATION TO BE CONDUCTED IN 2009.
4) USE OF COARSE FILTER AGAINST PIT SIDE FACE OF EXCAVATION IS REQUIRED, UNLESS APPROVED IN WRITING BY THE ENGINEER.
5) ALL SLOPES SHOWN ARE NOMINAL VALUES.
6) ADDITIONAL ROCKFILL MAY BE REQUIRED TO MAINTAIN HAUL ROAD MINIMUM WIDTH.
7) WIDTH OF ROCKFILL TO BE ADJUSTED IN FIELD TO SUIT CONDITIONS. ADDITIONAL WIDTH MAY BE REQUIRED TO PROVIDE STABLE UPSTREAM EXCAVATION SLOPE.
8) ROCKFILL SURFACING TO BE PLACED BY AEM. SURFACING ON DOWNSTREAM SLOPE TO BE PLACED FOLLOWING DEWATERING.
9) NPAG ROCK PLACED AS 1m SURFACING TO BE ULTRAMAFIC VOLCANIC (UM) ROCKFILL.
10) GEOCHEMICAL CLASSIFICATION OF NPAG MATERIALS IS THE RESPONSIBILITY OF AEM.
11) BEDROCK OR APPROVED DENSE COMPETENT SURFACE.

LEGEND:

- BEDROCK
- COARSE FILTER
- CORE BACKFILL
- GRANULAR CAP
- NPAG ROCKFILL SURFACING AND THERMAL CAP
- ROCKFILL
- CUTOFF WALL

REDUCED DRAWING
NOT TO SCALE

REVISION DATE:	REFERENCES	DRAWING NO.
09/02/03 09:01AM	INITIAL ROCKFILL LAYOUT PLAN	4200-04
By: jkownacki	TYPICAL MATERIAL PLACEMENT PLAN	4200-05

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	02FEB09	JU	ISSUED FOR REVIEW	EA		
B	24DEC08	JU	ISSUED FOR REVIEW	EA	JU	JCC

NOT FOR CONSTRUCTION

STAMP: **ORIGINAL SIGNED**

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PROJECT: AEM
AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE
BAY-GOOSE DIKE TYPICAL MATERIAL PLACEMENT SECTIONS

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_B_06	
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CADD	AS	03DEC08			
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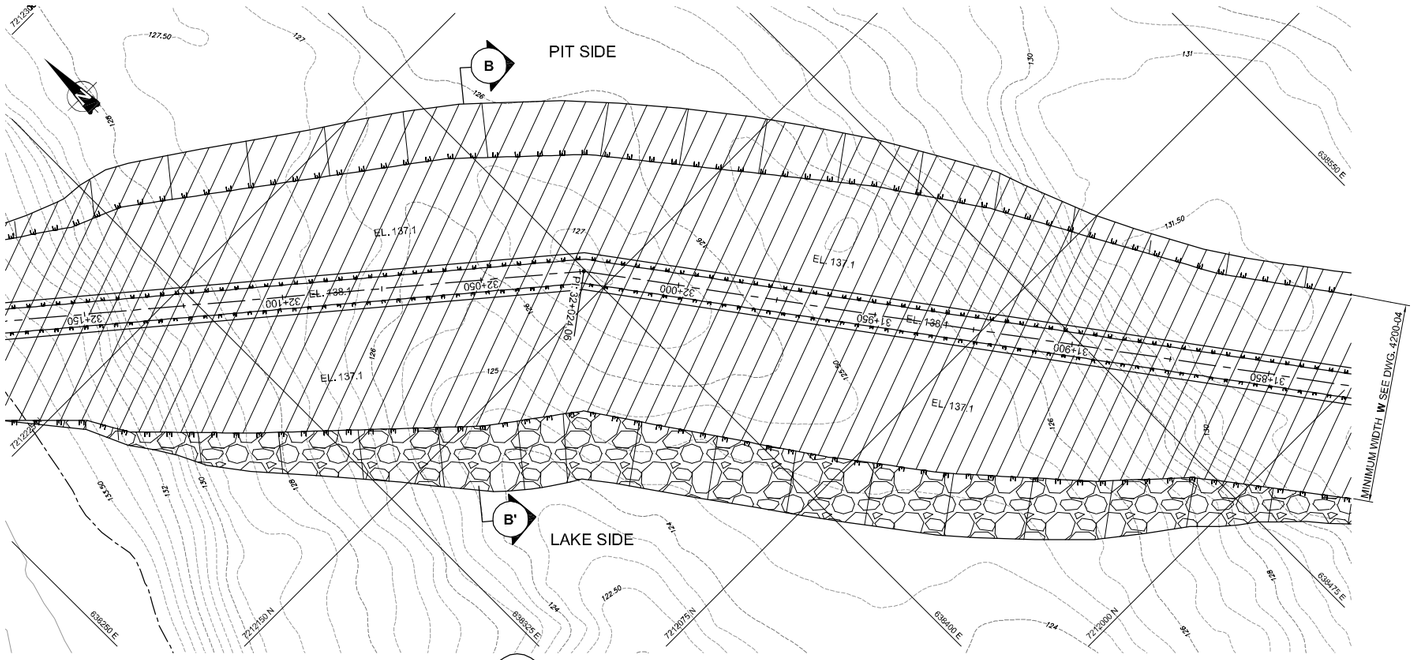
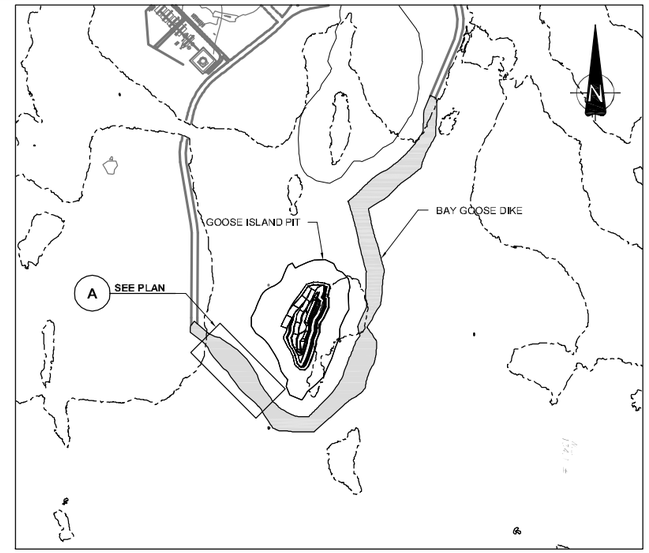
REVIEW					

4200-06



A **MEDIUM DEPTH TYPICAL PLAN**

0 7.5 15 22.5 30 37.5
SCALE IN METRES (1:750)



KEY PLAN
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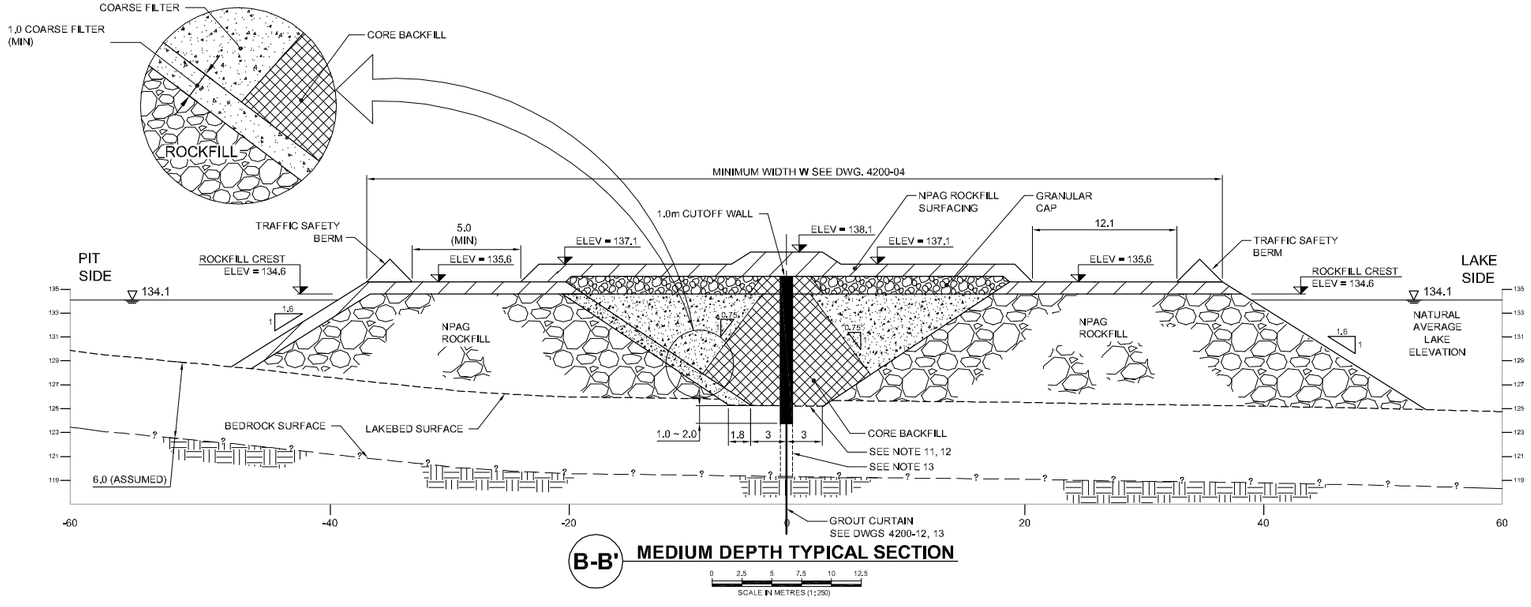

B-B' **MEDIUM DEPTH TYPICAL SECTION**

0 2.5 5 7.5 10 12.5
SCALE IN METRES (1:250)

LEGEND:

- COARSE FILTER
- ROCKFILL SURFACING
- INITIAL ROCKFILL
- GRANULAR CAP
- CORE BACKFILL
- SHORELINE
- MINOR BATHYMETRY CONTOUR
- MAJOR BATHYMETRY CONTOUR
- MINOR TOPOGRAPHIC CONTOUR
- MAJOR TOPOGRAPHIC CONTOUR

NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3) GRID REFERENCE: NAD 83, UTM ZONE 14.
4) LAKEBED SURFACE BASED ON BATHYMETRIC AND SEISMIC SURVEYS BY GOLDER ASSOCIATES LTD., 2006 AND 2008. DEPTH TO LAKEBED AND BEDROCK AT EXCAVATION CENTRELINE ASSUMED BASED ON APRIL/MAY 2008 AND 2003 INVESTIGATIONS. ADDITIONAL INVESTIGATION TO BE CONDUCTED IN 2009.
5) ROCKFILL SURFACING TO BE PLACED BY AEM. SURFACING ON DOWNSTREAM SLOPE TO BE PLACED FOLLOWING DEWATERING. SURFACING TO BE ULTRAMAFIC VOLCANIC (UM) ROCKFILL.
6) GEOCHEMICAL CLASSIFICATION OF NPAG MATERIALS IS THE RESPONSIBILITY OF AEM.
7) USE OF COARSE FILTER AGAINST PIT SIDE FACE OF EXCAVATION IS REQUIRED, UNLESS APPROVED IN WRITING BY THE ENGINEER.
8) ALL SLOPES SHOWN ARE NOMINAL VALUES.
9) ADDITIONAL ROCKFILL MAY BE REQUIRED TO MAINTAIN HAUL ROAD MINIMUM WIDTH.
10) WIDTH OF ROCKFILL TO BE ADJUSTED IN FIELD TO SUIT CONDITIONS, ADDITIONAL WIDTH MAY BE REQUIRED TO PROVIDE STABLE UPSTREAM EXCAVATION SLOPE.
11) CORE BACKFILL AND COARSE FILTER TO BE FOUNDED ON COMPETENT LAKEBED SOILS.
12) FOR THE CONCEPTUAL MEDIUM DEPTH OPTION SHOWN WITH THE CUTOFF WALL FOUNDED IN COMPETENT LAKEBED SOILS, A POTENTIAL FOR HIGH LOCALIZED SEEPAGE GRADIENTS EXISTS AND CHANGES TO THIS SECTION MAY BE REQUIRED, TO BE CONFIRMED FOLLOWING THE 2009 GEOTECHNICAL INVESTIGATIONS.
13) EXCAVATE AND EXTEND CUTOFF WALL UNTIL REFUSAL ENCOUNTERED.

REDUCED DRAWING
NOT TO SCALE

PROJECT
AEM
AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE
BAY-GOOSE DIKE
TYPICAL CONCEPTUAL MEDIUM DEPTH PLAN AND SECTION

REVISION	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	02FEB09	JU	ISSUED FOR REVIEW	EA		
A	24DEC08	JU	ISSUED FOR REVIEW	EA	JU	JCC

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ORIGINAL SIGNED

NOT FOR CONSTRUCTION

4200-04 — DRAWING NO.
INITIAL ROCKFILL LAYOUT PLAN — REFERENCES

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_B_07	
DESIGN	JU	04JUL08	SCALE	AS SHOWN	REV. B
CADD	EA	03DEC08			
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REVIEW					

4200-07

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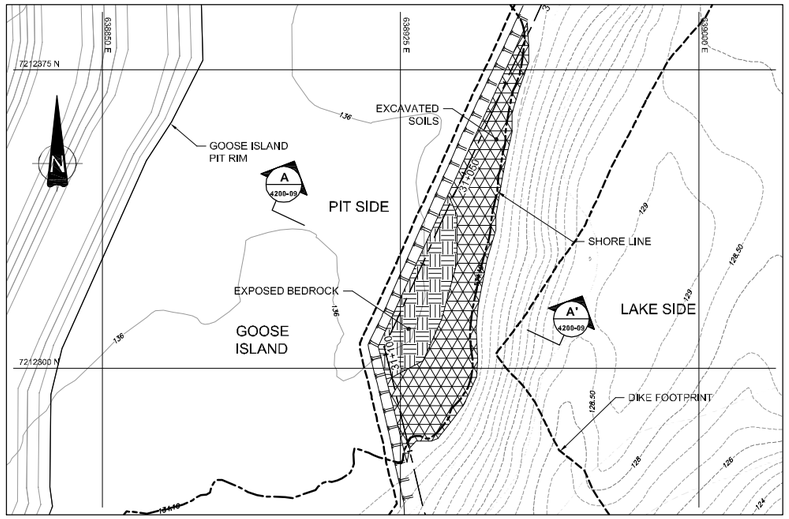
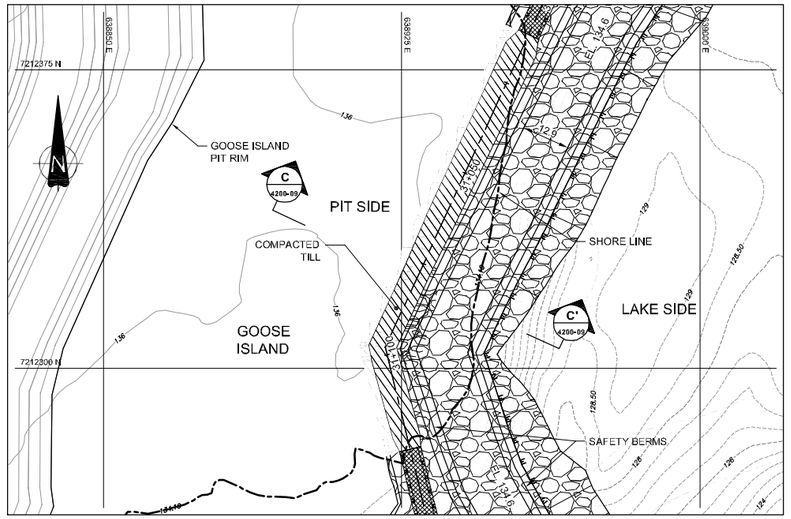
By: jkownacki
REVISION DATE: 09/02/03 12:40PM



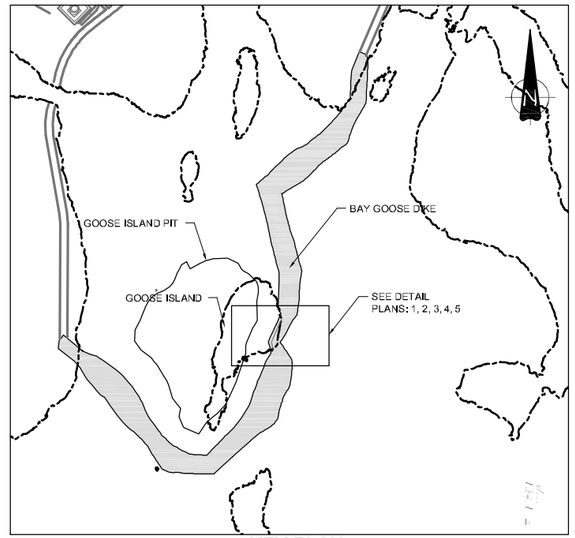
1 EXCAVATION PLAN

SCALE IN METRES (1:750)



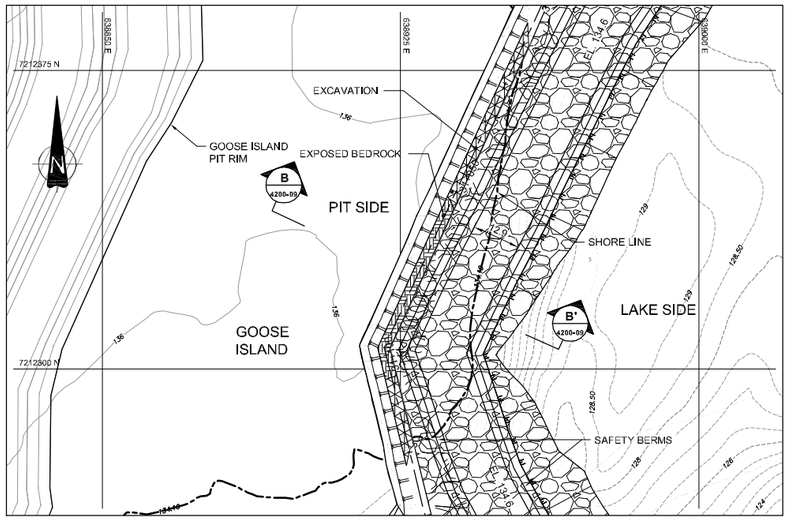
3 COMPACTED TILL PLACEMENT PLAN

SCALE IN METRES (1:750)



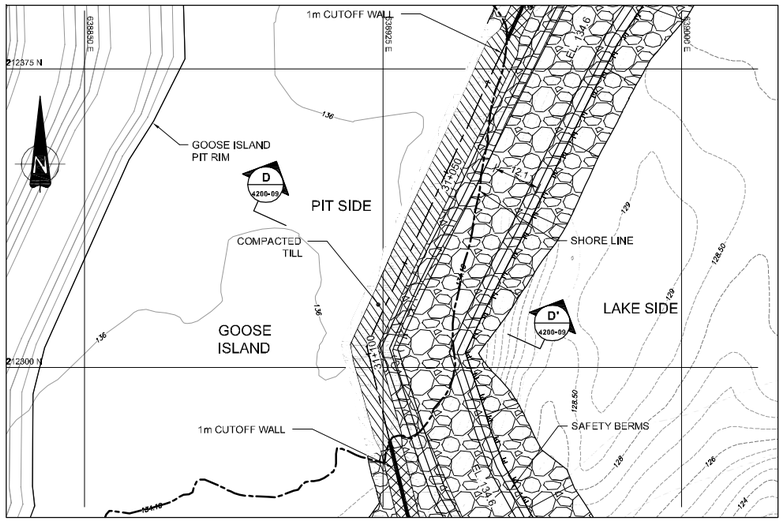
KEY PLAN

NOT TO SCALE



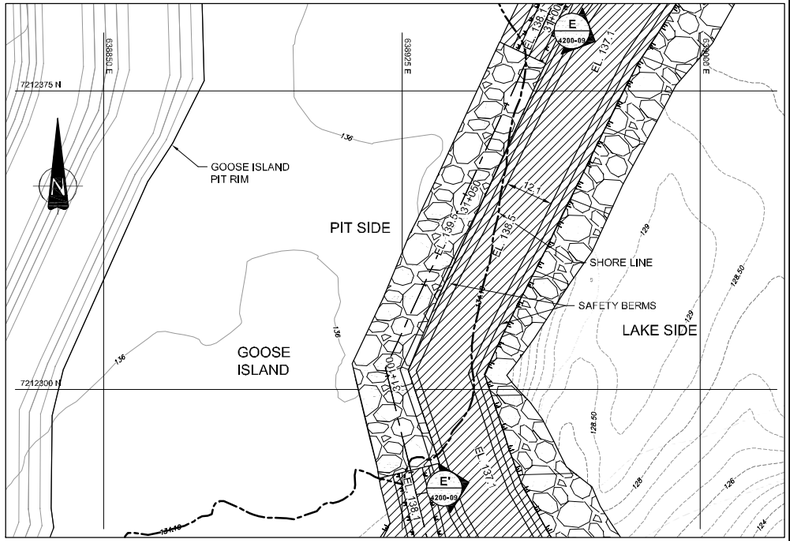
2 INITIAL ROCKFILL PLACEMENT PLAN

SCALE IN METRES (1:750)



4 TIE IN TO CUTOFF WALL

SCALE IN METRES (1:750)



5 ROCKFILL SURFACING PLACEMENT PLAN

SCALE IN METRES (1:750)

NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3) GRID REFERENCE: NAD 83, UTM ZONE 14.
4) LAKEBED SURFACE BASED ON BATHYMETRIC AND SEISMIC SURVEYS BY GOLDER ASSOCIATES LTD., 2006 AND 2008. DEPTH TO LAKEBED AND BEDROCK AT EXCAVATION CENTRELINE ASSUMED BASED ON APRIL/MAY 2008 INVESTIGATION.
5) ROCKFILL SURFACING TO BE PLACED BY AEM. SURFACING ON DOWNSTREAM SLOPE TO BE PLACED FOLLOWING DEWATERING.
6) USE OF COARSE FILTER AGAINST PIT SIDE FACE OF EXCAVATION IS REQUIRED, UNLESS APPROVED IN WRITING BY THE ENGINEER.
7) ALL SLOPES SHOWN ARE NOMINAL VALUES.
8) ADDITIONAL ROCKFILL MAY BE REQUIRED TO MAINTAIN HAUL ROAD MINIMUM WIDTH.
9) WIDTH OF ROCKFILL TO BE ADJUSTED IN FIELD TO SUIT CONDITIONS. ADDITIONAL WIDTH MAY BE REQUIRED TO PROVIDE STABLE UPSTREAM EXCAVATION SLOPE.
10) NPAG ROCK PLACED AS 1m SURFACING TO BE ULTRAMAFIC VOLCANIC (UM) ROCKFILL.
11) GEOCHEMICAL CLASSIFICATION OF NPAG MATERIALS IS THE RESPONSIBILITY OF AEM.
12) CUTOFF WALL FOUNDED ON PERMAFROST OR BEDROCK, WITH EXTENT OF PERMAFROST AT ABUTMENTS TO BE CONFIRMED WITH THERMISTORS.

LEGEND:

- BEDROCK
- CORE BACKFILL
- NPAG ROCKFILL SURFACING
- ROCKFILL
- CUTOFF WALL
- COMPACTED TILL
- EXCAVATION TO COMPETENT SOILS

REFERENCE:

1) PORTAGE PIT DESIGN BY AEM, NOVEMBER, 2008.
2) GOOSE ISLAND PIT DESIGN BY AEM, NOVEMBER, 2008.
3) ROAD AND MINE FACILITIES PROVIDED BY AEM, OCTOBER, 2008.

REDUCED DRAWING
NOT TO SCALE

DRAWING NO.	REFERENCES
4200-09	GOOSE ISLAND ABUTMENT SECTIONS
4200-04	INITIAL ROCKFILL LAYOUT PLAN

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
2	02FEB09	JU	ISSUED FOR REVIEW	EA		
1	24DEC08	JU	ISSUED FOR REVIEW	EA	JU	JCC

NOT FOR CONSTRUCTION

STAMP

ORIGINAL SIGNED

PROJECT

AEM

AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE

BAY-GOOSE DIKE
GOOSE ISLAND ABUTMENT DETAILS

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_B_08	
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CADD	SWD	03DEC08	4200-08		
CHECK					
REVIEW					

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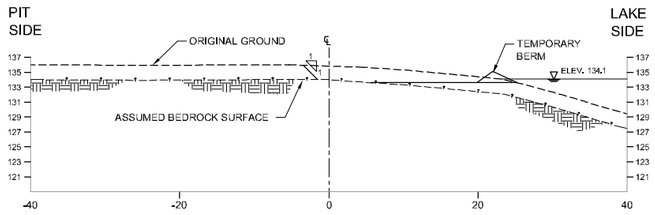
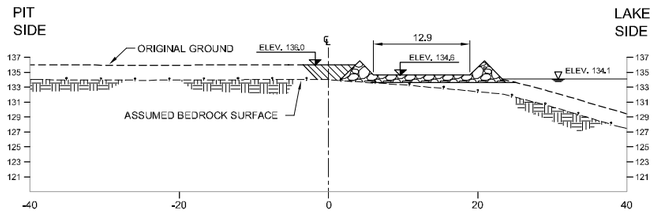
By: jkownacki
REVISION DATE: 09/02/03 01:20PM



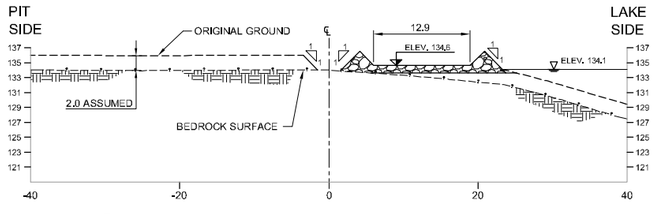
A 4200-08 EXCAVATION SECTION

SCALE IN METRES



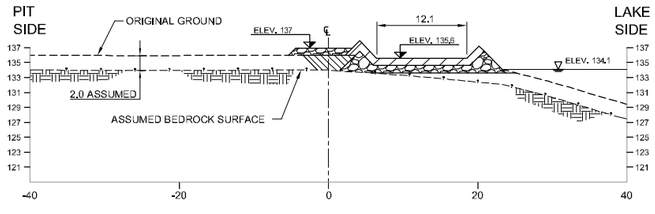
C 4200-08 COMPACTED TILL PLACEMENT SECTION

SCALE IN METRES



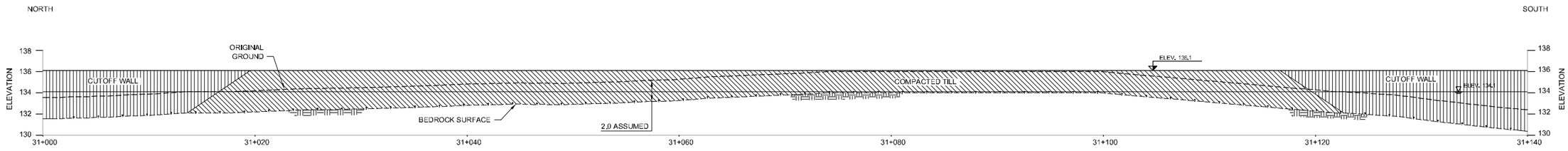
B 4200-08 INITIAL ROCKFILL PLACEMENT SECTION

SCALE IN METRES



D 4200-08 ROCKFILL SURFACING PLACEMENT SECTION

SCALE IN METRES



E 4200-08 ISLAND ABUTMENT PROFILE

SCALE IN METRES

NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3) LAKEBED SURFACE BASED ON BATHYMETRIC AND SEISMIC SURVEYS BY GOLDER ASSOCIATES LTD., 2006 AND 2008. DEPTH TO LAKEBED AND BEDROCK AT EXCAVATION CENTRELINE ASSUMED BASED ON APRIL/MAY 2008 AND 2003 INVESTIGATION. ADDITIONAL INVESTIGATION TO BE CONDUCTED IN 2009.
4) ROCKFILL SURFACING TO BE PLACED BY AEM.
5) NPAG ROCK PLACED AS 1m SURFACING TO BE ULTRAMAFIC VOLCANIC (UM) ROCKFILL.
6) GEOCHEMICAL CLASSIFICATION OF NPAG MATERIALS IS THE RESPONSIBILITY OF AEM.
7) ALL SLOPES SHOWN ARE NOMINAL VALUES.
8) ADDITIONAL ROCKFILL MAY BE REQUIRED TO MAINTAIN HAUL ROAD MINIMUM WIDTH.
9) WIDTH OF ROCKFILL TO BE ADJUSTED IN FIELD TO SUIT CONDITIONS. ADDITIONAL WIDTH MAY BE REQUIRED TO PROVIDE STABLE UPSTREAM EXCAVATION SLOPE.
10) REQUIREMENT FOR COARSE FILTER TO BE DETERMINED BY THE ENGINEER IN THE FIELD.
11) CUTOFF WALL TO BE EXTENDED 2m (MIN.) INTO COMPACTED TILL ALONG CENTRELINE, AT NORTH AND SOUTH END OF GOOSE ISLAND ABUTMENT.

LEGEND:

- BEDROCK
- GRANULAR CAP
- NPAG ROCKFILL SURFACING
- COMPACTED TILL
- ROCKFILL
- CUTOFF WALL

REDUCED DRAWING
NOT TO SCALE

PROJECT

AEM

AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE

BAY-GOOSE DIKE
GOOSE ISLAND ABUTMENT SECTIONS

NOT FOR CONSTRUCTION

STAMP

ORIGINAL SIGNED

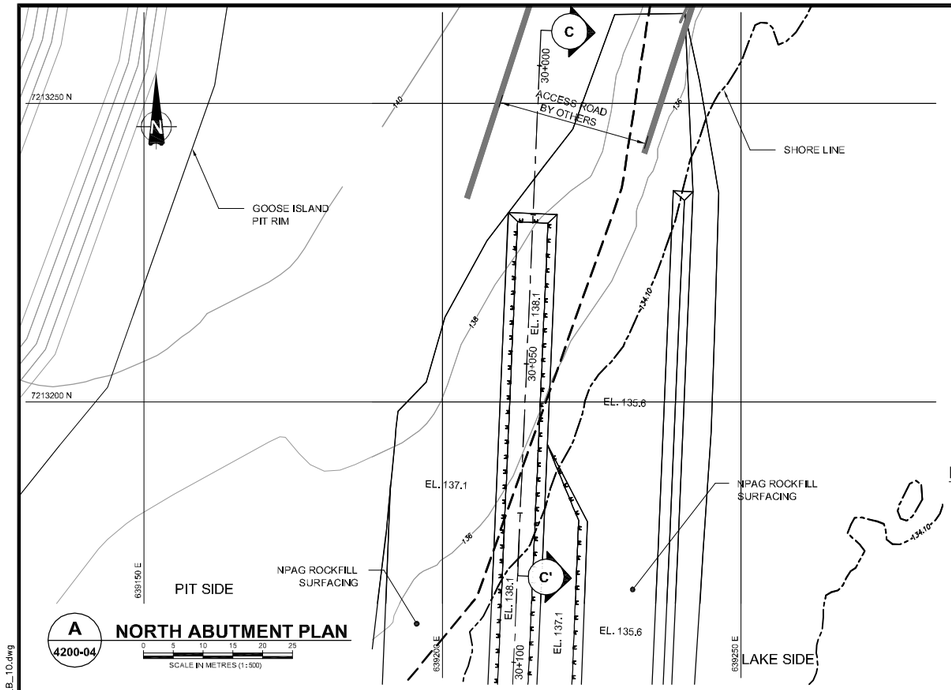
REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	02FEB09	JU	ISSUED FOR REVIEW	EA		

4200-08 — GOOSE ISLAND ABUTMENT DETAILS
DRAWING NO. — REFERENCES

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_A_09	
DESIGN	JU	03DEC08	SCALE	AS SHOWN	REV. A
CADD	SWD	03DEC08			
CHECK			4200-09		
REVIEW					

REVISION DATE: 09/02/03 01:24PM By: jkownacki CADD FILE: N:\Bur-Graphics\Projects\2008\1428\08-1428-0028\Drafting\4200\Task-1000\30JAN09-Rev-B\0814280028-4200_A_09.dwg

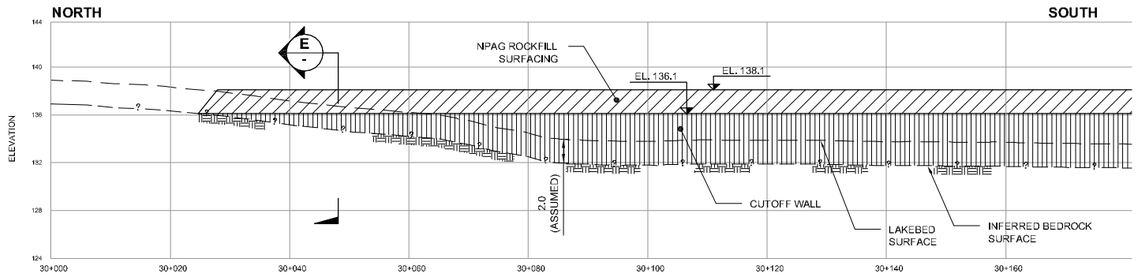


A 4200-04 **NORTH ABUTMENT PLAN**

SCALE IN METRES (1:500)

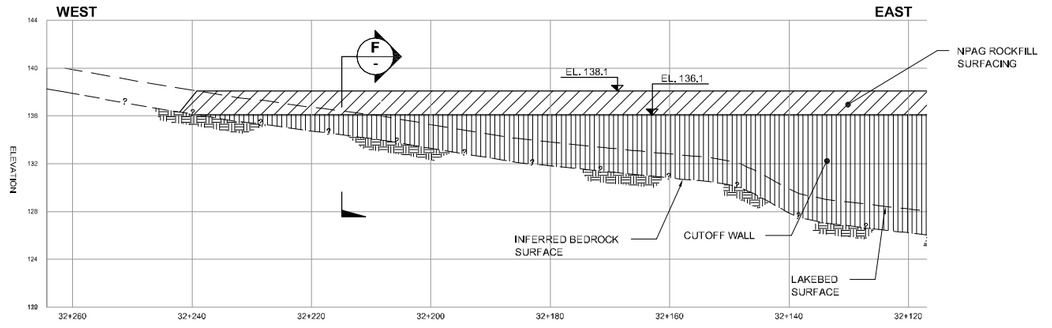
B 4200-04 **SOUTH ABUTMENT PLAN**

SCALE IN METRES (1:500)



C-C' **NORTH ABUTMENT PROFILE**

SCALE IN METRES (1:500)



D-D' **SOUTH ABUTMENT PROFILE**

SCALE IN METRES (1:500)

LEGEND:

- BEDROCK
- COARSE FILTER
- CORE BACKFILL
- GRANULAR CAP
- NPAG ROCKFILL SURFACING AND THERMAL CAP
- ROCKFILL
- CUTOFF WALL (SECTION)
- CUTOFF WALL (PROFILE)

NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3. LAKEBED SURFACE BASED ON BATHYMETRIC AND SEISMIC SURVEYS BY GOLDER ASSOCIATES LTD., 2006 AND 2008. DEPTH TO LAKEBED AND BEDROCK AT EXCAVATION CENTRELINE ASSUMED BASED ON APRIL/MAY 2008 AND 2003 INVESTIGATIONS. ADDITIONAL INVESTIGATION TO BE CONDUCTED IN 2009.
4. SURFACING TO BE PLACED BY AEM. SURFACING ON DOWNSTREAM SLOPE TO BE PLACED FOLLOWING DEWATERING .
5. NPAG ROCK PLACED AS 1m SURFACING TO BE ULTRAMAFIC VOLCANIC (UM) ROCKFILL.
6. GEOCHEMICAL CLASSIFICATION OF PAG AND NPAG MATERIALS IS THE RESPONSIBILITY OF AEM
7. USE OF COARSE FILTER AGAINST PIT SIDE FACE OF EXCAVATION IS REQUIRED, UNLESS APPROVED IN WRITING BY THE ENGINEER.
8. ALL SLOPES SHOWN ARE NOMINAL VALUES.
9. WIDTH OF ROCKFILL TO BE ADJUSTED IN FIELD TO SUIT CONDITIONS. ADDITIONAL WIDTH MAY BE REQUIRED TO PROVIDE STABLE UPSTREAM EXCAVATION SLOPE.
10. CUTOFF WALL FOUNDED ON PERMAFROST OR BEDROCK, WITH EXTENT OF PERMAFROST AT ABUTMENTS TO BE CONFIRMED WITH THERMISTORS.

REDUCED DRAWING
NOT TO SCALE

REVISION DATE:	DRAWING NO.	REFERENCES
09/02/02 08:03PM	4200-04	INITIAL ROCKFILL LAYOUT PLAN
By: jkownacki	4200-03	CUTOFF WALL CENTRELINE SETOUT PLAN

CADD FILE: N:\Bur-Graphics\Projects\2008\1428\08-1428-0028\Drafting\4200\Task-1000\30JAN09-Rev-B\08142800028-4200_B_10.dwg

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	02FEB09	JU	ISSUED FOR REVIEW	EA		
A	24DEC08	JU	ISSUED FOR REVIEW	EA	JU	JCC

NOT FOR CONSTRUCTION

STAMP: **ORIGINAL SIGNED**

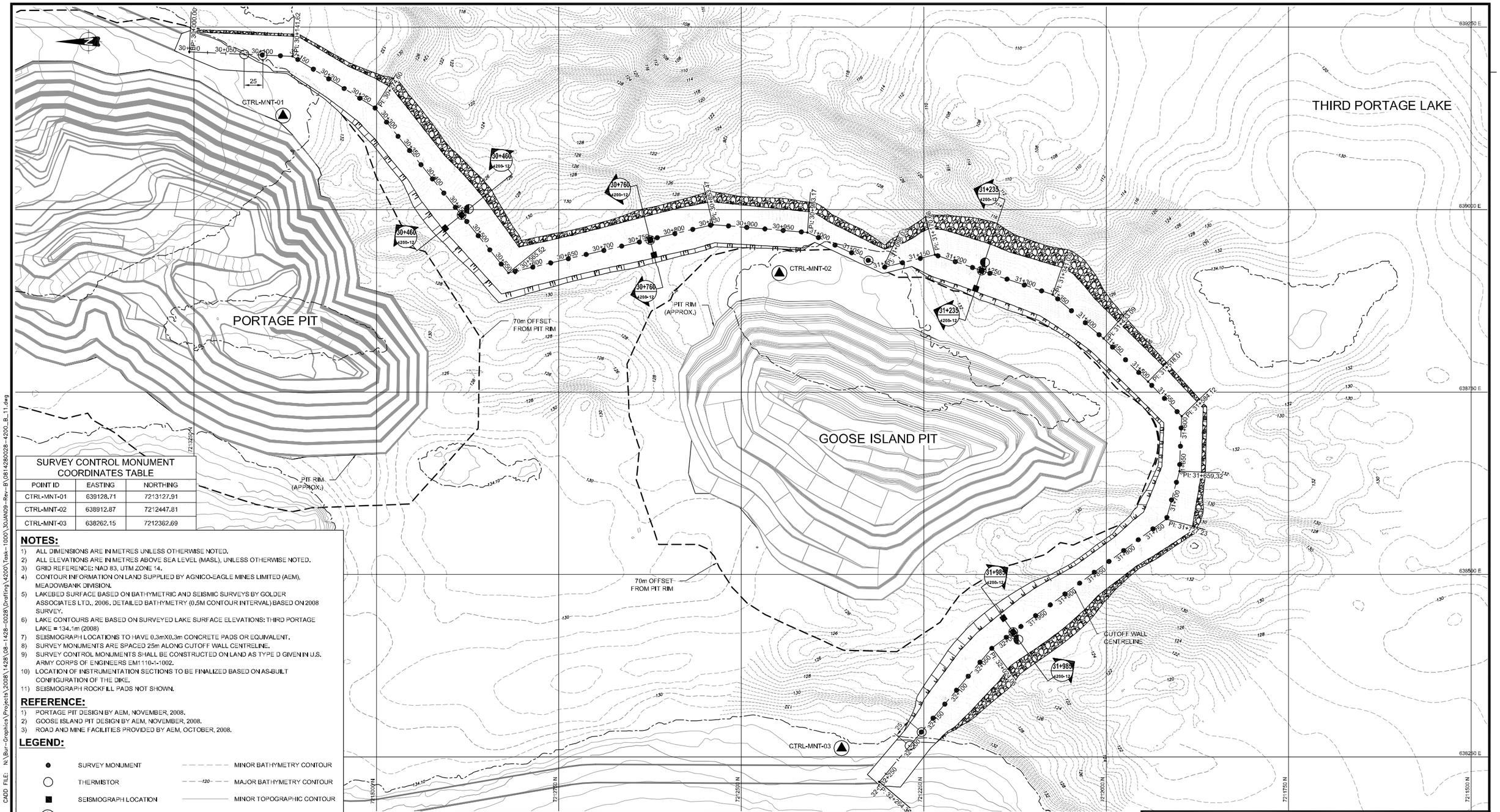
PROJECT: AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE: **BAY-GOOSE DIKE NORTH AND SOUTH ABUTMENT PLANS AND DETAILS**

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_B_10	
DESIGN	JU	04JUL08	SCALE	AS SHOWN	REV. B
CADD	MJH	04JUL08			
CHECK					
REVIEW					

4200-10



SURVEY CONTROL MONUMENT COORDINATES TABLE		
POINT ID	EASTING	NORTHING
CTRL-MNT-01	639128.71	7213127.91
CTRL-MNT-02	638912.87	7212447.81
CTRL-MNT-03	638262.15	7212362.69

NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3) GRID REFERENCE: NAD 83, UTM ZONE 14.
4) CONTOUR INFORMATION ON LAND SUPPLIED BY AGNICO-EAGLE MINES LIMITED (AEM), MEADOWBANK DIVISION.
5) LAKEBED SURFACE BASED ON BATHYMETRIC AND SEISMIC SURVEYS BY GOLDER ASSOCIATES LTD., 2006. DETAILED BATHYMETRY (0.5M CONTOUR INTERVAL) BASED ON 2008 SURVEY.
6) LAKE CONTOURS ARE BASED ON SURVEYED LAKE SURFACE ELEVATIONS: THIRD PORTAGE LAKE = 134.1m (2008)
7) SEISMOGRAPH LOCATIONS TO HAVE 0.3mX0.3m CONCRETE PADS OR EQUIVALENT.
8) SURVEY MONUMENTS ARE SPACED 25m ALONG CUTOFF WALL CENTRELINE.
9) SURVEY CONTROL MONUMENTS SHALL BE CONSTRUCTED ON LAND AS TYPE D GIVEN IN U.S. ARMY CORPS OF ENGINEERS EM1110-1-1002.
10) LOCATION OF INSTRUMENTATION SECTIONS TO BE FINALIZED BASED ON AS-BUILT CONFIGURATION OF THE DIKE.
11) SEISMOGRAPH ROCKFILL PADS NOT SHOWN.

REFERENCE:

1) PORTAGE PIT DESIGN BY AEM, NOVEMBER, 2008.
2) GOOSE ISLAND PIT DESIGN BY AEM, NOVEMBER, 2008.
3) ROAD AND MINE FACILITIES PROVIDED BY AEM, OCTOBER, 2008.

LEGEND:

- SURVEY MONUMENT
- THERMISTOR
- SEISMOGRAPH LOCATION
- SURVEY CONTROL MONUMENT
- INCLINOMETER
- SHORELINE
- MINOR BATHYMETRY CONTOUR
- MAJOR BATHYMETRY CONTOUR
- MINOR TOPOGRAPHIC CONTOUR
- MAJOR TOPOGRAPHIC CONTOUR
- 70M PIT OFFSET FROM PIT RIM
- PIT RIM

REDUCED DRAWING
NOT TO SCALE

0 25 50 75 100 125
SCALE IN METRES (1:2,500)

PROJECT

AEM

AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE

BAY-GOOSE DIKE INSTRUMENTATION PLAN

DRAWING NO.	REFERENCES
4200-13	INSTRUMENTATION AND GROUTING DETAILS
4200-12	INSTRUMENTATION SECTION AND GROUTING DETAILS

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	02FEB09	JU	ISSUED FOR REVIEW	EA		
A	25DEC08	JU	ISSUED FOR REVIEW	EA	JU	JCC

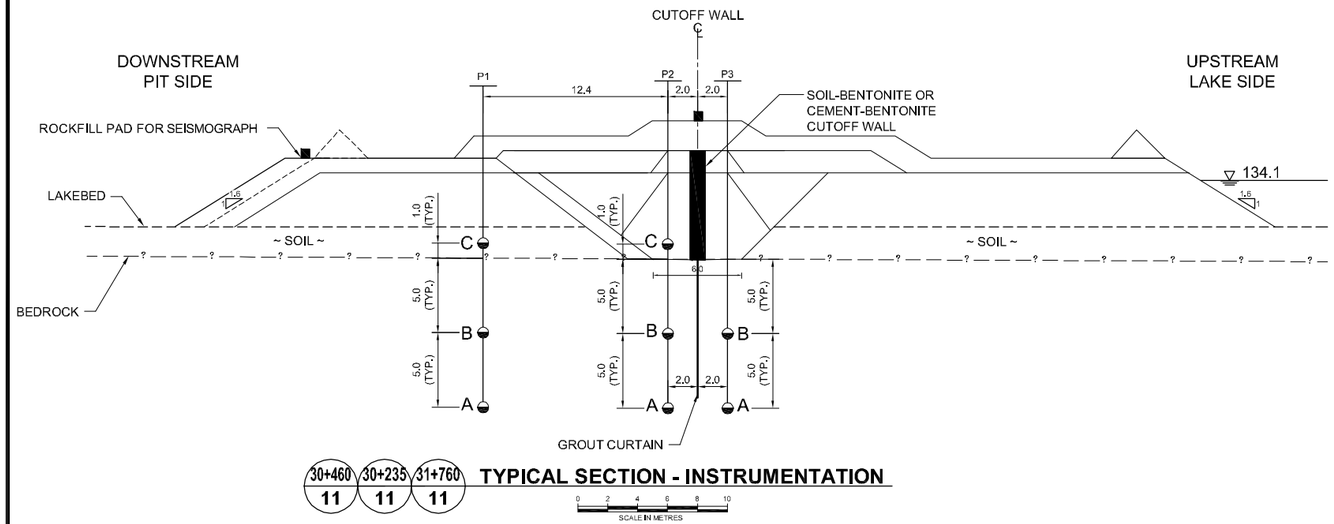
STAMP

ORIGINAL SIGNED

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_B_11	
DESIGN	JU	01DEC08	SCALE	AS SHOWN	REV. B
CADD	EA	05DEC08			
CHECK			4200-11		
REVIEW					

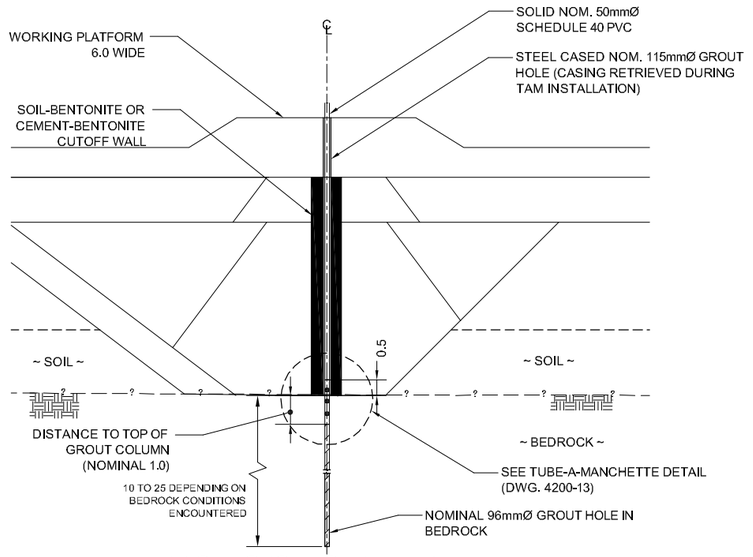
REVISION DATE: 09/01/30 05:10PM By: EAbello CADD FILE: N:\Burr-Graphics\Projects\2008\1428\08-1428-0028\Drafting\4200\Task-1000\30JAN09-Rev-B\0814280028-4200_B_11.dwg



30+460 11 | 30+235 11 | 31+760 11

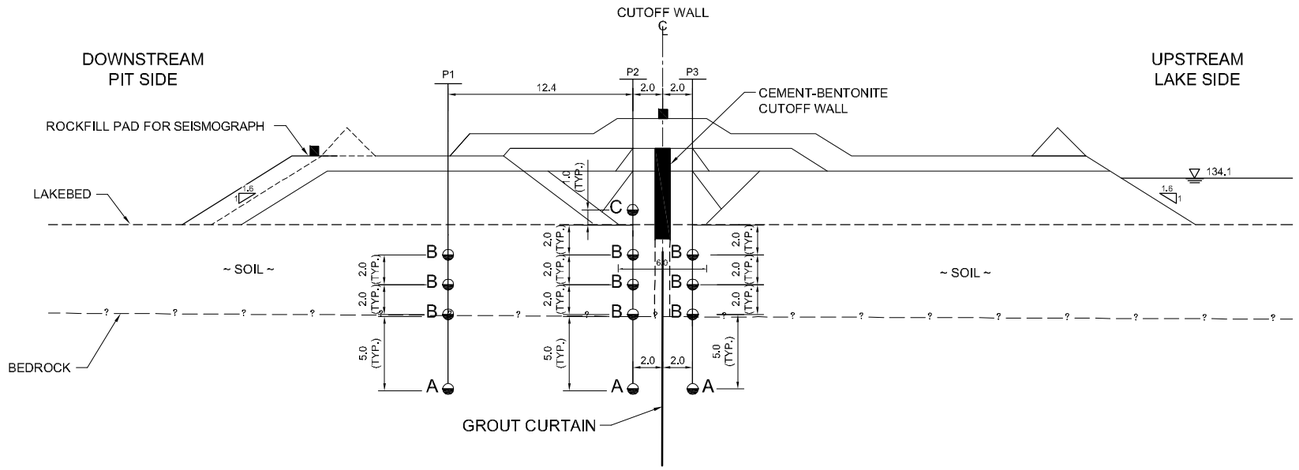
TYPICAL SECTION - INSTRUMENTATION

SCALE IN METRES



TYPICAL GROUT CURTAIN DETAIL

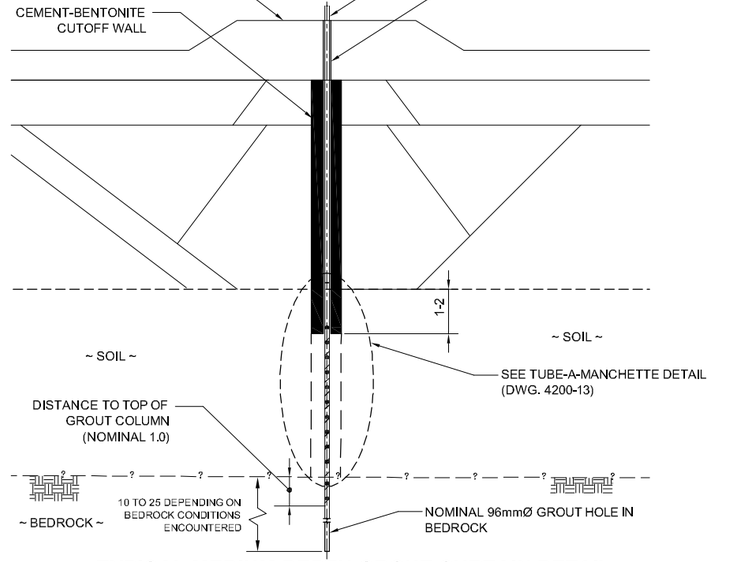
NOT TO SCALE



31+985 11

MEDIUM DEPTH SECTION - INSTRUMENTATION

SCALE IN METRES



TYPICAL MEDIUM DEPTH GROUT CURTAIN DETAIL

NOT TO SCALE

NOTES:

LOCATION OF INSTRUMENTATION SECTIONS TO BE FINALIZED BASED ON AS-BUILT CONFIGURATION OF THE DIKE

LEGEND:

- P1 PIEZOMETER.
- SEISMOGRAPH STATION

REDUCED DRAWING
NOT TO SCALE

DRAWING NO.	REFERENCES
4200-11	INSTRUMENTATION PLAN
4200-13	INSTRUMENTATION AND GROUTING DETAILS

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	02FEB09	JU	ISSUED FOR REVIEW	EA		
A	24DEC08	JU	ISSUED FOR REVIEW	EA	JU	JCC

NOT FOR CONSTRUCTION

STAMP

ORIGINAL SIGNED

PROJECT

AEM

AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

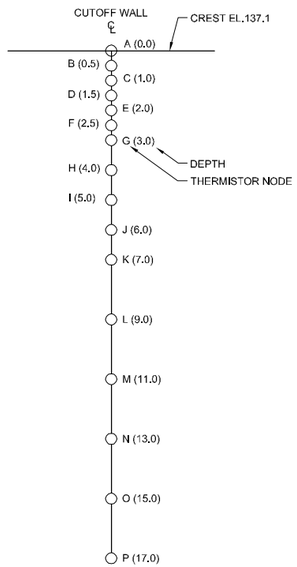
TITLE

BAY-GOOSE DIKE INSTRUMENTATION SECTION AND GROUTING DETAILS

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_B_12	
DESIGN	JU	01DEC08	SCALE	AS SHOWN	REV. B
CADD	EA	05DEC08	4200-12		
CHECK					
REVIEW					

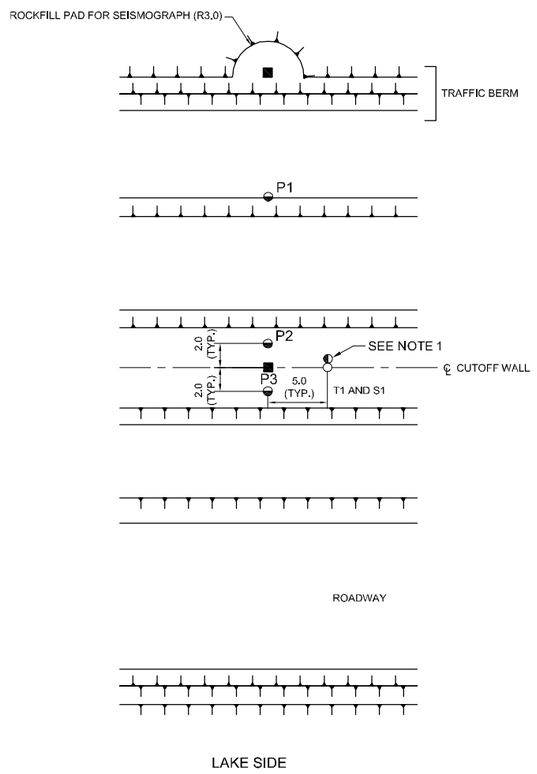
REVISION DATE: 09/02/03 09:19AM By: jkownacki CADD FILE: N:\Bur-Graphics\Projects\2008\1428\08-1428-0028\Drafting\4200\Task-1000\30JAN09-Rev-B\0814280028-4200_B_12.dwg



31+985 4200-12 | 30+460 4200-12 | 31+760 4200-12 | 30+235 4200-12

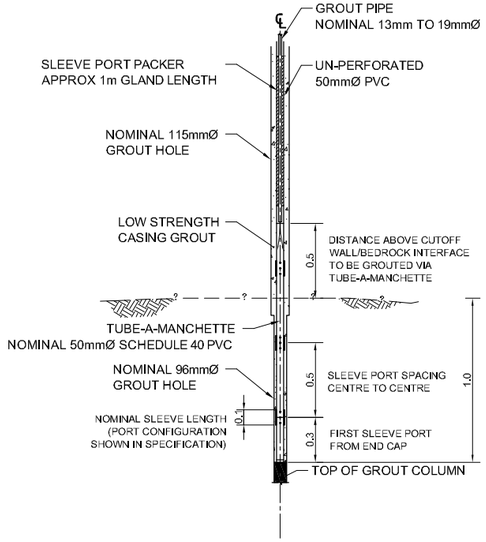
TYPICAL THERMISTOR SECTION

0 1 2 3 4 5
SCALE IN METRES



INSTRUMENTATION PLAN

NOT TO SCALE



TUBE-A-MANCHETTE DETAIL

NOT TO SCALE

LEGEND:

- ◒ P1 PIEZOMETER.
- ○ T1 THERMISTOR STRING
- ◐ S1 INCLINOMETER
- ■ SEISMOGRAPH STATION

NOTES:

1. INCLINOMETER TO BE INSTALLED ADJACENT TO THERMISTORS AND 5M INTO BEDROCK.

REDUCED DRAWING
NOT TO SCALE

DRAWING NO.	REFERENCES
4200-11	INSTRUMENTATION PLAN
4200-12	INSTRUMENTATION SECTION AND GROUTING DETAILS

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	02FEB09	JU	ISSUED FOR REVIEW	EA		

NOT FOR CONSTRUCTION

STAMP

ORIGINAL SIGNED

PROJECT

AEM

AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE

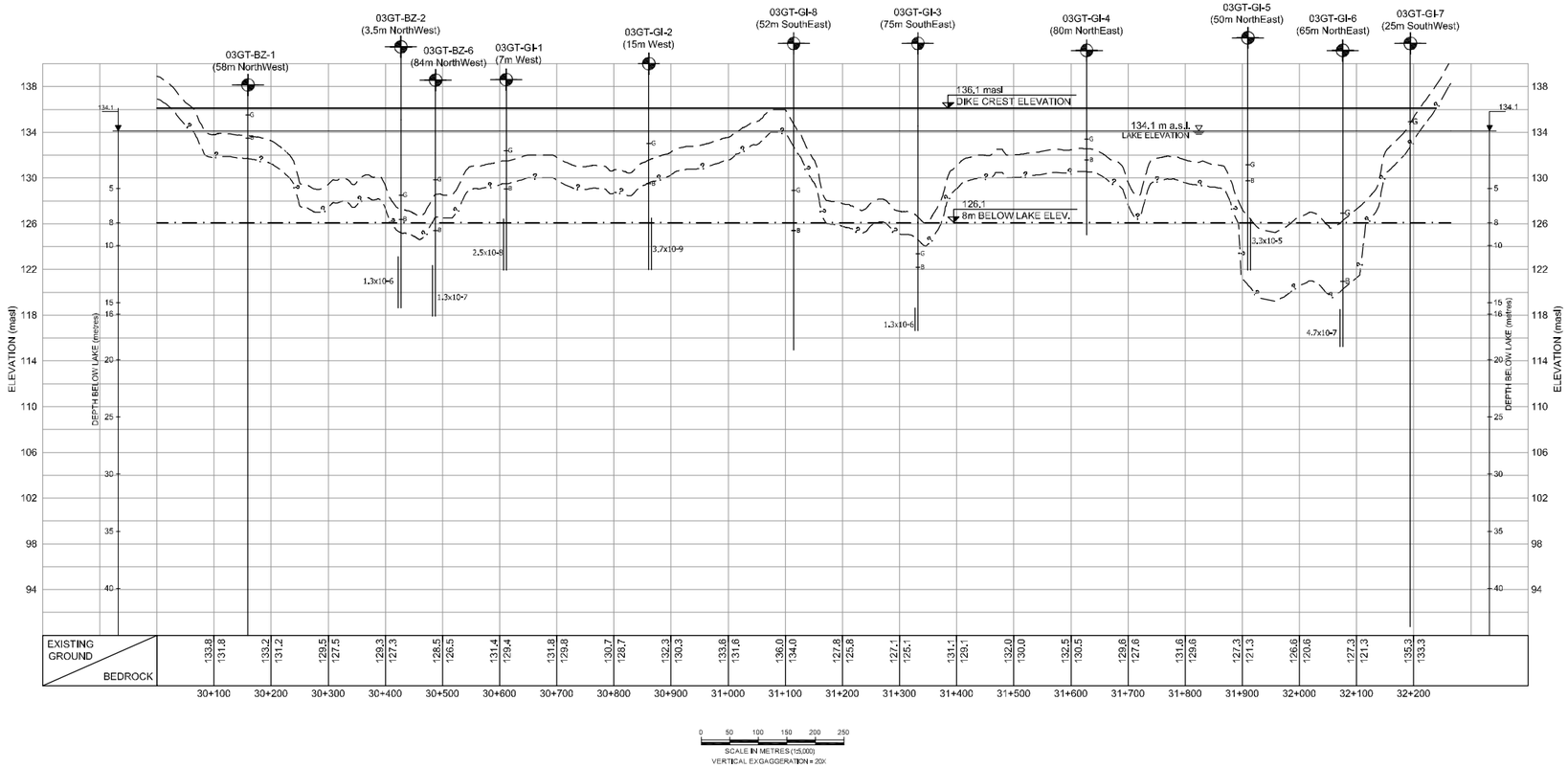
BAY-GOOSE DIKE INSTRUMENTATION AND GROUTING DETAILS

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_A_13	
DESIGN	JU	01DEC08	SCALE	AS SHOWN	REV. A
CADD	EA	05DEC08			
CHECK					
REVIEW					

4200-13

REVISION DATE: 09/02/03 08:43AM By: jkwanocki CADD FILE: N:\Bur--Graphics\Projects\2008\1428\08--1428--0028\Drafting\4200\Task--1000\30JAN09--Rev--B\0814280028--4200_A_13.dwg



LEGEND:

- $2x10^{-8}$ — HYDRAULIC CONDUCTIVITY TEST INTERVAL WITH RESULTS IN m/s
- 03GT-SE-2 (9m WEST) — BOREHOLE NAME (OFFSET TO DIKE CENTRELINE AND DIRECTION)
- EXISTING BOREHOLE (2003)
- B — BEDROCK
- G — GROUND OR LAKEBED SOILS
- LAKEBED SURFACE
- INFERRED CONTACT LAKEBED SOIL AND BEDROCK

NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3) CONTOUR INFORMATION ON LAND SUPPLIED BY AGNICO-EAGLE MINES LIMITED (AEM), MEADOWBANK DIVISION.
4) LAKEBED SURFACE BASED ON OCTOBER 2008 INVESTIGATION.
5) LAKE CONTOURS ARE BASED ON SURVEYED LAKE SURFACE ELEVATIONS; THIRD PORTAGE LAKE = 134.1m (2008)
6) CONDITIONS AWAY FROM BOREHOLES ARE ASSUMED AND SHOULD BE CONFIRMED BY THE CONTRACTOR IN THE FIELD.
7) INFERRED FOUNDATION CONDITIONS TO BE UPDATED FOLLOWING 2009 GEOTECHNICAL INVESTIGATION PROGRAM.

REDUCED DRAWING
NOT TO SCALE

PROJECT
AEM
AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE
BAY-GOOSE DIKE CUTOFF WALL PROFILE

REVISION	DATE	BY	REVISION DESCRIPTION	CADD	CHK	RVW
B	02FEB09	JU	ISSUED FOR REVIEW	EA		
A	24DEC08	JU	ISSUED FOR REVIEW	EA	JU	JCC

NOT FOR CONSTRUCTION

STAMP
ORIGINAL SIGNED

DRAWING NO.	REFERENCES
4200-02	BOREHOLE LOCATION PLAN
4200-01	SITE PLAN

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_B_18	
DESIGN	JU	04JUL08	SCALE	AS SHOWN	REV. B
CADD	EA	09DEC08			
CHECK					
REVIEW					

4200-18

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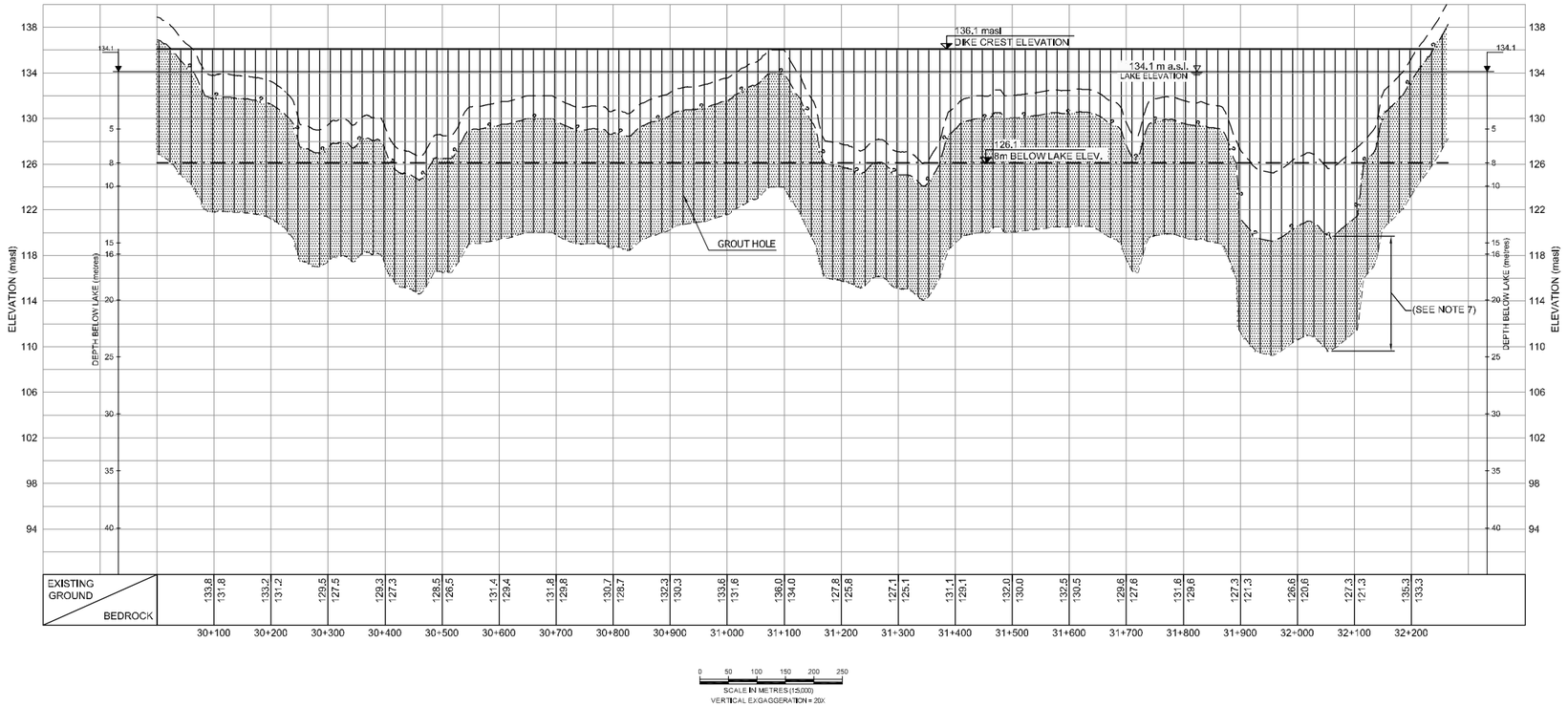
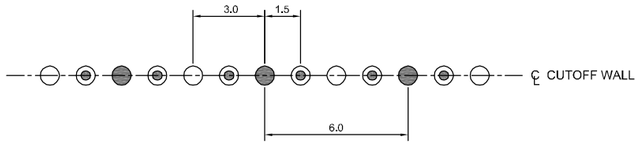




1 **GROUTING DETAIL**
NOT TO SCALE

LEGEND:

- PRIMARY HOLES (6.0 SPACING)
- SECONDARY HOLES (3.0 FROM PRIMARY HOLE)
- TERTIARY HOLES (1.5 FROM PRIMARY HOLE)
- LAKEBED SURFACE
- INFERRED CONTACT LAKEBED SOIL AND BEDROCK
- BEDROCK GROUTING

NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3) CONTOUR INFORMATION ON LAND SUPPLIED BY AGNICO-EAGLE MINES LIMITED (AEM), MEADOWBANK DIVISION.
4) LAKEBED SURFACE BASED ON OCTOBER 2008 INVESTIGATION.
5) LAKE CONTOURS ARE BASED ON SURVEYED LAKE SURFACE ELEVATIONS: THIRD PORTAGE LAKE = 134.1m (2008)
6) INFERRED FOUNDATION CONDITIONS TO BE UPDATED FOLLOWING 2009 GEOTECHNICAL INVESTIGATION PROGRAM.
7) BEDROCK GROUTING 10 TO 25m DEPENDING ON BEDROCK CONDITIONS ENCOUNTERED.
8) FOR GROUTING PROCEDURES SEE SPECIFICATION S7.

REDUCED DRAWING
NOT TO SCALE

NOT FOR CONSTRUCTION

ORIGINAL SIGNED

STAMP

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	02FEB09	JU	ISSUED FOR REVIEW	EA		

DRAWING NO.	REFERENCES
4200-01	SITE PLAN
4200-02	BOREHOLE LOCATION PLAN

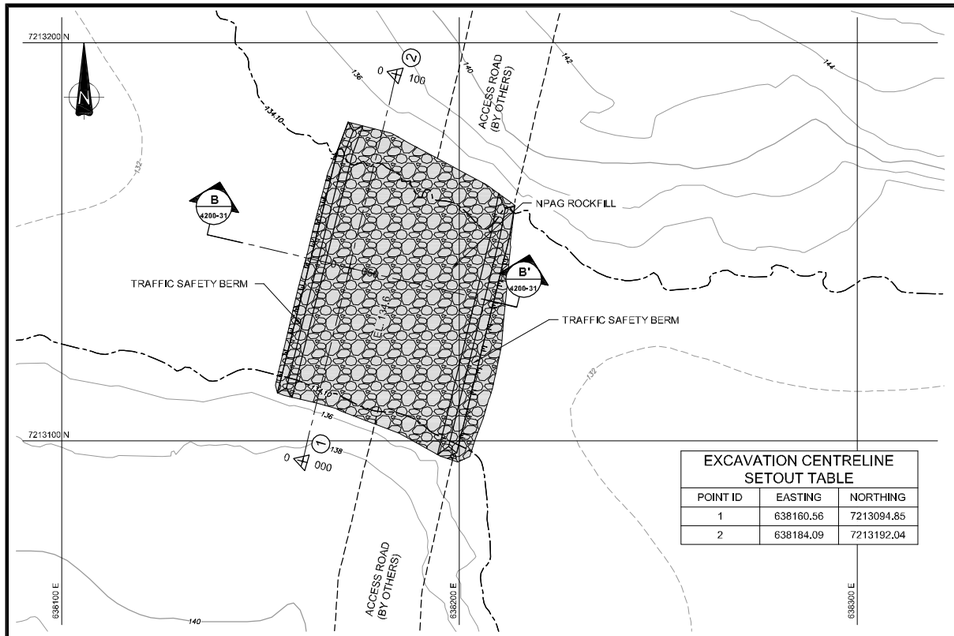
PROJECT: AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE: **BAY-GOOSE DIKE GROUTING PROFILE**

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_A_19	
DESIGN	JU	04JUL08	SCALE	AS SHOWN	REV. A
CADD	EA	09DEC08			
CHECK			4200-19		
REVIEW					

REVISION DATE: 09/02/03 09:48AM By: jkownacki CADD FILE: N:\Bur~Graphics\Projects\2008\1428\08~1428~0028\Drafting\4200\Task~1000\30JAN09~Rev~B\0814280028~4200_A_19.dwg



ROCKFILL PLACEMENT PLAN

SCALE IN METRES (1:750)

EXCAVATION CENTRELINE SETOUT TABLE		
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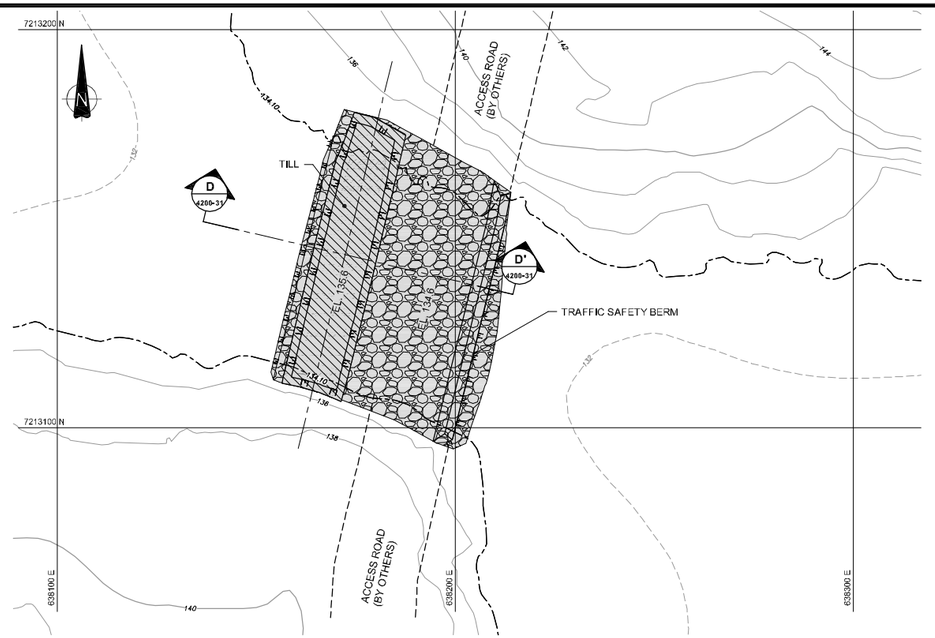
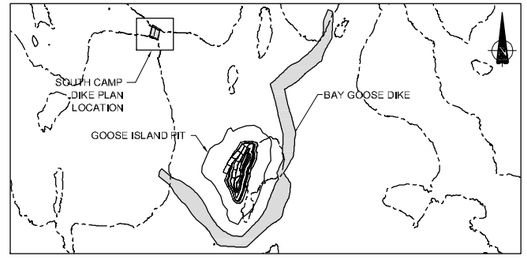
2	638184.09	7213192.04



TILL PLACEMENT PLAN

SCALE IN METRES (1:750)



KEY PLAN

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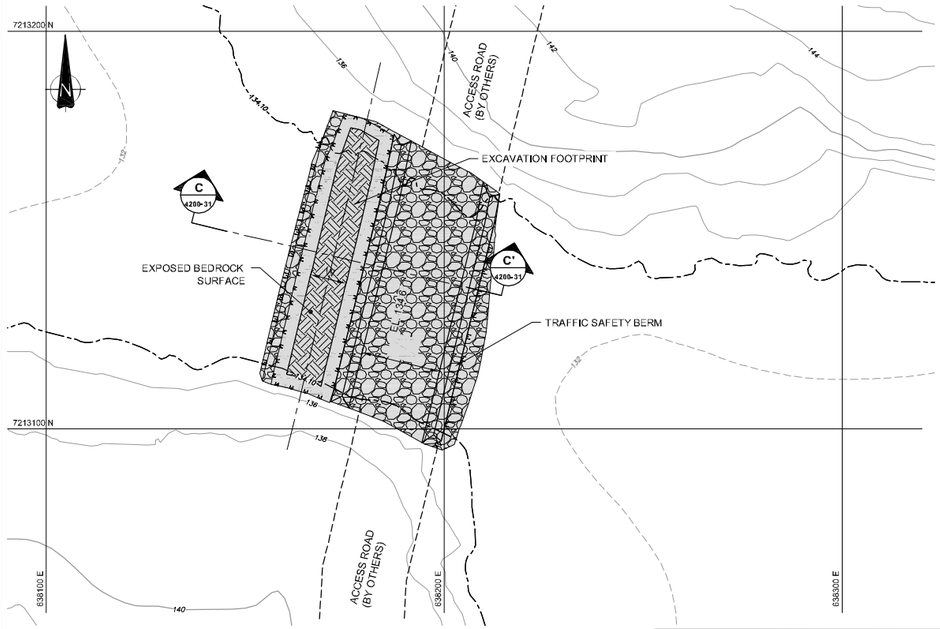
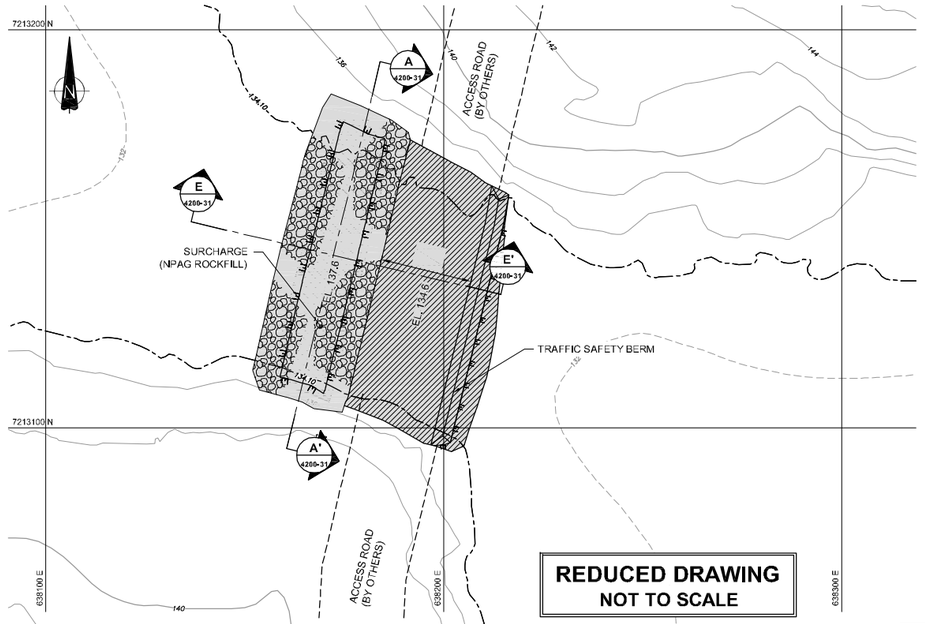


EXCAVATION PLAN

SCALE IN METRES (1:750)



SURCHARGE PLACEMENT PLAN

SCALE IN METRES (1:750)

REDUCED DRAWING
NOT TO SCALE

NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3) CONTOUR INFORMATION ON LAND SUPPLIED BY AGNICO-EAGLE MINES LIMITED (AEM), MEADOWBANK DIVISION.
4) LAKEBED SURFACE BASED ON BATHYMETRIC AND SEISMIC SURVEYS BY GOLDER ASSOCIATES LTD., 2006. DETAILED BATHYMETRY (0.5M CONTOUR INTERVAL) BASED ON 2008 SURVEY.
5) WIDTH OF EXCAVATION AND TILL PLACEMENT TO BE CONFIRMED BASED ON FIELD CONDITIONS.
6) TILL TO BE COMPACTED WITH 4 PASSES OF A 10 TONNE SHEEPSFOOT ROLLER. MAXIMUM LIFT THICKNESS OF TILL IS 0.5M.
7) TILL TO HAVE MINIMUM FINES CONTENT (PASSING #200 SIEVE) OF 30% BY MASS AND BOULDERS REMOVED.
8) TILL MAY BE REPLACED BY SAND, GRAVEL AND BENTONITE UPON APPROVAL OF ENGINEER.
9) BEDROCK SURFACE SHALL BE CLEARED OF LOOSE MATERIAL, SMOOTHED OF OVERHANGS, IRREGULARITIES TO PROVIDE A REGULAR SURFACE.
10) LAKE CONTOURS ARE BASED ON SURVEYED LAKE SURFACE ELEVATIONS: THIRD PORTAGE LAKE = 134.1m (2008)
11) WIDTH OF ROCKFILL DOWNSTREAM OF EXCAVATION MAY BE VARIED TO ALLOW ACCESS.

LEGEND:

- LAND-BASED TOPOGRAPHIC MAJOR CONTOURS INTERVAL 10m
- LAND-BASED TOPOGRAPHIC MINOR CONTOURS INTERVAL 2m
- BATHYMETRIC MAJOR CONTOURS INTERVAL 10m
- BATHYMETRIC MINOR CONTOURS INTERVAL 2m
- SHORE LINE
- BEDROCK
- INITIAL ROCKFILL
- TILL
- SURCHARGE ROCKFILL SURFACING
- SETOUT POINT
- ROCKFILL SURFACING

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A	24DEC08	JU		

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	02FEB09	JU	ISSUED FOR REVIEW	EA		
A	24DEC08	JU	ISSUED FOR REVIEW	EA	JU	JCC

NOT FOR CONSTRUCTION

STAMP

ORIGINAL SIGNED

DRAWING NO.	REFERENCES
4200-31	SOUTH CAMP DIKE PROFILE AND SECTIONS

PROJECT

AEM

AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE

SOUTH CAMP DIKE MATERIAL PLACEMENT PLAN

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_B_30	
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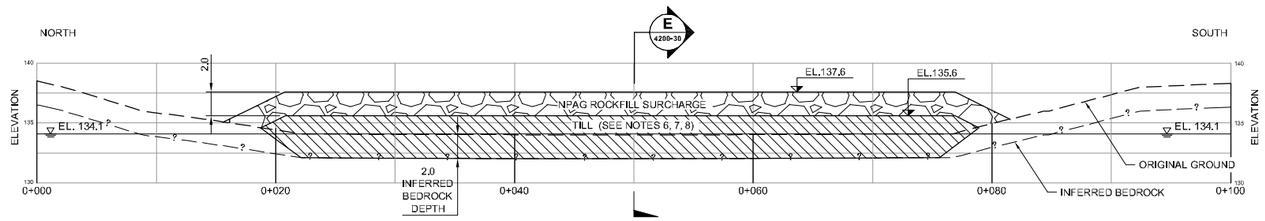
CADD	EA	08DEC08			
CHECK			4200-30		
REVIEW					



A 4200-30 SOUTH CAMP DIKE PROFILE

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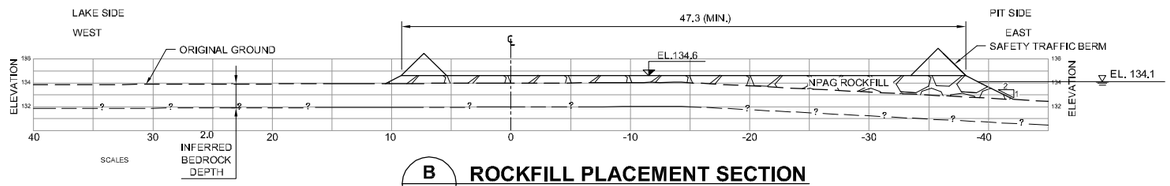
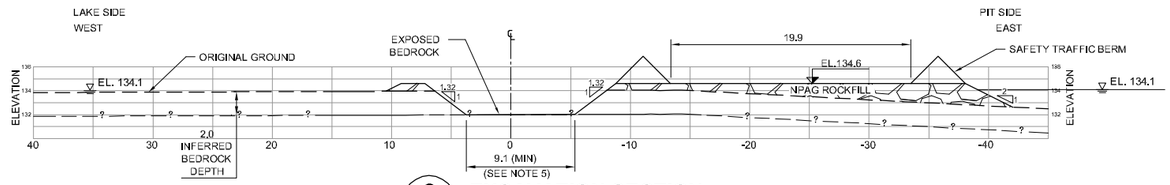


B 4200-30 ROCKFILL PLACEMENT SECTION

SCALE IN METRES (1:250)



C 4200-30 EXCAVATION SECTION

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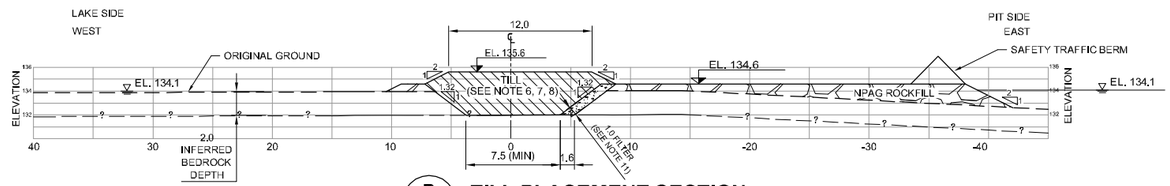

D 4200-30 TILL PLACEMENT SECTION

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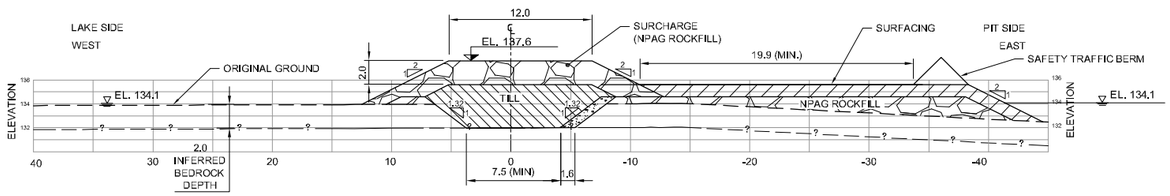

E 4200-30 SURCHARGE PLACEMENT SECTION

SCALE IN METRES (1:250)

LEGEND:

- COARSE FILTER
- TILL
- INITIAL ROCKFILL
- ROCKFILL SURFACING

NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3) CONTOUR INFORMATION ON LAND SUPPLIED BY AGNICO-EAGLE MINES LIMITED (AEM), MEADOWBANK DIVISION.
4) LAKEBED SURFACE BASED ON BATHYMETRIC AND SEISMIC SURVEYS BY GOLDER ASSOCIATES LTD., 2006. DETAILED BATHYMETRY (0.5M CONTOUR INTERVAL) BASED ON 2008 SURVEY.
5) WIDTH OF EXCAVATION AND TILL PLACEMENT TO BE CONFIRMED BASED ON FIELD CONDITIONS. DEPTH OF EXCAVATION TO BE CONFIRMED FOLLOWING GEOTECHNICAL INVESTIGATION.
6) TILL TO BE COMPACTED WITH 4 PASSES OF A 10 TONNE SHEEPSFOOT ROLLER. MAXIMUM LIFT THICKNESS OF TILL IS 0.5m.
7) TILL TO HAVE MINIMUM FINES CONTENT (PASSING #200 SIEVE) OF 30% BY MASS AND BOULDERS REMOVED.
8) TILL MAY BE REPLACED BY SAND, GRAVEL AND BENTONITE UPON APPROVAL OF ENGINEER.
9) BEDROCK SURFACE SHALL BE CLEARED OF LOOSE MATERIAL, SMOOTHED OF OVERHANGS, IRREGULARITIES TO PROVIDE A REGULAR SURFACE.
10) WIDTH OF ROCKFILL DOWNSTREAM OF EXCAVATION MAY BE VARIED TO ALLOW ACCESS.
11) FILTER REQUIREMENT TO BE DETERMINED BY ENGINEER AS BASED ON CONDITIONS IN FIELD.
12) ROCKFILL SURFACING TO BE PLACED BY AEM, SURFACING ON DOWNSTREAM SLOPE TO BE PLACED FOLLOWING DEWATERING.
13) GEOCHEMICAL CLASSIFICATION OF NPAG MATERIALS IS THE RESPONSIBILITY OF AEM.
14) ROCKFILL FOR ROAD SHALL BE A MINIMUM OF ONE METER THICK.

REDUCED DRAWING
NOT TO SCALE

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B	02FEB09	JU	ISSUED FOR REVIEW	AS		
A	24DEC08	JU	ISSUED FOR REVIEW	AS	JU	JCC

4200-30 — DRAWING NO.
SOUTH CAMP DIKE MATERIAL PLACEMENT PLAN — REFERENCES

PROJECT
AEM
AGNICO-EAGLE MINES LIMITED
MEADOWBANK GOLD PROJECT
NUNAVUT

TITLE
SOUTH CAMP DIKE PROFILE AND SECTIONS

Golder Associates

PROJECT No.	08-1428-0028/4200		FILE No.	0814280028-4200_B_31	
DESIGN	JU	01DEC08	SCALE	AS SHOWN	REV. B
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REVIEW					

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APPENDIX B

Bay-Goose Dike Design Specifications Rev. B

PREPARED FOR:
AGNICO-EAGLE MINES LIMITED
MEADOWBANK DIVISION

PREPARED BY:

REV.	DATE	REASON FOR REVISION	BY	APP.
B	02FEB09	ISSUED FOR REVIEW		
A	24DEC08	ISSUED FOR REVIEW		

TABLE OF CONTENTS

LIST OF TABLES

S1 ADMINISTRATION

S1.1 Scope

This Specification provides general administrative requirements for construction of the Bay-Goose Dike and South Camp Dike at the Meadowbank Gold Project site in Nunavut Territory of Canada.

S1.2 General

The gold ore deposits at the Meadowbank Gold Project site are situated adjacent to and beneath Second Portage Lake, Third Portage Lake, and Vault Lake. Dewatering dikes are required to isolate open pit mining activities from the lakes. These Specifications are for construction of the Bay-Goose Dike and South Camp Dike, which together will allow dewatering of a portion of Third Portage Lake. Specifications for the construction of the South Camp Dike are covered on the Drawings.

The Bay-Goose Dike is a wide rockfill structure with a granular core, cutoff wall, and foundation grout curtain. There are two designs for the dike, one for shallow areas, where the depth to bedrock is 8 m or less, and medium areas where the depth to bedrock is 8 to 16 m. The shallow areas involve excavation of lakebed soils to bedrock and construction of the cutoff wall to bedrock, with grouting of the contact and bedrock foundation. The medium areas involve construction of a cutoff wall, extended into the lakebed soils until refusal and treatment of the lakebed soils where necessary and grouting of the foundation bedrock. In general, earthworks for the dike will occur “in the wet” during the open water season, and over two seasons. Other work, including bedrock and contact grouting and treatment of the lakebeds soils may occur throughout the year. The Bay-Goose Dike alignment is shown in the Drawings that accompany these Specifications.

These Specifications are not for piping, barges or other works associated with dewatering.

S1.2.1 General Site Conditions

The site is remote, and requires considerable logistic support for transport of materials to site. Climate is described in the accompanying letter and will be described in the design report that will be prepared prior to construction of the dike. Extreme cold weather conditions exist between October and May.

The current understanding of subsurface conditions is based on a limited number of boreholes and on interpretation of geophysical data. The presentation of subsurface conditions in the letter, design report, and Drawings are therefore subject to a large degree of interpretation. Future investigations are planned to support construction and finalization of the preferred cutoff option. The Contractor is to make his own interpretation of geologic conditions.

S1.2.2 Definitions

The definitions used in the Specifications are given in Table 1-1.

TABLE 1-1: Definitions

Term	Definition
Accuracy	Degree of approximation of a measurement to the true value of the quantity measured.
Approval	A written engineering or geotechnical opinion concerning the Work.
Bentonite-Water Slurry	A stable colloidal suspension of powdered bentonite in water. The terms "slurry" and "bentonite-water slurry" are used interchangeably.
Cement Bentonite (CB) Slurry	A mixture of Bentonite-Water Slurry and cement used to form a cutoff wall by slurry trench construction.
Coarse Filter	Material produced from crushing of IV Rockfill and meeting the design specifications.
Construction Manager (CM)	Person employed by the Owner in order to oversee the project works and the Owner's interests. The primary point of contact for the Engineer and Contractor.
Contractor	A construction company contracted by the Owner to successfully carry out the Scope of Work described herein. For Work completed by mine employees, the Owner assumes responsibility for duties of the Contractor described in these Specifications.
Core Backfill	Crushed granular material to support slurry trench construction, and meeting the design specifications.
EMP	Environmental Management Plan.
Engineer	Golder Associates Ltd. (Golder).
Field Laboratory	The area and facilities provided for QC and QA testing at the Meadowbank Gold Project Site.
Health and Safety (H&S)	A planned set of activities and approach to ensure the health and safety of all persons involved in or affected by construction activities.
Ice-Rich Soil	Frozen soils that contain more than 10 percent visible ice and/or have a moisture content greater than 30%. Normally ice lenses are present.
Ice-Poor Soil	Frozen soils that contain less than 10 percent visible ice and have a moisture content less than 30%. No visible ice lenses.
Meadowbank	The Meadowbank Gold Project site.
NPAG	Non-Potentially Acid Generating
Owner	Agnico-Eagle Mines Limited, Meadowbank Division
PAG	Potentially Acid Generating
Quality Assurance (QA)	A planned system of inspection and testing that documents, to the satisfaction of the Owner, the Engineer, other stakeholders and regulators, that the Work complies with the Drawings and Specifications.

Term	Definition
Quality Assurance Manager (QA Manager)	Engineer's representative that oversees QA activities.
Quality Control (QC)	A planned system of inspection, testing and documentation carried out during construction to ensure that the Work is being completed in a manner that complies with the drawings and specifications.
Quality Control Manager (QC Manager)	Contractor's representative responsible for QC activities.
Reproducibility	Degree of approximation to the arithmetic average of each one of a series of similar measurements.
IV Rockfill	Intermediate volcanic mine aggregate material meeting the design specification.
IF Rockfill	Iron formation mine aggregate material meeting the design specification.
UM+Q Rockfill	Ultramafic and quartzite mine aggregate material meeting the design specification.
Sensitivity	Minimum unit of pressure or deformation to be detected by a system of measurement.
Subcontractor	A construction company contracted by the Contractor to complete a portion of the Work.
Slurry	A stable colloidal suspension of powdered bentonite in water. The terms "slurry" and "bentonite-water slurry" are used interchangeably. Where cement is added to bentonite-water slurry, the resulting mixture is designated as CB Slurry in these Specifications.
Slurry Trench	A vertical-walled trench of specified width excavated by the Slurry Trench Method which is backfilled with materials meeting the specification to form a cutoff wall of low permeability.
Slurry Trench Method/Technique	A method of excavating a narrow, vertical walled trench using a slurry mixture to support the trench walls and prevent movement of groundwater into or through the excavated trench.
Slurry Trench Specialist	A Subcontractor who has proven and successful experience in the Slurry Trench Method and is knowledgeable of: (1) the proper methods employed to mix slurry and backfill; (2) the use, testing and control of water-bentonite slurry and CB slurry; and (3) construction equipment for slurry trench construction; (4) excavation and backfill operations for the Slurry Trench Method; and (5) testing for Slurry Trench QC.
Slurry Wall or Cutoff Wall	A Slurry Trench backfilled with specified materials to form a cutoff wall of low permeability. The terms "Slurry Wall" and "Cutoff Wall" are used interchangeably.

Term	Definition
Soil-Bentonite (SB) Backfill	A homogenous mixture of Till and/or processed aggregate, bentonite-water slurry and/or bentonite meeting the design specifications.
Till	Unfrozen soil consisting of sizes ranging from clay to boulders and meeting the design specification.
Tube-a-manchette	Sleeve-port grout pipes allowing for the precise location and injection of grout at a predetermined depth at locations spaced apart where there are "sleeve-ports" formed into the "tube-a-manchette" pipe for that purpose.
Work	All activities associated with the construction of the Bay-Goose Dike including instrumentation installation and seepage collection systems.
Work Completion Report (WCR)	Summary report prepared by the Contractor.
Contractor's Work Plan	Proposed construction equipment, procedures, schedules, QC plan, and Health and Safety plan for all components of Work to be completed by the Contractor and any Subcontractor the Contractor may employ to complete the Work.
Working Platform	The working platform is the surface of fill and/or excavated surface from which the Work is conducted, e.g. for Slurry Wall construction, for grouting and for instrumentation installation.

S1.2.3 Standards and Regulations

Work shall conform to, but not be limited to the requirements of the standards, acts and regulations, listed in Table 1-2. Work included in this Specification shall conform to the applicable provisions of these publications, except as modified by the requirements specified herein or as indicated in the Drawings. Each publication shall be the most recent revision and addendum in effect at the time of construction.

TABLE 1-2: Standards and Regulations

Name or Number	Description
AEM	March 2007 Safety Handbook
API Spec 13A	Specification for Drilling Fluid Materials
API RP 13B-1	Recommended Practice for Field Testing Water-Based Drilling Fluids

Name or Number	Description
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C185	Standard Test Method for Air Content of Hydraulic Cement Mortar
ASTM C191	Standard Test Methods for Time of Settling of Hydraulic Cement by Vicat Needle
ASTM C266	Standard Test Method for Time of Setting of Hydraulic-Cement Paste by Gillmore Needles
ASTM C305	Standard Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency
ASTM C349	Standard Test Method for Compressive Strength of Hydraulic-Cement Mortars (Using Portions of Prisms Broken in Flexure)
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C596	Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C845	Standard Specification for Expansive Hydraulic Cement
ASTM C940	Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C941	Standard Test Method for Water Retentivity of Grout Mixtures for Preplaced-Aggregate Concrete in the Laboratory
ASTM C942	Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C953	Standard Test Method for Time of Setting of Grouts for Preplaced-Aggregate Concrete in the Laboratory

Name or Number	Description
ASTM C1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D422-63	Standard Test Method for Particle-Size Analysis of Soils
ASTM D1140	Standard Test Methods for Amount of Material in Soils Finer Than No. 200 (75 µm) Sieve
ASTM D1633	Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders.
ASTM D2113	Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation
ASTM D2216	Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2434	Standard Test Method for Permeability of Granular Soils (Constant Head)
ASTM D2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils
ASTM D4380	Standard Test Method for Density of Bentonitic Slurries
ASTM D4381	Standard Test Method for Sand Content by Volume of Bentonitic Slurries
ASTM D5084	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D5856	Standard Test Method for Measurement of Hydraulic Conductivity of Porous Material Using a Rigid-Wall, Compaction-Mold Permeameter
ASTM D6910	Standard Test Method for Marsh Funnel Viscosity of Clay Construction Slurries
CSA A3000	Cementitious Materials Compendium
Mine Health and Safety Act, (Nunavut) S.N.W.T. 1994, c25	
Mine Health and Safety Regulations, N.W.T. Reg. 125-95	

AEM: Agnico-Eagle Mines Limited; ASTM: ASTM International, originally known as American Society for Testing and Materials; API: American Petroleum Institute

S1.2.4 Alternative Standards

If the Contractor offers materials which conform to a standard other than that specified then the standard offered shall be equal to or superior, when tested, to the specified standard and full details of the differences between the standard offered and the standard specified shall be given.

S1.3 Execution

The Bay-Goose Dike construction package includes work to be carried out by the Contractor(s) and work to be carried out by the Owner's mine employees.

S1.4 Scope of Work

Table 1-3 includes a general description of tasks for Bay-Goose Dike construction. The tasks are not listed in order. A construction sequence shall be developed by the Construction Manager (CM).

TABLE 1-3: Scope of Work

Construction Item	By
Placement of works for control of water	Owner
Placement of turbidity barrier	Owner
Placement of rockfill embankment	Owner
Excavation through rockfill embankment to expose in-situ soil or bedrock, including abutments	Contractor
Placement of Coarse Filter on downstream face of excavation	Contractor
Placement of core materials	Owner
Densification of core materials	Contractor
Geotechnical investigation along Cutoff Wall alignment	Contractor

Construction Item	By
Installation of Slurry Trench and Cutoff Wall	Contractor
Grouting (including soil and bedrock)	Contractor
Installation of instrumentation	Contractor
Dewatering of the portion of Third Portage Lake isolated by the Bay-Goose Dike and the South Camp Dike	Owner
Construction of drainage works in the dewatered downstream area	Owner
Installation of instrumentation in the dewatered area	Contractor

S1.5 Roles and Responsibilities

S1.5.1 General

Unless otherwise stipulated by project-specific addenda, the responsibility and authority of each party involved in the Work shall follow the lines set forth in the following sections and the applicable regulations and/or permit conditions for the following management structure.

S1.5.2 Owner

The Owner is Agnico-Eagle Mines Limited (AEM), Meadowbank Division. All references to the Owner in this document shall implicitly include the Construction Manager (CM), who is the Owner's representative designated specifically for the project by the Owner. The Owner is responsible for:

- health and safety at the work site and mine site;
- submittals listed in Section S1.12;
- responsibilities and tasks listed in the QC and QA Requirements Specification;
- inspection and maintenance of the site before any section of the site is handed to the Contractor for commencement of Works;

- providing items as required in these specifications and all incidentals needed to bring the Work to final completion, not including those to be supplied by the Contractor;
- obtaining all relevant permits;
- environmental management including prevention of pollution and other environmental problems related to the construction activities of the Bay-Goose Dike construction;
- providing reasonable access to the general open areas surrounding the work site for the Contractor and Subcontractors;
- traffic control on dike crest and in abutment areas;
- maintaining the Construction Schedule, including coordination and direction of the general stages of work;
- coordinating communication for the project;
    - arranging the Pre-Construction and Construction meetings;
    - arranging Deficiency Resolution Meetings for resolving QC and QA issues;
        - preparing plans for corrective action for Work not in compliance with the Specifications;
- QA survey for layout of the work, for documentation of as-built configurations, and for payment;
- pre-processing of construction materials, including Coarse Filter, Core Backfill and Till;
- supply of water sources, diesel, cement, bentonite, rockfill materials, Till, Coarse Filter, Core Backfill, and disposal areas for waste materials;
- Delivery of all goods for use on site;
- Storing all goods and materials appropriately on site;
- any blasting, including blast notification to the Contractor and Engineer or their representative;
- for mine operations aspects related to efficiency of the Work;
- grading the site to the proper elevation as set forth in the Drawings; and
- preparation of an as-built report at the completion of the Work.

For Work completed by mine employees, the Owner assumes the responsibilities of the Contractor described in these Specifications.

S1.5.3 Contractor

The Contractor is responsible for:

- health and safety of employees under the Contractor's supervision at the worksite, and for health and safety of Subcontractors employed by the Contractor;
- submittals listed in Section 1.12;

- responsibilities and tasks listed in the QC and QA Requirements Specification;
- construction of the Work in compliance with the Drawings and Specifications, including any work performed by Subcontractors;
- compliance with requirements of the Meadowbank Safety Handbook (2007) and Mine Health and Safety Regulations in Nunavut;
- blast notification to the Contractors employees and Subcontractors;
- site preparation;
- protection of materials before and after placement;
- survey and survey control for Quality Control of the Work;
- Quality Control of all Work undertaken by the Contractor and his Subcontractors;
- protection of the environment during construction; and
- inspection and maintenance of site, e.g. sumps, before any section of the site is handed to the Owner after the completion of works, or a Subcontractor before their work is due to commence.

For Work involving grouting, the Contractor is responsible for:

- Providing a technical expert to direct the work;
- QC of the Work, including testing specified in the QC and QA Requirements Specification;
- Successful completion of the scope of Work described in the Specification;
- Supply of additives for grouting including microfine cement; and
- Clean up as the work progresses on site.

For Work involving Slurry Wall construction, the Contractor is responsible for:

- Providing a technical expert to direct the work, the Slurry Trench Specialist;
- Geotechnical investigation of the core materials;
- Excavation and backfill of the Slurry Trench; and
- Clean up as the work progresses on site.

The Slurry Trench Specialist is responsible for:

- Directing the Contractor;
- Maintaining slurry levels within specified limits;
- Ensuring that the preparation of the trench backfill and any stockpiles does not affect slurry trench stability; and
- Quality Control of the Work, including slurry and trench backfill materials, including testing and documentation specified in the QC and QA Requirements Specification.

S1.5.4 Subcontractors

The Contractor is responsible for any Work undertaken by Subcontractors they may employ.

S1.5.5 Engineer

The Engineer is Golder Associates Ltd. (Golder), the dike design Engineer of Record. The Engineer is responsible for:

- submittals in Section 1.12;
- responsibilities listed in the QA and QC Requirements Specification;
- the design including the Drawings and Specifications;
- generation and approval of any and all modifications and clarifications which pertain to the design, Drawings and Specifications; and
- design modifications and clarifications that may occur prior to and/or during construction.

The Engineer is represented on site by the QA Manager.

S1.5.6 QA Manager

The Quality Assurance Manager (QA Manager) represents the Engineer on site and is responsible for:

- performing QA tasks outlined in QC and QA Requirements Specification including observing, testing, inspecting, documenting, monitoring and reporting the relevant project activities;
- implementation of changes in QA aspects of the work including frequency of testing, monitoring, or additional testing to confirm conformance with the specifications;
- approving aspects of the Work as compliant with the Drawings and Specifications and capturing the intent of the design; and
- blast notification to QA staff.

The QA Manager has the authority to stop work that is not in compliance with the design but does not have the authority to change methodology or to make any decisions related to the cost without prior approval of the Construction Manager.

S1.5.7 QC Manager

The Quality Control Manager (QC Manager) is responsible for checking the Work as construction proceeds with the purpose of aiding the Contractor to complete the Work in accordance with the Drawings and Specifications. The QC Manager is responsible for:

- performing QC tasks outlined in QC and QA Requirements Specification, which includes observing testing, inspecting, documenting, monitoring and reporting the relevant project activities;
- directing QC work and QC personnel; and
- implementing changes in QC aspects of the work including frequency of testing, monitoring, or additional testing to confirm conformance to the Specifications.

The Contractor is responsible for QC of his own work.

S1.6 Communications

The Construction Manager has the responsibility to organize communications through various meetings described in this Section. Other meetings may be called as required by the CM.

All official communications shall be in writing, in English, including all paper and electronic records, survey data, and test results, with records of communications kept by both the Owner and the Engineer. Radio communications will be on the same channels as the mine and will be in English.

Official communications between the Engineer and the Contractor will be through the CM.

S1.6.1 Pre-Construction Meeting

Prior to the start of construction, the Owner, Engineer and Contractor will meet to discuss:

- The design, Specifications and Drawings;
- Responsibilities, authorities, and submittal requirements of all parties as defined in the Specifications;
- Procedures for deficiency resolution, documentation and reporting;
- QC and QA procedures and responsibilities, including QC tasks documented in the Contractor's Work Plan, testing frequencies, testing methods and material acceptance/rejection criteria, reporting and documentation;

- Site conditions;
- Stockpile areas and areas to be used for temporary storage/stockpiling where applicable;
- Laboratory facilities with respect to volume of testing and requirements for QA and QC laboratory testing for each phase of construction;
- Construction quantities;
- Construction Schedule and Contractor's Work Plan;
- Each task of the Work with respect to overall Construction Schedule;
- Health and Safety, including both AEM's Site H&S Plan and the Contractor's H&S plan as defined included in the Contractor's Work Plan, including procedures for QA and QC activities, and procedures related to blasting, white-out, medical emergency, fire, mine equipment, driving protocols for the site, and hours of work;
- Supply of materials, water, and waste disposal areas;
- The EMP;
- To conduct site walk-over to discuss proposed construction sequence, start-up and inspect borrow areas, where applicable; and
- Any other concerns raised by each party.

S1.6.2 Daily H&S Meeting

Daily H&S Meetings will be held at the Bay-Goose Dike Construction area prior to start of each shift. The CM will relay any relevant information to on-site representatives of the Contractor and Engineer. The CM will be responsible for meeting minutes.

S1.6.3 Construction Meeting

Construction progress meeting shall occur monthly or more frequent as required, and be held and chaired by the CM. Meetings shall be attended by the Engineer and the Contractor, or their representatives. H&S concerns will be reviewed.

The CM will be responsible for meeting minutes.

S1.6.4 Deficiency Resolution Meeting

If a construction problem or deficiency occurs, then a deficiency resolution meeting shall be held by the CM and the relevant construction work shall be suspended until a resolution is attained. A deficiency resolution document shall be filled out by the party that identified the deficiency and shall be provided to the various other parties (CM, QA Manager and QC Manager) prior to the deficiency resolution meeting.

The purpose of the meeting shall be to identify, isolate and resolve the problem or deficiency to achieve compliance with the Specifications and the intent of the design to the satisfaction of all parties to the extent possible. The deficiency resolution document will include method of resolution and will be signed by the CM and the QA Manager once the deficiency has been corrected. Documentation requirements for deficiencies are described in the QC and QA Requirements Specification.

The deficiency resolution meeting shall be attended by the CM, Contractor, QA Manager, and QC Managers or their representatives, either in person or by phone. If the conditions or circumstances require modification(s) to the design, then only the Engineer will make changes to the design.

The CM is responsible for meeting minutes and for distribution to all parties in attendance.

S1.7 Environmental

An Environmental Management Plan (EMP) shall be prepared by the Owner and provided to the Contractor and Engineer prior to start of construction, as described in the Section 1.12.

The Owner shall provide labour and equipment as required to contain and/or clean up any environmental spills.

The Contractor shall incorporate environmental considerations while developing and while implementing the Contractor's Work Plan. The EMP may discuss, but is not limited to the following:

- Spill Management;
- Animal protection;
- Total Suspended Solids (TSS) or Turbidity Monitoring;
- Water Management; and
- Refuse Management.

An up-to-date EMP must be maintained to cover all work activities being conducted throughout the Work.

The Contractor will comply with the EMP and all standard procedures related to environmental issues.

Any spill or environmental concern shall be reported immediately to the CM.

S1.8 Health and Safety

The site is under regulation by the Mines Act and follows Mine Health and Safety Regulations of Nunavut.

The Owner is entirely responsible for the Health and Safety at the site, including the All Weather Private Access Road to Baker Lake. The Owner will provide a site orientation including regulations, Health and Safety, driving on the site and any procedures related to blasting, medical emergency, radio procedures, and incident reporting. The site orientation shall be completed by every person prior to the start of any Work at the site.

The Contractor is responsible for Health and Safety of the Contractor's employees and the Subcontractor's employees.

The Contractor and his Subcontractors shall incorporate Health and Safety considerations while developing and implementing their own work procedures.

The Contractor shall also comply with relevant Health and Safety regulations and AEM Health and Safety protocols and procedures (March 2007 Safety Handbook) or those in effect at the time of construction.

The Contractor shall observe the regulations, procedures and restriction for the ingress to the construction area.

The Contractor must submit as part of the Contractor's Work Plan, a Health and Safety plan covering all work activities being conducted for approval by the Owner, as described in Section 1.12. The plan must comply with AEM regulations and any additional health and safety requirements specifically related to the Contractor's work, and shall comply with the Mine Health and Safety Act and Regulations in effect in Nunavut Territory, including requirements for Supervisors. Following approval of the Health and Safety plan, the plan shall be implemented and updated as the need arises.

Any dangerous occurrence or reportable incident or Health and Safety concern shall be reported immediately to the CM.

S1.9 Cooperation

The Contractor and his Subcontractors shall cooperate with other parties to allow time and provide safe work conditions to carry out any site visit required to check environmental or health & safety concerns, perform control surveys and QC/QA activities. The Contractor and his Subcontractors shall provide labour and equipment as required to contain and/or clean up any environmental spills.

S1.10 Construction Facilities and Temporary Controls

Access to the site will be provided by the CM. The Contractor will not have sole access to the Work area and must be prepared to share and coordinate activities and access with others, through the CM. The Contractor shall coordinate with the CM the location of any staging areas, temporary facilities, haul roads or access roads.

S1.10.1 Power Supply

The Contractor shall provide any temporary power required for the Work in the form of a diesel powered generator. The Owner will supply diesel at no charge to the Contractor.

S1.10.2 Water Supply for Construction

Water for dust control, for slurry, for moisture conditioning material to be placed as fill, for drilling, for grouting, and for maintaining in-place fill soils shall be obtained by the Contractor. The Contractor must supply all the pumps and tanks necessary. Water will be available at a location defined by the CM.

S1.10.3 Dust Control

During performance of the Work defined by the Specifications or any related operations, the Contractor shall control dust emissions.

S1.10.4 Surface Water Control

The Contractor is responsible for controlling surface water and protecting Work from damage caused by this water, as set out in the Care of Water Specification.

S1.10.5 Work Area

The Contractor shall:

- Store and dispense fuel, lubricating oils, and chemicals in such a manner to prevent or contain spills and prevent materials from entering local streams, lakes or groundwater according to applicable regulatory requirements.

- Maintain copies of Material Safety Data Sheets (MSDS) on file at the site for all hazardous materials. Copies of MSDS are to be provided to the CM as the CM is responsible for the delivery and storage of goods on site.

- Avoid damaging instrumentation or instrumentation cables, such as piezometers, and survey monuments used at the site.

S1.10.6 Traffic Control

The Owner is responsible for traffic control at the site and at the construction site.

AEM Mine heavy equipment and haulage traffic has the right of way at all times with the exception of wild life and emergency vehicles.

The Owner shall provide a flag person or persons at intersections with limited visibility and heavy traffic.

S1.11 Mobilization and Demobilization

Mobilization comprises mobilizing to the mine all materials, supplies, equipment and tools required to carry out the Work. Demobilization includes transporting out of the mine all remaining materials, equipment, and tools, hauled on site to carry out the Work.

The Contractor is solely responsible for the planning and mobilization of materials in consultation with the Owner in accordance with the construction schedule. Subcontractors and their transportation equipment must comply with the same safety regulations as the Contractor.

It is required that all equipment that is to be used in the Work, pass a technical inspection to be conducted before being sent to site. This is to be completed by qualified Mine Operations' personnel employed by the Owner.

Upon completion of the Work, any temporary structure built during the Work and/or any temporary construction that may have been installed during the Work shall be removed.

All regulations regarding mobilization towards and within the mine shall be followed.

S1.12 Submittals

Table 1-4 summarizes the submittals required prior to construction, during construction and post construction. These documents are in addition to those presented by the Contractor to the Owner at the tender stage.

TABLE 1-4: Submittals

Item	Submitted From	Submitted To	Required
Construction Schedule	Owner	Engineer, Contractor	60 days prior to start of construction and maintained during construction
Site H&S Plan	Owner	Engineer, Contractor	60 days prior to start of construction and maintained during construction
Site EMP	Owner	Engineer, Contractor	30 days prior to start of construction and maintained during construction
Contractor's Work Plan	Contractor	Owner, Engineer	30 days prior to start of construction maintained during construction
Daily Summary Report	Contractor	Owner, Engineer	Within 24 hours.
QA Weekly Report	Engineer	Owner	Weekly
Work Completion Report	Contractor (one for each Contract)	Owner, Engineer	Within 1 month following completion of work
As-built Report	Engineer	Owner	Within 6 weeks following receipt of Work Completion Report

S1.12.1 Contractor's Work Plan

The Contractor's Work Plan shall include the following but not be limited to:

- Proposed construction equipment, procedures, and schedules;
- Procedures for coordinating construction, maintenance and removal of working platforms, mixing pads, and haul roads;

- Equipment set-up and site use layout including storage areas, haul roads and work platform dimensions;
- Any updates or changes as necessary;
- Equipment specifications including: maximum working depth capability of excavator; number and type of backfill mixing equipment; and specifications of slurry mixing equipment; service record for equipment;
- Material properties, sources, and (manufacturer's) certificates of quality;
- Control of drainage, spills, wastes, etc.;
- Clean-up, spoils disposal, slurry disposal; and
- Site clean-up and removal of refuse.

For Cutoff Wall construction details shall include:

- Schedule and sequence of operations including typical working hours and days; sequence of operations; and maintenance schedule;
- Coordinating the construction, maintenance and removal of working platforms, mixing pads, and haul roads;
- Equipment set-up and site use layout including storage areas, haul roads and work platform dimensions;
- Equipment specifications including: maximum working depth capability of excavator (or equivalent); number and type of backfill mixing equipment; and specifications of slurry mixing equipment;
- Procedure for deep excavation and/or cutting;
- Procedure for water-bentonite slurry mixing, transportation and re-circulation;
- Procedure for cement-bentonite slurry mixing and transportation;
- Procedure for trench excavation and backfilling;
- Procedure for mixing trench backfill materials;
- Material properties, sources, and (manufacturer's) certificates of quality for bentonite materials;
- Specifications for slurry mixing equipment;
- Mixture design and test results for CB and/or SB mixes;
- Procedure for control of drainage, spills, wastes, etc.;
- Procedure for clean-up, spoils disposal, slurry disposal;
- A QC Plan for slurry trench and Cutoff Wall construction, including but not limited to:
    - Details of the personnel and their roles and responsibilities;
    - The minimum site inspections and quality testing requirements (see QA and QC Requirements Specification for minimum testing frequency, tests, surveys and soundings);
    - Sampling methods;

- Sampling frequency;
- Location of samples;
- Checklists for each of the works specified;
- Non-conforming materials and corrective action procedures;
- The company name, key contact, and qualifications of the Slurry Trench Specialist's;
- off-site laboratory; and
- Copies of QC forms (templates).

The Contractor's Work Plan shall be updated in writing at least 2 weeks prior to start of Cutoff Wall construction.

For drilling and grouting, the Contractor's Work Plan shall include:

- Proposed drilling and grouting equipment, materials, procedures, and schedules;
- Schedule and sequence of operations including typical working hours, days and crew rotations; sequence of operations; and maintenance schedule;
- Coordination of drilling, grouting, and equipment maintenance;
- Equipment set-up and site use layout including storage areas, grout plants, and mobile shelters both for drill rigs and grouting equipment;
- Drill rod and bit diameter, rod length and number for total depth drillable;
- Equipment specifications including: drills, grout mixers, agitators, grout pumps, water pressure testing pumps, packers, hose lines, valves, pipe fittings, magnetic flow meters, pressure transducers, oil-filled pressure gauges, gauge savers, water heaters, and grout mix testing equipment;
- Procedure for installing casing and drilling grout holes in bedrock;
- Procedure for setting up and moving shelters and grout plants;
- Procedure for grouting operations including: packer inflation/deflation, grout pump control, and grout line circulation;
- Procedure for installing tube-a-manchettes, backfill grouting the annular space surrounding the casing, removing the casing and topping up the annular space;
- Procedure for breaking the casing grout, and carrying out water pressure testing and grouting from within the tube-a-manchettes; and
- Material properties, sources, and (manufacturer's) certificates of quality for bentonite materials, concrete admixtures, and cement.

At any time during the works, the Engineer may request that the proposed sequence of works and schedule of grouting activities be updated and re-submitted within 48 hours of

the request. Proposed revisions to the specified method of execution shall be subject to the approval of the Engineer.

For Instrumentation, the Contractor's Work Plan shall include:

- the proposed method of anchoring and constructing the inclinometers shall be submitted by the Contractor to the QA Manager; and
- proposed instrumentation cabin design (to be provided or updated at least 2 weeks in advance of construction).

The Contractor's Work Plan shall be updated in writing at least 2 weeks prior to start of installation of instrumentation.

S1.13 Work Completion Report

Immediately upon completion of the Work the Contractor shall finalize the Work Completion Report (WCR) that shall provide as a minimum the following:

- Descriptive report;
- Original Construction Record;
- Copies of Meeting minutes, Field Change Notices (FCN), Site Instructions (SI), Request for Information (RFI), and any other format that has been part of the Work;
- Original protocols of field or lab tests, duly signed by both the Contractor and QA Manager;
- Any as-built survey information collected for any aspect of the Work in electronic AutoCAD and hard copy format;
- Calculation sheets for actual quantities of work executed, duly signed by both the Contractor and Construction Manager;
- Liquidation of the Work;
- Installation details of instrumentation in electronic and hard copy format; and
- Final Safety Report.

S1.14 Unit Measurement and Payment

Quantities for payment will be determined by the Owner's survey.

S1.15 Preliminary List of Quantities

Estimated quantities associated with the Work are provided in Table 1-5. Estimated quantities are subject to construction method and material properties, and will necessarily vary from actual quantities.

TABLE 1-5: Quantities

Material	Quantity	Units
TO BE COMPLETED FOLLOWING GEOTECHNICAL INVESTIGATIONS		

A list of drawings is given in Table 1-6.

TABLE 1-6: List of Drawings

No.	Title	Revision
4200-00	BAY-GOOSE DIKE AND SOUTH CAMP DIKE LOCATION MAP AND DRAWING INDEX	B
4200-01	BAY-GOOSE DIKE AND SOUTH CAMP DIKE SITE PLAN	B
4200-02	BAY-GOOSE DIKE BOREHOLE LOCATION PLAN	B
4200-03	BAY-GOOSE DIKE CUTOFF WALL CENTRELINE SETOUT PLAN	B
4200-04	BAY-GOOSE DIKE INITIAL ROCKFILL LAYOUT PLAN	B
4200-05	BAY-GOOSE DIKE TYPICAL MATERIAL PLACEMENT PLAN	B
4200-06	BAY-GOOSE DIKE TYPICAL MATERIAL PLACEMENT SECTIONS	B
4200-07	BAY-GOOSE DIKE TYPICAL CONCEPTUAL MEDIUM DEPTH PLAN AND SECTION	B
4200-08	BAY-GOOSE DIKE GOOSE ISLAND ABUTMENT DETAILS	B
4200-09	BAY-GOOSE DIKE GOOSE ISLAND ABUTMENT SECTIONS	A
4200-10	BAY-GOOSE DIKE NORTH AND SOUTH ABUTMENT PLANS AND DETAILS	B
4200-11	BAY-GOOSE DIKE INSTRUMENTATION PLAN	B
4200-12	BAY-GOOSE DIKE INSTRUMENTATION SECTION AND GROUTING DETAILS	B
4200-13	BAY-GOOSE DIKE INSTRUMENTATION AND GROUTING DETAILS	A
4200-14	BAY-GOOSE DIKE CROSS SECTIONS (1 OF 4)	A
4200-15	BAY-GOOSE DIKE CROSS SECTIONS (2 OF 4)	A
4200-16	BAY-GOOSE DIKE CROSS SECTIONS (3 OF 4)	A
4200-17	BAY-GOOSE DIKE CROSS SECTIONS (4 OF 4)	A
4200-18	BAY-GOOSE DIKE CUTOFF WALL PROFILE	A
4200-19	BAY-GOOSE DIKE GROUTING PROFILE	B
4200-20	BAY-GOOSE DIKE SEEPAGE COLLECTION SYSTEM PLAN	A
4200-21	BAY-GOOSE DIKE SEEPAGE COLLECTION SYSTEM PROFILE AND DETAILS	A

No.	Title	Revision
4200-22	BAY-GOOSE DIKE SEEPAGE COLLECTION SYSTEM SECTIONS (1 OF 2)	A
4200-23	BAY-GOOSE DIKE SEEPAGE COLLECTION SYSTEM SECTIONS (2 OF 2)	A
4200-30	SOUTH CAMP DIKE MATERIAL PLACEMENT PLAN	B
4200-31	SOUTH CAMP DIKE PROFILE AND SECTIONS	B

S2 CARE OF WATER

S2.1 Scope

This Specification describes care of water for the construction of Bay-Goose Dike. The care of water consists of all work required to control water from any sources, including groundwater, surface water, snow melt and precipitation, in order to complete the Work in accordance with the Drawings and Specifications, and in accordance with the EMP, the Site H&S Plan, and all environmental and H&S controls established by the Owner.

Care of water shall include the following:

- Managing water before, during and after: excavating; preparing, and constructing foundation and abutments; placing dike fills; designated waste areas, use and construction of access roads, and stockpiles; constructing seepage collection works; and undertaking any other part of the Work.

- Dewatering foundations and associated working areas. The Contractor shall provide, operate and maintain any channels, flumes, drains, culverts, sumps, pumps and other drainage facilities and equipment necessary to divert water away from or to remove water from areas required to be used for construction of the Work and/or as required to meet environmental or safety requirements.

- Constructing and maintaining any embankments and other protective works required to divert water away from areas required for the Work, and where applicable, removing such structures upon completion of the Work.

- Diverting and controlling surface runoff occurring along the abutments at the edge of the crest and toe.

S2.2 General

Surface water shall be temporarily diverted and managed during construction of the Work. Any channel, ditch, dike or other facility required to divert surface water from any area required to complete the Work shall be constructed. All pumps, hoses, culverts and any other equipment required to dewater and maintain all parts of the construction site free from water shall be furnished, installed, maintained and operated.

The Contractor shall adequately operate and maintain temporary diversion and protective works and pumping stations. These shall also be readily accessible at all times.

The Contractor shall remove temporary dikes and other temporary works promptly, when they are no longer required at the direction of the CM. Materials from such removal shall be hauled to disposal areas designated by the CM.

S2.3 Execution

The Work shall not commence until appropriate Care of Water measures have been designed, submitted for review and approval by the Engineer and CM, and approved.

Care of Water systems shall include, but are not necessarily limited to: embankments, trenches, ditches, and lined channels to divert or collect surface water runoff; pipes, drains and sumps to manage groundwater; and pumping systems.

S2.3.1 Dewatering Foundations

Excavations on land shall be dewatered in advance, to ensure that the Work is carried out in safe and dry conditions. Proposed methods for preventing and controlling seepage shall be submitted to the CM for approval as part of the Contractor's Work Plan.

S3 TURBIDITY BARRIER

S3.1 Scope

This Specification describes the requirements for supply and installation of a turbidity barrier for the construction of the Bay-Goose Dike at the Meadowbank Gold Project, Nunavut.

S3.2 General

A turbidity barrier shall be placed upstream and downstream of the Bay-Goose Dike construction area.

S3.3 Materials

To be provided under separate cover.

S3.4 Dimensions

To be provided under separate cover.

S3.5 Execution

The barrier shall be placed prior to any construction related disturbances and may only be removed after the completion of the construction of the adjacent rockfill embankment and water between the embankment and the turbidity barrier has total suspended solids levels at pre-construction levels, or as required by the Owner's EMP, including any TSS or Turbidity monitoring requirements.

S3.6 QC AND QA

Work for installation of the turbidity curtain shall conform to the items listed in the QC and QA Requirements Specification.

S4 FOUNDATION PREPARATION

S4.1 Scope

This Specification provides the technical requirements for foundation preparation and excavation for the Bay-Goose Dike including:

- excavation through rockfill, lakebed soils, and at the dike abutments;
- bedrock foundation preparation; and
- on-land foundation preparation.

S4.2 Work Sequence

The Work shall only start upon receipt of approval to proceed from the CM and following inspection, as-built survey and approval of pre-work conditions.

S4.3 General

Excavation shall be carried out by the Contractor in accordance with the Drawings and Specifications, using ground support and water control measures required for safe and effective operation.

Excavation will be through the rockfill embankment and into lakebed soils along the centreline of the Cutoff Wall, to dimensions shown in the Drawings.

Temporary drainage and pumping systems shall be provided, operated and maintained by the Contractor as required to direct water away from the surface excavation areas as specified in the Care of Water Specification.

S4.3.1 Waste Soil and Rock

Waste soil and rock shall be disposed of at areas designated by the CM. Wasted material includes rockfill from the excavation, lakebed soils, and abutment foundation preparation stripping. Except for rockfill excavated from the Bay-Goose Dike embankment, waste materials shall not be deposited into any riverbed, lake, or other water channel and shall not be burned, unless directed by the CM.

S4.3.2 Dimensional Tolerances

All excavations shall be completed to be within 300 mm horizontally and vertically of specified lines and grades unless otherwise specified by the Engineer.

S4.4 Execution

The Contractor's Work Plan will include proposed methods for each part of the Works, including sequencing and stages of protection of excavated surfaces and water handling.

The Contractor shall lay out each excavation subject to inspection by the Engineer, prior to commencing any excavation. The Contractor shall not initiate excavation of any part of the Work until the proposed methodology and construction sequence has been approved by the Engineer.

Surface excavation work may begin only after the necessary infiltration and runoff control measures have been completed in accordance with the Care of Water Specification, and the necessary equipment, elements and materials for protection of surface excavations are available at that site.

S4.4.1 In-water Foundation Preparation

Prior to any construction activities occuring along the alignment of the Bay-Goose Dike, a detailed bathymetric survey and video survey using a GPS data-logger should be performed along the cutoff wall alignment to identify the type of soil present at lakebed surface (boulders, sediment, etc…). Once information is recorded, in-water foundation preparation can be performed.

Foundation preparation shall be carried out along the cutoff wall alignment at the bedrock surface at the base of the lakebed excavation, and continued to on land areas at the abutments.

In-Lake foundation preparation shall consist of:

- Surveying or sounding of the base of the excavation through the rockfill, paying particular attention to the footprint of the cutoff wall;
- Removing sediment, till, rockfill, soils overlying bedrock, and other deleterious materials including any trees, brush, roots, debris, peat, topsoil, snow and ice that may be present;

- Stripping and scalping/removing loose material, including boulders, along the cutoff wall foundation to a depth shown on the Drawings; and
- Loading, hauling and dumping such materials in designated areas, as directed by the CM.

S4.4.2 On-land Foundation Preparation

Foundation preparation shall be carried out within the dike footprint at the abutments. Foundation preparation on-land shall include:

- Lay-out of each on-land excavation for inspection by the Engineer prior to commencing any excavation;
- Any necessary infiltration and runoff control measures completed in accordance with the Care of Water Specification, and with the necessary equipment, elements and materials for protection of surface excavations available at the site;
- Removing topsoil, vegetation and other deleterious materials including trees, brush, roots, debris, peat, topsoil, snow and ice;
- Stripping and scalping organic hummocks, ice rich soils, and boulders protruding more than 150 mm above the ground to expose competent mineral soil and bedrock as shown on the Drawings; and
- Dumping stripped materials into stockpile areas designated by the CM.

S4.4.3 Excavation

The excavation shall meet the minimum dimensions shown on the Drawings. Method of excavation and stability of the excavation shall be the responsibility of the Contractor, with method subject to approval by the Engineer. The downstream slope of the excavation must be flat enough to allow stable placement of Coarse Filter, where Coarse Filter is required. The upstream slope of the excavation must be flat enough to allow heavy equipment to drive on the upstream crest platform.

All necessary precautions shall be taken by the Contractor to obtain regular and stable excavation surfaces, which follow the boundary lines and grades shown on the Drawings.

S4.4.4 Excavating by Blasting

Any blasting will be by the Owner.

All operations in connection with transporting, storage and use of explosives shall be subject to the rules and regulations of governing authorities. Blasting shall be performed using experienced and licensed personnel.

S4.4.4.1 Vibration Control

Vibrations induced by blasting must not alter the natural state of rock beyond the excavation limits nor the previously grouted rock, fills or already-placed concrete of any permanent structure. Therefore the maximum instantaneous explosive charge, as deduced from the following equation, shall be permanently monitored and not surpassed:

$$SD = D/(W)^{1/2}$$

Where:

SD = Scaled distance
D = Blasting distance, in feet, to the nearest structure requiring protection
W = Maximum instantaneous charge, in pounds

The SD relation will equal 50 when the blasting distance to the structure requiring protection is less than 50 m; when greater, the SD relation to deduce the maximum instantaneous charge will be 65.

S4.4.5 Work Areas

The Contractor shall take the necessary precautions to obtain regular and stable excavation surfaces. Generally, the equipment work surfaces will be upon the rockfill embankment which is to be constructed within the lake by the Owner. For such purpose, the Contractor shall inspect the embankment with the CM and QA Manager prior to the trafficking of any heavy equipment. If the embankment requires any remedial work the Owner will carry this out, or alternatively the CM may issue a variation and request the Contractor to carry out such work at the rate tendered by the Contractor in the Tender Documents.

Whenever working close to open excavations, the Contractor shall use appropriate methods and take necessary precautions to avoid damage or disturbance of the banks of the excavation. Any damage caused as a result of negligence by the Contractor shall be repaired at his expense and to the satisfaction of the CM.

Access to the rockfill embankment will be controlled by the CM. Once the rockfill embankment is approximately 300 m long and still under construction, the Contractor may

commence work with the approval of the CM. Overlapping of construction tasks will allow for survey and approval of each completed portion.

S4.5 QC and QA

- The Work shall be completed to the requirements laid out in the QC and QA Requirements Specification.

- QC shall be by the Contractor, and shall demonstrate the limits of the as-built excavation achieve the grades and limits shown on the Drawings. Results of bathymetric surveys by single beam sonar, manual soundings, and instrumentation of the excavation equipment with high resolution shall be compiled by the Contractor and provided to the QA Manager for review.

S5 FILL PLACEMENT

S5.1 Scope

This Specification provides the technical information for the fill placement for construction of the Bay-Goose Dike at Meadowbank Gold Project, Nunavut.

S5.2 Work Sequence

The Work will only start upon receipt of approval to proceed from the CM and following inspection and approval of pre-work conditions including as-built survey, requirements of the Care of Water Specification, installation of turbidity barrier and the implementation any water quality monitoring procedures required by the EMP.

S5.3 General

Fill placement shall be to the lines, grades and cross-sections shown on the Drawings and in accordance with the Specification.

Water control measures such as temporary drainage and pumping systems shall be operated and maintained as required to direct water away from the on-land fill placement areas as specified in the Care of Water Specification.

S5.3.1 Access

Access to the Work will be provided and coordinated by the CM.

S5.3.2 Waste Soil and Rock

Waste soil and rock shall be disposed of by the Contractor in an area designated by the CM.

Waste materials shall not be deposited into any riverbed, lake or other water channel and shall not be burned.

S5.3.3 Borrow Sources

The various borrow sources shall be tested prior to the start of construction and through construction as detailed in the QC and QA Requirements Specification.

S5.3.3.1 Rockfill Material

UM+Q Rockfill, and IV Rockfill shall be supplied by the Owner. The Owner is solely responsible for the supply, geochemical classification, segregation and appropriate use of NPAG materials.

S5.3.3.2 Coarse Filter

Filter materials shall be stockpiled in the crusher area. The storage area for the Coarse Filter material shall be inspected by the QC Manager prior to storage. Handling, stockpiling, and sampling of Coarse Filter materials shall be done to prevent segregation and contamination.

S5.3.3.3 Core Backfill

Core Backfill material shall be stockpiled in the crusher area. The storage area for the Core Backfill materials shall be inspected by the QC Manager prior to storage. Handling, stockpiling, and sampling of Core Backfill materials shall be done to prevent segregation and contamination.

S5.3.3.4 Till

Prior to approval of a borrow source, the gradation of the Till material shall be checked for filter compatibility against the Core Backfill gradation and approved by the Engineer. Other borrow sites may be considered subject to gradation testing and moisture testing and approval of the Engineer.

S5.4 Fill Materials

S5.4.1 IV Rockfill

IV Rockfill shall be run of mine material consisting of sound, hard, durable, well graded rock fragments free from ice, frozen chunks, organic matters, debris and other deleterious materials. NPAG IV rockfill can be placed above and below water level.

S5.4.2 UM+Q Rockfill

Rockfill UM + Q shall not be placed below water level.

UM+Q Rockfill material shall be run of mine material consisting of sound, hard, durable, well graded rock fragments free from ice, frozen chunks, organic matters, debris and other deleterious materials.

S5.4.3 Coarse Filter

Coarse Filter will be placed between Core Backfill and Rockfill, as shown in the Drawings.

Coarse Filter shall be from IV Rockfill, crushed, or screened to meet the design specification. Coarse Filter shall fall within the gradation limits shown in Table 5-1. Coarse Filter shall be free of clay, organic matters, debris, cinders, ash, refuse, snow, ice and other deleterious material, subject to the satisfaction of the Engineer.

TABLE 5-1: Gradation Limits for the Coarse Filter

Size (mm)	Percent Passing (%)
200	100
152.4	86-100
76.2	35-100
25.4	5-40
12.7	0-18
4.76	0-9
2	0-5

S5.4.4 Core Backfill

Core Backfill will be placed at the Cutoff Wall centreline, as shown in the Drawings.

Core Backfill shall be crushed material from IV Rockfill. Core Backfill shall fall within the gradation limits shown in Table 5-2. Core Backfill shall be free of organic material, debris, cinders, ash, refuse, snow, ice and, other deleterious material subject to the satisfaction of the Engineer.

TABLE 5-2: Gradation Limits for Core Backfill

Grain Size (mm)	Percent Passing by Mass (%)
50	100
25.4	66-100
12.7	46-100
4.76	23-68
0.425	0-20
0.075	0-15

S5.4.5 Till for Soil Bentonite

Till for use in soil-bentonite backfill or as backfill on its own shall be of free of organic material, debris, cinders, ash, refuse, snow, ice, boulder sizes and other deleterious material subject to the satisfaction of the Engineer.

Recommended gradation limits are provided in Table 5-3.

TABLE 5-3: Gradation Limits for Till

Grain Size (mm)	Percent Passing by Mass (%)
152.4	100
76.2	91-100
25.4	75-91
12.7	65-84
4.76	53-73
0.425	33-48
0.075	20-35

Alternative materials may be used for Cutoff Wall construction, subject to filter compatibility with Core Backfill material, and the approval of the Engineer. Cutoff Wall material performance criteria are provided in Cutoff Wall Specification.

S5.5 EXECUTION

Fill Placement shall be to the lines, grades and cross-sections shown on the Drawings using only suitable materials as required by these Specifications, or as approved by the Engineer on the basis of geochemical classification and gradation testing results.

Rockfill slope angles shown on Drawings are assumed and actual performance may vary.

Equipment suitability, methods of working, rate of progress and quality of work shall be demonstrated during the initial stages of the Work. In the event that the work performance is unsatisfactory for either quality or schedule requirements, there shall be immediate implementation of such changes as are required to ensure the required quality and scheduled completion of the Work are achieved.

Accumulation of water, snow, ice or other deleterious material(s) shall be prevented on the surface of the fill or foundations.

Material placement shall cease when satisfactory work cannot be carried out due to rain, snow, unsatisfactory materials or any other unsatisfactory conditions.

During placement of materials, mixing of the materials from adjoining zones shall be prevented. Segregation during transportation, dumping and spreading of material shall be avoided so that the material placed meets the gradation requirements in this Specification.

S5.6 Examination

Prior to commencing construction, the Contractor shall thoroughly examine other Work upon which his Work is dependent and report any deficiencies discovered to the CM.

S5.7 Survey and Initiation

Before the Work starts, all surfaces on which fill will be placed shall be surveyed and provided to the QA Manager in electronic form and paper form for use as base plans for layout, quantity calculations and as-built reporting.

The responsibility of surveys and soundings lies with the Contractor, unless otherwise arranged by the Owner.

The Contractor is responsible for the correctness and exactness of his work.

S5.8 Dimensional Tolerances

Minimum dimensions of fill areas are shown on the Drawings.

Coarse Filter materials shall be equal to or greater than the minimum thickness shown on Drawings.

Fill materials may experience settlement during and post construction. Settled areas shall be brought to grade by placing additional appropriate fill material in the settled area.

S5.9 Fill Placement and Compaction

Fill materials placed through water do not require compaction, with the exception of Core Backfill. Fill materials placed on land shall be compacted at the direction of the Engineer.

Methods for placement of Rockfill, Coarse Filter, and Core Backfill (with Coarse Filter wings) will require trials during the initial stages of the Work, with method subject to approval by the Engineer.

S5.9.1 IV Rockfill

Rockfill shall be advanced across the lake by "bulkheading," which consists of dumping short of the advancing rockfill face and then pushing the rockfill into the water with a bulldozer or other appropriate means deemed suitable by the Engineer.

S5.9.2 UM+Q Rockfill

UM+Q Rockfill shall be spread with a bulldozer or other appropriate means deemed suitable by the Engineer. UM+Q Rockfill shall not be placed below the lake surface.

There shall be no nesting of oversize stones and no existence of significant voids in the placed material.

The UM+Q Rockfill shall be placed in a maximum uncompacted lift thickness of 1,000 mm.

S5.9.3 Coarse Filter on Excavation Slope

Coarse Filter material shall be placed on the downstream face of the excavation as shown on the Drawings.

Coarse Filter placement shall be a minimum of 50 m behind the advancing excavation until the excavation is complete, surveyed and approved by the QA Manager. The slope of the rockfill embankment on which the Coarse Filter will be placed shall be surveyed and documented.

Coarse Filter material shall be placed to minimize segregation, such as by excavator bucket to minimize drop height and sorting, or by other method approved by the Engineer.

The Coarse Filter on Excavation Slope shall be a minimum of 1 m in thickness measured perpendicular to the rockfill slope.

Use of Coarse Filter against the downstream slope of the excavation is required, unless approved in writing by the Engineer.

S5.9.4 Core Backfill and Coarse Filter Wings

Core Backfill shall be placed in the excavation between the Coarse Filter on the downstream face of the excavation and the rockfill on the upstream face of the excavation.

Core Backfill placement shall be a minimum of 50 m behind the advancing Coarse Filter face until the advancing Coarse Filter face is completed, surveyed, and approved by the QA Manager. Core Backfill shall not be placed until the base of the excavation is approved by the QA Manager.

Trials shall be carried out during the initial stages of the Work for method of placement of Core Backfill and Coarse Filter “wings”, to the satisfaction of the Engineer. The leading edge of material placed in the excavation will be Core Backfill to ensure a continuous section, with no penetration by Coarse Filter materials or materials that might cause slurry loss during Slurry Trench construction.

S5.9.5 Fill Compaction and Geotechnical Investigation

Compaction or densification of the Core Backfill shall be carried out along the centreline of the slurry trench, with the final condition of the Core Backfill subject to the satisfaction of

the Slurry Trench Specialist and the Engineer. Methods for compaction or densification of Core Backfill will be trialed during construction, and are subject to approval by the Engineer.

The Contractor will demonstrate to the satisfaction of the Slurry Trench Specialist that the backfill is sufficiently stable for slurry trench construction. The Contractor will conduct a geotechnical investigation of the core materials at the discretion of and to the satisfaction of the Slurry Trench Specialist.

S5.10 QC and QA

The Work shall be conducted in accordance with the QC and QA Requirements Specification.

All foundation surfaces shall be approved by the QA Manager prior to placement of additional fill. All fill surfaces shall be approved by the QA Manager prior to subsequent placement of different fill materials.

QA inspection shall be carried out by the QA Manager and/or personnel to confirm the QC results including whether the specified fill placement, construction grades and limits are being attained and construction materials are meeting the required specifications.

S6 CUTOFF WALL

S6.1 Scope

This Specification provides the technical requirements for construction of the Cutoff Wall by slurry trench technique for the Bay-Goose Dike at the Meadowbank Gold Project, Nunavut. The scope of Work includes:

- Furnishing plant, labour, material, and equipment to construct the Cutoff Wall to bedrock surface as much as 8 m below still water line, for the shallow areas;
- Furnishing plant, labour, material, and equipment to construct the Cutoff Wall a minimum of 1.0 m into competent lakebed soils, for the medium depth areas;
- Furnishing plant, labour, material, and long reach equipment to extend the Cutoff Wall until refusal is encountered, to the approval of the Engineer;
- Construction and review of a test section; and
- Construction of the slurry trench and Cutoff Wall composed of soil-bentonite and/or cement-bentonite for the shallow areas;
- Construction of the slurry trench and Cutoff Wall composed of cement-bentonite for the medium depth areas.

S6.2 General

S6.2.1 Qualifications

The Contractor, his Subcontractor or his consulting advisor will have sufficient competent experienced personnel to construct a soil-bentonite and/or cement bentonite Cutoff Wall by Slurry Trench Method.

In particular, the Contractor shall retain a Slurry Trench Specialist to supervise the construction, slurry preparation, and perform Quality Control. The Slurry Trench Specialist shall demonstrate and have at least ten years of experience and/or five projects involving the successful construction of slurry walls.

The QC laboratory shall employ technicians with previous experience with slurry wall materials and modern permeability testing equipment.

S6.2.2 Responsibilities and Submittals

Responsibilities and submittals are summarized in the Administration Specification and in the QC and QA Requirements Specification.

S6.2.3 Access

Access to the Work will be provided and coordinated by the CM. The Contractor will not have sole access to the work area.

S6.2.4 Storage Area

Storage areas will be assigned within 1 kilometre of either abutment.

S6.2.5 Removal of Refuse

The Contractor shall clean up the work area as the Work progresses, removing debris from the work site to the designated disposal area from day to day. When the work is finished all buildings, tools, machinery, rubbish and waste materials shall be disposed of properly and the Contractor shall leave the site in a neat and orderly condition. The Contractor will arrange his work such that a minimum or no slurry remains at the end of construction.

S6.2.6 Waste Water

Any waste water from the works shall be directed to locations approved by the CM. The sizing and maintenance of any sumps or lagoons required to carry out the work shall be the responsibility of the Contractor.

S6.2.7 Site Investigation

The Contractor shall conduct a geotechnical investigation to characterize the condition of core materials prior to Slurry Trench construction at the discretion of the Slurry Trench Contractor. Soil conditions for construction shall be approved by the Contractor's Slurry Trench Specialist prior to Slurry Trench construction.

S6.3 Materials

S6.3.1 Slurry for SB Cutoff Wall Construction

Slurry shall consist of a stable colloidal suspension of bentonite in water and shall be controlled in accordance with the most current API Recommended Practice 13B-1, and the following requirements:

- At the time of introduction of the slurry into the trench, the slurry shall contain sufficient bentonite to ensure that the walls of the trench do not collapse. The Contractor is responsible for determining this quantity. Additional bentonite or admixtures may be required depending on the hardness and temperature of the water and the quality of the bentonite.

- The slurry shall have a minimum apparent viscosity of 45 to 55 seconds reading through a Marsh Funnel Viscometer given that the bentonite has had sufficient time to hydrate.

S6.3.2 Bentonite

Bentonite used in preparing slurry shall be pulverized (powder or granular) premium grade sodium cation montmorillonite and shall meet the most current API Specification 13A. Peptizing of the bentonite is not acceptable.

S6.3.3 Water

Fresh water, free of excessive amounts of deleterious substances that adversely affect the properties of the slurry shall be used to manufacture bentonite slurry. The slurry resulting from the water shall always meet the standards of this specification.

S6.3.4 Additives

Admixtures of the type used in the control of oil-field drilling muds such as softening agents, dispersants, and retarder or plugging or bridging agents may be added to the water or the slurry to permit efficient use of bentonite and proper workability of the slurry. No additives shall be used except as approved by the Engineer.

S6.3.5 SB Backfill

Where a SB backfill is selected, the material for trench backfilling shall be composed of fresh slurry, trench slurry and selected fills obtained from a designated borrow area and/or trench spoils. Trench slurry may be disallowed if additives are not acceptable to the Engineer. The soil shall be friable and free from roots, organic matter, refuse, ice, snow, or other deleterious materials. The backfill shall be thoroughly mixed and reasonably well graded with the properties listed below. The Contractor shall conduct tests on site to determine the proportions of all materials in order to meet these property requirements. Testing shall be by methods described in the QC and QA Requirements Specification, or equivalent approved by the Engineer:

- The hydraulic conductivity of the SB backfill shall be less than $1x10^{-9}$ m/sec;
- The slump of the backfill shall be 50 to 150 mm; and
- The ratio of bentonite to soil by dry mass shall greater than 1%.

S6.3.6 CB Backfill

Where a cement bentonite backfill is selected, the material for trench backfilling shall be composed of a mixture of fresh slurry, trench slurry, and powdered cement. Cement shall be thoroughly mixed with the slurry and introduced immediately prior to backfilling. The Contractor shall conduct tests on site to determine the proportions of all materials in order to meet the following requirements:

- The hydraulic conductivity of the CB backfill shall be less than $1x10^{-8}$ m/sec;
- The density of the CB mixture shall be 1120 to 1200 kg/m^3; and
- The CB mixture shall have a compressive strength of at least 172 kPa when fully cured (28-days).

S6.3.7 Dimensions and Alignment

A slurry trench Cutoff Wall shall be constructed to the lines, grades, and cross sections indicated on the Drawings. The trench shall have essentially vertical walls, a minimum width of 1.0 m, and shall extend to the prepared bedrock surface, for shallow areas and a minimum of 1.0 meters into competent lakebed soils for medium areas. Attempts shall be made to extend the Cutoff Wall until refusal is encountered for the medium areas. Refusal to be approved by the Engineer.

S6.3.8 Tolerances

The following tolerances shall apply to the slurry trench dimensions and construction.

- The slurry trench shall be essentially vertical. The working platform and/or excavating equipment may be levelled such that trench walls are plumb to within 3% of vertical.

- The depth of the slurry trench shall be measured and recorded as both a depth and an elevation to within 15 cm of the actual elevation.

- The slurry trench shall follow the designed alignment within 0.3 m of the centerline. The slurry trench may vary from the designed alignment if approved by the Engineer.

- Construction will not be permitted when the air temperature is below -6 ^{o}C or when severe weather conditions may compromise the quality of the work.

- Overlaps and changes in direction of the slurry trench shall require an over excavation at least 2 m beyond the centerline of the trench. In cases where the trench must be re-excavated (for example, due to an extended shutdown, cave-in, rework, etc.) the overlap into acceptable backfill shall be at least 3 m.

S6.3.9 Equipment

S6.3.9.1 Trench Excavation

Excavation of the slurry trench Cutoff Wall shall be accomplished by use of any suitable earth-moving equipment, or combination thereof, such as a backhoe, clamshell, chisels, road header attachment, cutter, and ripper teeth so the trench can be carried to its final depth of cut continuously along the trench alignment. Subsurface conditions shall be confirmed to the satisfaction of the Slurry Trench Specialist by geotechnical investigation prior to construction (investigation by Contractor). The equipment shall have the capability to excavate at least 2 m deeper than the maximum depth shown on the Drawings. Special chopping, chiselling or other suitable equipment may be used as necessary to satisfactorily accomplish the required excavation. The width of the excavating tool shall be equal to or greater than the specified minimum width of the slurry trench. Additional equipment such as airlift pumps and slurry desanders shall be used, if required, to clean the trench bottom slurry in accordance with the requirements of the specification. Equipment shall be designed and or used in a manner to minimize material left at the base of the trench. For example, the final pass of the excavator will be with a smooth bucket, or without teeth.

Ultimate depth of the trench will be recorded by manual soundings and by GPS instrumentation on the Contractor's excavation equipment.

S6.3.9.2 Slurry Batching Plant

The slurry batching plant shall include the necessary equipment including a high shear mixer capable of producing a colloidal suspension of bentonite in water, pumps, valves, hoes, supply lines, and all other equipment as required to adequately supply slurry to the trench. Storage ponds or tank shall be provided as needed to store initially mixed slurry to allow hydration, and to retain a reserve in case of substantial slurry loss for example, through underlying pervious zones. Slurry held in storage shall be agitated or recirculated to maintain a homogeneous mix. All slurry for use in the trench shall be prepared using a suitable mixer. No slurry is to be made in the trench. Mixing of water and bentonite shall continue until bentonite particles are fully hydrated and the resulting slurry is homogeneous.

S6.3.9.3 Mixing Equipment

Equipment for mixing and placing soil-bentonite backfill may consist of any suitable earthmoving or grading equipment, such as bulldozers, or blade graders or backhoes, or blenders such as a pug mill, that are capable of thoroughly mixing the backfill materials into a homogeneous blend having the required gradation and properties and placing the material in the trench as specified.

Equipment for batching CB slurry shall be capable of producing a stable suspension of cement in bentonite-water slurry, including a high shear mixer such as a colloidal or paddle mixer, pumps, valves, hoses, supply lines, and other equipment as required to adequately supply slurry to the trench. No slurry is to be made in the trench.

S6.4 Execution for SB Cutoff Wall

S6.4.1 Slurry Trenching

Excavation shall proceed continuously from the starting point to the finishing point. Slurry shall be introduced into the trench at the time trenching begins and shall be maintained in the trench during excavation and until backfilled. The stability of the excavated trench shall be maintained at all times for its full depth, to the satisfaction of the Slurry Trench Specialist. The slurry shall always be maintained at a level that ensures the stability of the

trench. Personnel, equipment, and prepared slurry shall be ready to raise the slurry level at any time.

S6.4.2 Stability

The Contractor shall be responsible for insuring and maintaining the stability of the excavated trench at all times for its full length and depth and shall be responsible for maintaining slurry densities and levels within specified limits. The Contractor shall control surcharges from all excavation and backfilling equipment, waste, berm construction, backfill stockpiles and any other loading situations that may affect trench stability. It is the Slurry Trench Specialist's sole responsibility to ensure that the mixing of the backfill and any stockpiles do not affect the open trench stability. In the event of failure of the trench walls prior to completion of backfilling, the Contractor shall re-excavate the trench and remove all material displaced into the trench and take corrective action to prevent further deterioration or collapse.

S6.4.3 Key

Unless otherwise directed by the Engineer, the bottom of the slurry trench will be keyed a minimum of 1 m into competent foundation soils, and into bedrock if possible prior to equipment refusal. The final depth of the trench shall be measured and checked and then provided to the QA Manager for approval immediately following excavation.

S6.4.4 Cleaning Trench Bottom

Upon completion of excavation, any loose material or cuttings shall be removed from the bottom of the trench with the excavation tools or other suitable means such as air lift pumps. If the slurry becomes unworkable, the heavy slurry shall be removed from the trench by airlift pump, clamshell, or other methods approved by the Engineer or the excess solids shall be removed from the slurry by settling ponds, screening, or desanding. The trench bottom shall be cleaned of debris and excess sand sediment backfilling. The trench shall be sounded immediately before placing backfill, and soundings shall be compared to the trench excavation soundings to verify the bottom. At a minimum, soundings shall be taken each morning and each evening and compared to monitor for cave-ins or excessive settlement.

S6.4.5 SB Backfill Mixing

The SB backfill shall be mixed beside the trench or in a designated remote location on site. If the backfill is mixed beside the trench, the Owner, in coordination with the Slurry Trench Specialist, shall control and provide sufficient equipment and work platform space to support slurry spills, trench stability, and mixing equipment operation. Unmixed materials shall not be placed or be allowed to fall into the trench. If the backfill is mixed in a remote location, adequate haul roads between the mixing pit or pad shall be built and maintained. The mixing pit or pad shall be lined with compatible soils or cement to prevent contamination with unsuitable materials. In either case, the Slurry Trench Specialist shall be responsible for the quality of the backfill.

Till and/or prepared aggregate materials and bentonite-water slurry and additional bentonite shall be mixed and blended in mechanical blenders or by windrowing, disk harrowing, bulldozing, and blading or by other approved methods by the Engineer. Deleterious materials, debris, snow, ice, and oversized particles shall be removed from the backfill before approval by the QA Manager for placement.

Mixing and blending shall be performed in such a manner as to produce the required gradation of backfill. The backfill material shall be thoroughly mixed into a homogeneous mass, free of large soil clods, lumps or pockets of fines, sand, or gravel. Occasional particles of up to 0.2 m in their largest dimension are permitted. Just prior to placing, the backfill material shall have a slump of 50 to 150 mm. To this end, the materials shall be sluiced with slurry from the trench or with fresh slurry during blending operations. Sluicing with water will not be permitted. Backfill shall be sampled and tested for permeability, density, slump, and gradation after preparation in accordance with the QC and QA Requirements Specification.

S6.4.6 SB Backfill Placement

The backfill shall be placed continuously from the beginning of the trench, in the direction of the excavation, to the end of the trench. The toe of the slope of the trench excavation shall precede the toe of the backfill slope so that the toe of the backfill shall not be closer than 6 m to the toe of the excavation slope, or as required to permit proper cleaning of the trench bottom as approved by the Engineer. Excavation shall not exceed 45 m from the toe of the backfill. Excavation must permit inspection and measurement immediately after completion and prior to backfilling. Placing operations shall proceed in such fashion that the surface of the backfill below the slurry shall follow a reasonably smooth grade and shall not have hollows, which may trap pockets of slurry during subsequent backfilling. Free

dropping of backfill material through the slurry will not be permitted. Initial backfill shall be placed by lowering it to the bottom with clamshell bucket or backhoe until the surface of the backfill rises above the surface of the slurry or by lead-in slope. Additional backfill may then be placed in such a manner that the backfill enters the trench by sliding down the forward face of the previously placed backfill. To accomplish this, sufficient backfill shall be piled behind the crest of the existing backfill slope to cause a mud wave action at the face of the backfill. The backfill shall not be dropped or deposited in any manner that will cause segregation.

An acceptable substitute for the initial placing of backfill by the use of a clamshell bucket may be a lead-in trench. The lead-in trench shall begin at a point outside of the limits of work and provide sufficient distance for the backfill face to form, by placing the backfill into the trench, before the toe of the backfill reaches the point where the cutoff is required. The lead-in trench shall be 10 Horizontal: 1 Vertical or flatter.

S6.4.7 Treatment for Top of Backfill

The surface of the backfill shall not be allowed to desiccate prior to placing the final cap. The cap shall consist of a 1 m thick layer of Till or UM+Q rockfill, both placed by the Owner. A temporary covering may be used to protect the backfill prior to placing the final cap. The temporary covering shall consist of at least 0.3 m of uncompacted backfill placed within 1 day after the SB backfill is placed. After a minimum of one week, the temporary cover may be removed. Any depressions or settlement shall be repaired by placing additional backfill or the permanent cap. Crossings of the Cutoff Wall for equipment will require either trench plates or compacted soil.

Upon completion of backfill placement and before desiccation of the backfill surface can occur, the Cutoff Wall shall be covered in accordance with the final cap details shown on the Drawings.

S6.4.8 Clean-Up

After completion of the backfill and capping, all remaining excavated material and slurry shall be removed and the surface shall be cleaned and levelled as directed by the Slurry Trench Specialist. Excess slurry shall be disposed by drying, mixing with dry materials or spreading in thin layers on adjacent areas designated by the CM. No slurry shall be left in ponds, and all ponds shall be pumped dry and backfilled in a controlled manner.

S6.5 Execution of CB Cutoff Wall

S6.5.1 Panel Construction

CB slurry trench construction is completed in discrete sections called panels. Panels are trench excavations completed by slurry trench technique. The Cutoff Wall is completed by extending alternating panels, by continuous excavation, or by a combination of alternating panels and continuous excavation until a continuous wall is completed.

CB slurry shall be introduced into each panel trench at the start of excavation and maintained in the trench during excavation.

Where panels are extended from or joined to existing panels, then the excavation of the new panel shall overlap the existing panel by a minimum of 1 m, as measured at the bottom of the trench.

The Slurry Trench Specialist shall direct the Work to ensure QC as specified in the QC and QA Requirements Specification and to minimize waste.

S6.5.2 Slurry and Trench Stability

Excavation for the CB Cutoff Wall will follow the same procedure as for SB Cutoff, Section 6.4.1. The Contractor shall maintain the stability of the excavated trench at all times for its full depth. The level of slurry shall not be permitted to drop more than 1 m below the surface of the Working Platform, except as approved by the Engineer.

S6.5.3 Mixing

Cement shall be thoroughly mixed with the water-bentonite slurry to form CB Slurry immediately prior to introduction of the CB Slurry into the trench.

S6.5.4 Backfill Placement

CB Slurry shall be introduced into the trench at the start of excavation of the trench, and shall be maintained in the trench during excavation.

For CB Slurry placement, the slurry shall be self-hardening, cement bentonite slurry. Once the CB Slurry is introduced into the trench, excavation shall be continuous. If excavation is delayed by more than 1 hour, the panel shall be agitated by other means to delay the set of

the CB Slurry. If the panel is not agitated, the panel shall not be disturbed for at least 8 hours or until the hardened cement bentonite is self supporting.

If at any time the slurry in the trench begins to set or gel before excavation is complete, or otherwise becomes unworkable, then fresh CB slurry with admixtures, as necessary shall be added to control the set. Addition of water to the CB slurry in the trench is not permitted.

S6.5.5 Key

Unless otherwise directed by the Engineer, the bottom of the slurry trench will be keyed a minimum of 1 m into competent foundation soils, and into bedrock if possible prior to equipment refusal. The final depth of the trench shall be measured and checked and then provided to the QA Manager for approval immediately following excavation.

S6.5.6 Top Treatment

After the panel has hardened, the panel is completed by topping off the CB by filling cracks with fresh CB or removing cracked portions and filling with fresh CB. As soon as possible after filling, a cap shall be placed over the CB Cutoff wall that consists of a 1 m thick layer of Till or UM+Q rockfill, placed by the Owner. The surface of the CB Wall shall not be allowed to desiccate prior to placing the final cap.

S6.5.7 Clean-up

Clean-up requirements for CB Cutoff Wall shall be the same as for the SB Cutoff Wall, as defined in Section 6.4.8.

S6.6 QC and QA

The Slurry Trench Specialist is responsible for QC of the Cutoff Wall construction. Survey, soundings, and materials testing shall be completed as per the QC and QA Requirements Specification.

S7 DRILLING AND GROUTING

S7.1 Scope

This section of the specification describes Drilling and Grouting for construction of the Bay-Goose Dike at the Meadowbank Gold Project, Nunavut. The Drilling and Grouting consists of all work required to seal fissures in the bedrock foundation and abutments by drilling and grouting holes from a working platform on the crest of the dike into bedrock foundations and abutments to provide a seepage cutoff.

Drilling and grouting shall include the following:

- All Works identified on the Drawings.

- Grouting along the dike foundation from the crest of the dike. The scope includes: installing casing, drilling grout holes in bedrock, water testing grout holes and pressure injecting grout in bedrock, installing tube-a-manchettes and removing casing, pressure injecting grout across the bedrock/cutoff wall interface (perhaps in multiple stages), and backfilling grout holes to surface.

- Curtain grouting shall include the drilling of one or more rows of holes and injecting the specified grout mix into the holes to create a low-permeability curtain. In rock, curtain grouting shall use staged working in the holes and shall use the split-spaced closure method.

- Across the bedrock/cutoff wall interface, tube-a-manchettes (or other approved comparable technique which achieves the same result) will be installed and injection grouting carried out on minimum 1.5 m centres.

Climate conditions may require working in enclosed areas on panels of limited length. The Contractor is responsible for any required enclosures or shrouding required.

Limited data is available on bedrock condition along the dike alignment.

S7.1.1 Provisional Extent of Work

The spacing, depth, orientation and pattern of grout holes, grout mixes, quantity and type may be varied at the discretion of the Engineer as a result of conditions revealed on site as grouting progresses.

Water pressure testing shall be used to control the sequence of work. As such, water pressure testing will be carried out before, during and as the curtain is brought to completion.

S7.2 Work Sequence

The Work will only start upon receipt of approval to proceed from the CM and following inspection, as-built survey, approval of pre-work conditions and approval of the Contractor's method by the Engineer.

S7.3 General

S7.3.1 Responsibilities

Responsibilities are listed in the Administration Specification and in the QC and QA Requirements Specification.

S7.3.2 Supervisory Staff Qualifications

The Contractor, his subcontractor or his consulting advisor shall have sufficient competent experienced personnel to drill and grout. The grouting operations manager shall have at least five (5) years experience of similar work. Drillers, grouting operators and grouting foremen shall have at least three (3) years experience in similar work.

S7.3.3 Weather Conditions

It is anticipated that the working conditions on site will be particularly challenging, with average temperatures ranging between -15 ^{o}C and -30 ^{o}C, and wind chill potentially taking these ambient temperature down to -50 ^{o}C.

S7.3.4 Access

Access to the Work will be provided and coordinated by the CM.

S7.3.5 Storage Area

Storage areas for all goods and materials will be provided by the CM. Cement, superplasticizer, bentonite and other concrete admixtures shall be stored in a dry heated building and held at a temperature between 7 ^{o}C and 12 ^{o}C.

S7.3.6 Delivery and Storage of Goods

The CM shall be responsible for the correct addressing of all goods and materials for their use on site.

The CM shall take delivery of goods and materials for grouting and store them appropriately on site.

S7.3.7 Water Supply

The CM shall be responsible to provide a water source. The Contractor is responsible for pipes, pumps, storage tanks and equipment to heat the water supply.

S7.3.8 Electronic Monitoring

Grouting will be directed based on measured ground response to grout injection. Measured flow rate and pressure data shall be digitally recorded. Flow meters, pressure transducers and pressure gauges shall be supplied and operated by the Contractor as required by this Specification.

S7.3.9 Removal of Refuse

The Contractor shall clean up the work area as the Work progresses, removing debris from the Site to the designated disposal area daily. When the work is finished all buildings, tools, machinery, rubbish and waste materials shall be disposed of properly and the site shall be left in a neat and orderly condition.

S7.3.10 Waste Water

Waste water from grouting operations shall be directed to locations approved by the CM. The sizing and maintenance of any sumps or lagoons required to carry out the work shall be the responsibility of the Contractor.

S7.3.11 Electrical Power

The Contractor shall provide generators sufficient for the electrical power needs of the drilling and grouting operations. Diesel for the generator(s) will be supplied by the Owner at no cost to the Contractor.

S7.4 Submittals

Requirements for the Contractor's Work Plan for drilling and grouting activities are described in Administration Specification. Requirements for reporting are described in QC and QA Requirements Specification and the Administration Specification.

S7.5 Setting Out and Dimensional Control

S7.5.1 Hole Locations

Grouting shall be carried out through the Cutoff Wall. The grouting centerlines and other key setting out information shall be provided by the Engineer following completion of the Cutoff Wall.

Set out of primary grout holes shall be approved by the Engineer prior to drilling.

S7.5.2 Permanence of Markings

Holes for grouting, drainage, checking or exploration shall be tagged in a logical and sequential manner for proper identification.

Each tag shall be installed immediately on completion of drilling and shall have a distinctive color and number as approved by the Engineer.

S7.5.3 Grout Hole Tolerances

Grout holes shall be collared within 200 mm of nominal locations.

Out of tolerance holes shall be backfill grouted and re-drilled.

S7.6 Materials

S7.6.1 Cement

Cement shall be obtained from one manufacturing source throughout the period of work to ensure consistent quality and compatibility with all concrete materials.

Cement used in grouting shall be Type III high early strength Portland cement as per ASTM C150 or C595 (or HE Portland cement as per CSA A3000-03 Cementitious

Materials Compendium). Cement shall be supplied in standard bags on pallets by the Owner.

Cement shall be less than 3 months old at the time of use in grout unless approved by the Engineer. Cement that has become partially hydrated during storage shall not be used in grout.

Microfine cement shall be Spinor A12 or equivalent approved by the Engineer, and supplied by the Contractor.

Heated storage for the cement is required to prevent the cement from freezing.

S7.6.2 Superplasticizer

Superplasticizer shall be a high-range water-reducing admixture used as a dispersion agent and shall comply with ASTM C494 Type F. Trials are required on site to verify satisfactory performance of specific superplasticizers with the cement used for grouting. Superplasticizer shall be:

Glenium 3030 NS supplied by:
BASF Admixtures Inc.
1800 Clark Boulevard, Brampton, Ontario
Tel: 800-387-5862

or similar, subject to satisfactory grout stability and viscosity being obtained as determined by the Engineer.

S7.6.3 Bentonite

Bentonite shall be finely ground (less than 200-mesh), premium grade sodium cation montmorillonite (Wyoming sodium bentonite) and shall meet all current API Standard 13A specifications. A suitable material is:

QUIK-GEL, supplied by
Baroid, Industrial Drilling Products
Houston, TX
Tel: 281-871-4612

S7.6.4 Viscosity Modifying Admixtures

Viscosity Modifying Admixtures (VMA's), if used, shall be required to increase the viscosity and prevent washout of the injected grout. VMA's shall comply with ASTM C494. Trial mixes at site will be required to determine the actual mix proportions and requirements for use. The VMA shall be:

Rheomac UW450 supplied by:
BASF Admixtures Inc.
1800 Clark Boulevard, Brampton, Ontario
Tel: 800-387-5862

or similar, subject to satisfactory grout stability and viscosity being obtained as determined by the Engineer.

S7.6.5 Accelerators

Because of the anticipated cold (and possibly frozen) bedrock conditions, a non-chloride set time accelerator shall be required to ensure that the water does not freeze before the grout mix sets. The set time accelerator shall comply with ASTM C494 Type C and Type E. Trials are required on Site to verify satisfactory performance of specified accelerators with the cement and other admixtures used for grouting. Accelerator shall be:

Pozzutec 20+ supplied by:
BASF Admixtures Inc.
1800 Clark Boulevard, Brampton, Ontario
Tel: 800-387-5862

or similar, subject to satisfactory grout stability, viscosity and set times being obtained as determined by the Engineer.

S7.6.6 Other Admixtures or Modifiers

Other additives could be required, such as retarders, inert fillers, volcanic ash or expanders. Such materials shall be products of proven quality and shall be subjected to the same field trial requirements as other mixes.

Prior to mobilization, all other grout additives shall be proposed by submittal to the Engineer for approval.

Trial mixes at site will be required to determine the actual mix proportions and requirements for use.

S7.6.7 Water

Water used in grout mix preparation shall be fresh, clean water from a local source which is free from injurious amounts of oil, silt, soluble chlorides, organic matter, acids, alkalis and other deleterious substances, and conforms to ASTM C1602. Water used for mixing shall be heated and held at temperature ranging between 7 ^{o}C and 12 ^{o}C.

S7.6.8 Materials Storage

Cement, superplasticizer, bentonite and other concrete admixtures shall be stored in heated, weather tight buildings or containers to provide protection from rain, dampness, and contamination and held at temperature ranging between 7 ^{o}C and 12 ^{o}C.

S7.7 Equipment

S7.7.1 Rock Drills

Drilling equipment shall be capable of installing/retrieving threaded steel casing through cutoff and overburden materials and a minimum 200 mm into bedrock, to a depth of 10 m. Steel casing may be replaced by PVC or other casing following completion of installation. In the absence of threaded casing, a casing jack shall be required on site for removal of installed casings.

Drilling equipment shall also be capable of drilling grout holes through the installed casing a further 50 m into bedrock. Grout holes in bedrock shall have a minimum internal diameter of 50 mm.

Drilling equipment shall be capable of installing/retrieving casing and drilling grout holes inclined vertically through to horizontally. All steel casing must be retrieved following the completion of grouting activities.

Water or foam flush shall be used as appropriate. Dry drilling (air flush) shall not be carried out.

S7.7.2 Water Heaters

Water heaters used to pre-heat mix water shall be of the West Coast Drilling Inc. propane water line heater variety or suitable alternative, as approved by the Engineer.

S7.7.3 Grout Mixers

Grout mixers shall be of the high-speed, high-shear ("colloidal") type operating at a mixing speed of more than 1,500 rpm, capable of thoroughly mixing the water, cement, bentonite and superplasticizers into a stable colloidal suspension. The nominal required capacity is 200 L of grout per batch.

Grout mixers shall be equipped with bag-splitters so that grout is mixed using whole bags of cement. Grout mixers shall be equipped with water meters (with units in litres) for batching the mix water, and each grout plant shall have available five 500 mL as well as three 250 mL graduated cylinders for batching superplasticizers and one, 1,000 g maximum weight, electronic, digital scale with an accuracy of ± 0.1 g for batching bentonite.

Paddle mixers shall not be used.

S7.7.4 Grout Holding Tanks (Agitators)

Grout holding tanks shall be of about 500 L capacity and equipped with paddles rotating at about 100 revolutions per minute. The lowest paddle shall be set within about 50 mm of the base of the tank.

Holding tanks shall be provided with a 0.15 mm sieve to screen solids or hardened grout from being discharged into the holding tank by the grout return line.

S7.7.5 Grout Pumps

Grout pumps shall be of the variable speed, progressing cavity (Moyno or Mono) type with a maximum delivery pressure of 20 bars at a sustained flow rate of 20 L/min. The rotation speed of each progressive cavity pump shall be controlled by a dial-pot voltage regulator (*i.e.* rate of injection shall be controlled by the rotation speed of the pump, not by re-circulation lines and valves).

Piston pumps (even if fitted with pressure surge chambers) shall not be used for grout injection.

S7.7.6 Pumps for Water Pressure Testing

Water pressure testing pumps shall be capable of delivering a sustained flow rate of 200 L/min at a maximum pressure of 8 bars.

S7.7.7 Grout Pipes

Pipes and hoses used to circulate grout from holding tank to point of injection shall have a maximum internal diameter of 25 mm and shall be rated for a safe working pressure of at least 30 bar. There shall be no sudden reductions in pipe diameter that might cause grout blockages. Fittings and connections on grout pipes and hoses shall be rated to 30 bar safe working pressure and shall include safety chains (whip checks).

S7.7.8 Valves

Valves to be used in-line with the injection lines shall be of the diaphragm type.

Plug cock valves and ball valves shall only be used for fully-open/fully-closed functions.

S7.7.9 Single Packers

Provide single packers for pressure grouting.

Single packers shall be capable of isolating a part of a grout hole to enable only the lower portion of the hole to be pressure grouted.

Single packers shall be sized based on the choice of grout hole diameter and method of drilling.

In general pneumatic packers shall be used for down hole work. Mechanical packers shall be used for grout injection at the top of the hole during consolidation grouting.

The maximum allowable leakage of grout past the packer shall be 0.1 L/min at a grout pressure of 20 bars at ground surface.

S7.7.10 Double Packers

Double packers shall be provided for water tests. Double packers shall be capable of isolating a 2 m long portion of the grout hole and allowing water to be pumped into that

isolated section. The supply of water to the injection point shall not be subject to significant head loss below the hole collar.

Double packers shall be sized based on the choice of grout hole diameter and method of drilling. Double packers shall be actuated by compressed nitrogen and the required compressed gas supplies, lines, regulators and pressure gauges shall be supplied. When sealing a section of grout hole the actuation pressure shall be at least 10 bars greater than the pressure used in the water test.

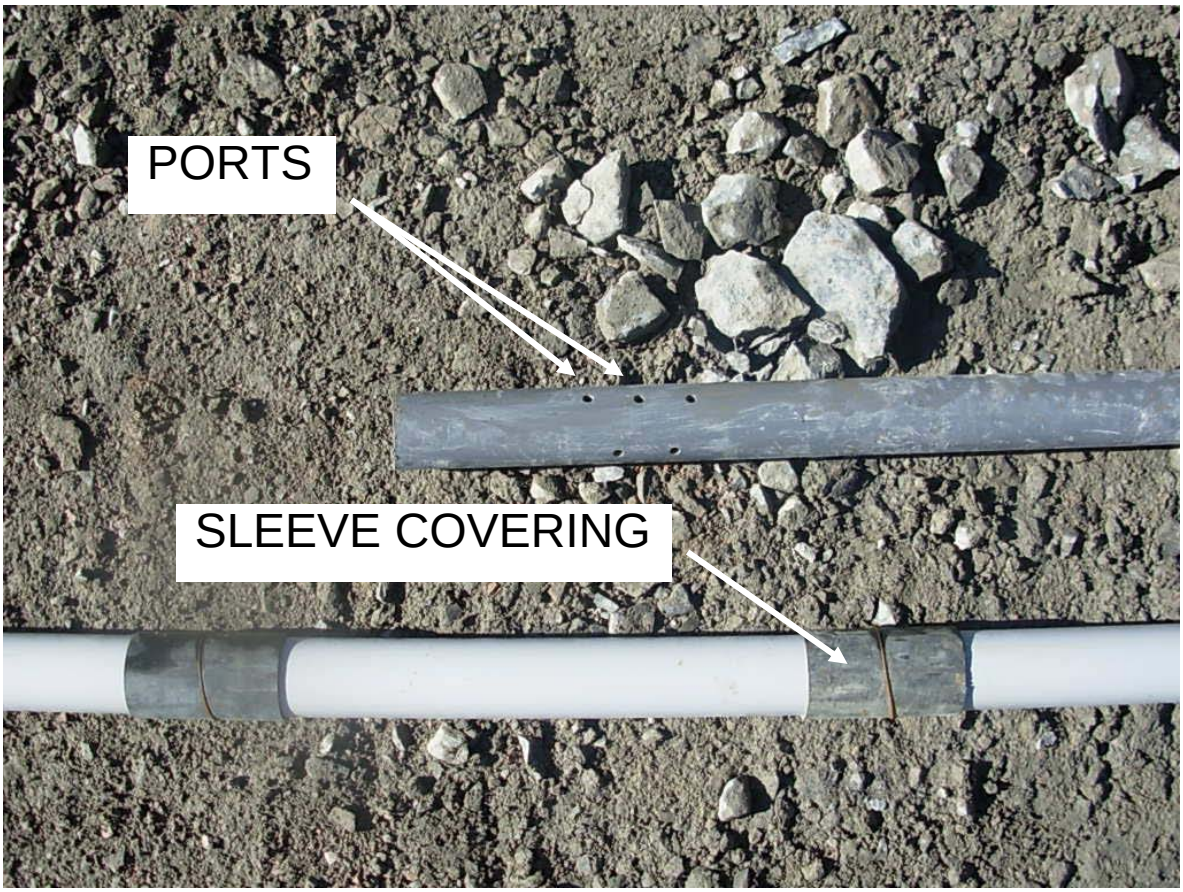
S7.7.11 Tube-a-manchette

Grouting of the upper bedrock, the soil between the Cutoff Wall and bedrock, or the Cutoff Wall/bedrock contact will be by tube-a-manchette method.

Tube-a-manchette (sleeve port) pipe shall be fabricated of threaded, nominal 50 mm diameter Schedule 40 PVC pipe, or suitable alternative as approved by the Engineer.

Port configuration shall be comprised of ten, 5 mm diameter holes spaced in an alternating 3 x 2 pattern equidistant around the circumference of the tube-a-manchette (*i.e.*, every 40 mm), as shown in the photo, and spaced at regular intervals of 30 cm to 50 cm centre-centre along the length of the tube-a-manchette interval drilled, or equivalent as approved by the Engineer.

Sleeve coverings shall be 20 mm in length and held stationary during the installation and backfill grouting process by tie-wire, zip-ties or equivalent as approved by the Engineer.



S7.7.12 Sleeve Port Packers

Sleeve Port Packers shall be selected by the Contractor to suit their choice of sleeve port (tube-a-manchette) pipe. Sleeve Port Packers shall be adjustable such that one to four adjacent ports may be injected with grout at the same time at the discretion of the Engineer.

S7.7.13 Pressure Transducers

Pressure transducers shall be of 25 bar maximum pressure and of the 4-20 mA type. Transducers shall have an accuracy of better than 1% FSD (Full Scale Deflection). Pressure transducers shall be mounted on the grout line tee at the hole collar, and shall be protected from the grout using an in-line gauge saver. Only one hole shall be monitored with each pressure transducer.

S7.7.14 Pressure Gauges

Bourdon-type pressure gauges shall be provided at each grout pump discharge and at each hole collar. Gauges shall be protected from grout using gauge savers independent of those used for the pressure transducers. Gauges shall have a minimum face diameter of 75 mm and shall be available with a 25 bar maximum pressure range.

S7.7.15 Flow Meters

Flow meters shall be of the electromagnetic type. Flow meters shall have a full scale capacity of 100 L/min and shall be capable of resolving flows as low as 0.3 L/min with an accuracy of ± 0.1 L/min. The flow meters shall provide an electronic signal of the 4-20 mA type.

S7.7.16 Calibration Checks

Pressure transducers and pressure gauges and flow meters shall be calibrated in the frequency specified in QC and QA Requirements Specifications.

Pressure transducers, pressure gauges and flow meters shall be re-calibrated if deviations are greater than ± 5%.

S7.7.17 Recording Equipment

The output of the pressure transducer (pressure) and flow meters (flow rate, total injected volume) shall be recorded and displayed on a data acquisition system, with the display visible close to the hole collar and adjacent to the pressure control valve. Graphical output capabilities shall be the same as those presented in this specification.

Data acquisition systems shall record time, pressure, and flow rate for each grout stage at one second intervals and these records shall be provided to the Engineer as comma separated (“csv”) files readable by a personal computer within 12 hours of completion of the shift.

Data acquisition systems shall also provide a RS232 output of pressure and flow rate to enable the Engineer to carry out real-time analysis of ground response to grout, if required, by connecting a laptop computer to the data acquisition system.

S7.7.18 Power Supplies and Electrical Protection

Data acquisition systems shall be powered by uninterruptible power supplies with surge and spike suppression.

Flow meters and pressure transducers shall be protected from electrical power surges and voltage spikes.

S7.7.19 Shelters

During periods of cold weather, the Contractor shall provide an enclosed, heated working area (Quonset Hut) of sufficient size to carry out the specified works on a panel-by-panel basis. Each panel will be a minimum of 50 m in length.

When not located within a Quonset Hut, temporary portable shelters shall be provided by the Contractor to protect data acquisition systems from rain, sun, snow, wind and freezing temperatures. Typical enclosures are shown on the following figure for reference.

S7.7.20 Radios

Sufficient handheld radios shall be provided by the Contractor so that grouting operators can communicate with the grout mixing station and with the grouting operations supervisor.

S7.7.21 Equipment Reliability

It is essential that grouting of a hole or stage of a hole shall continue smoothly until refusal of grout occurs. If grouting is interrupted through equipment breakdown or other delays, grouting of that hole and stage shall be terminated, if required by the Engineer, and all operations carried out in connection with that hole or stage as applicable shall not be measured for payment. Stand-by equipment of the same type as that specified above shall be provided by the Contractor to allow the grouting program to continue uninterrupted.

S7.7.22 Other Equipment

Hoses, pipes, wrenches, valves and all other equipment and small tools necessary for the drilling and grouting shall be provided by the Contractor.

S7.7.23 Spares

Sufficient spares shall be provided so that all equipment can be readily kept in full working order.

In particular, a sufficient number of mixers shall be available, ready for immediate use, to produce grout at rates required by the hole or holes being grouted and without interruption due to mixer breakdown.

S7.7.24 Water Pressure Testing Equipment

Water pressure testing shall be carried out using equipment dedicated to water testing and independent of the grouting operations.

The pump for water pressure testing shall be as specified.

S7.7.25 Grouting Testing Equipment

Equipment requirements for testing grout are listed in the QC and QA Requirements Specification.

S7.8 Grouting of Rock

S7.8.1 Methodology

Grouting of rock foundations will comprise of drilling and grouting of the curtain using the split-spaced closure method. Primary hole spacing shall be 6m or as directed by the Engineer.

Bedrock grouting will generally be upstage with packer, unless ground conditions require downstage working. If downstage working is required, it shall be instructed by the Engineer. Stages shall be 5 m length unless directed otherwise by the Engineer.

Depending on weather conditions or as directed by the Engineer, grouting activities and closure will be carried out panel-by-panel, with closure in one panel being achieved before work is initiated in the next.

S7.8.2 Performance Criterion

The grout cutoff shall have a target hydraulic conductivity of 4 Lugeons (1 Lugeons ~= $1x10^{-7}$ m/s) with no single test greater than 7 Lugeons as determined by water pressure testing in boreholes drilled into the installed grout curtain.

S7.8.3 Bedrock Drilling

Holes shall be drilled at locations shown on the Drawings, or as directed by the Engineer.

Holes through the Cutoff Wall shall be cased with Sch. 40 steel pipe socketed 200 mm minimum into rock. Steel casing may be replaced by PVC or other casing following completion of installation.

S7.8.4 Restriction on Drilling

Holes may not be drilled within 6 m of a grouted hole until at least 8 hours has elapsed after completion of grouting of that hole. If frequent communication between holes occurs, the minimum working distance requirements may be increased by the Engineer.

All primary holes can be drilled as most convenient. No secondary hole shall be drilled until its adjacent primary holes have been grouted.

S7.8.5 Protection and Cleaning of Drill Holes

Thoroughly wash all holes immediately before grouting the hole to remove cuttings, sediments, sludge and other loose material. Wash by injection of water at the bottom of the hole for five minutes or until return water is clear.

Protect cleaned holes from becoming clogged or obstructed using standpipes, rubber stoppers or similar means, until the holes are completely grouted. Drill holes shall be re-cleaned if clogging or obstruction occurs.

Grout hole casing shall be protected against damage prior to grouting.

S7.8.6 Removal of Water from Grout Holes

An air compressor and airline of sufficient capacity to be capable of blowing water or unset grout out of grout holes by the airlift technique shall be available on site. Water or unset grout shall be blown out of grout holes as required by the Engineer.

Drill holes shall be re-drilled if ice build-up occurs.

S7.8.7 Upstage Working

Upstage working shall comprise drilling the grout hole to full depth, washing and cleaning the hole, setting the packer at the top of the lowest stage, then grouting that stage. Provided that the target injection pressure is attained with grout refusal, grouting may continue by moving the packer to the next stage above after 10 minutes has elapsed and continuing to inject grout.

If the target pressure is not attained or, if the final grout flow rate when the volume limit of 1,500 L is reached is greater than 5 L per minute, then work shall stop on that hole until 6 hours have elapsed, unless otherwise instructed by the Engineer.

S7.8.8 Downstage Working

Downstage working shall comprise drilling the depth of a grout stage, washing and cleaning the hole, seating the packer at surface, injecting the grout, removing the packer, and washing the hole, completing these six operations before commencing the next stage.

Work shall commence in the stage nearest the surface and shall proceed down the hole until the final depth is reached.

At least 8 hours shall elapse between completing a stage and commencement of work on the next deeper stage.

After completion of the final stage, the hole shall not be washed and instead backfilled with grout.

S7.8.9 Split Spacing

The process of progressively closing a grout curtain by locating, drilling and grouting holes approximately at the midpoint between two other holes previously drilled and grouted. The spacing of the holes drilled and grouted may vary considerably from section to section, depending on conditions encountered. Deviation in spacing shall be at the direction of the Engineer.

S7.8.10 Closure Sequencing

Higher sequence holes shall not be started until both the adjacent prior holes have been completed. For example, a secondary hole shall not be drilled until grouting has been completed on both the adjacent primary holes.

S7.8.11 Panel-by-panel Sequencing

Depending on weather conditions or at the discretion of the Engineer, grouting activities and closure will be carried out panel-by-panel, with closure in one panel being achieved before work is initiated in the next.

Each panel will be a minimum of 50 m length, and shall overlap the previous panel by a minimum of 6 m.

S7.8.12 Water Pressure Testing

A water pressure test consists of measuring the rate at which water is accepted by bedrock for five periods of five minutes each. The pumping pressures to be used shall be supplied by the Engineer prior to testing.

Water pressure tests shall be carried out on 5 m long stages of cleaned grout holes. Generally, water pressure tests will be carried out in selected holes prior to grouting and in secondary holes to determine the adequacy of the grout curtain. Water pressure tests will be carried out independent of grouting operations.

The location and number of water pressure tests shall be determined by the Engineer. No such test shall be performed adjacent to a borehole grouted less than 8 hours previously.

S7.8.13 Grout Mix

The following grout mixes are proposed to initiate the grouting program:

Casing Grout

Water	200 L
Cement	100 kgs
Bentonite	7.5%
Superplasticizer	0 mL
7-day UCS value	~ 1 MPa

Mix A

Water	70 L
Cement	100 kg
Bentonite	0.0 kg
Superplasticizer	400 mL (0.9%)
Marsh Cone	30 seconds (nominal)

Mix B

Water	70 L
Cement	100 kg
Bentonite	0.0 kg
Superplasticizer	0 mL
Marsh Cone	35 seconds (nominal)

Mix C

Water	70 L
Cement	100 kg
Bentonite	0.6%
Superplasticizer	0 mL
Marsh Cone	45 seconds (nominal)

Mix D

Water	70 L
Cement	100 kg
Bentonite	1.2%
Superplasticizer	0 mL
Marsh Cone	60 seconds (nominal)

The above quantities shall be adjusted to match the cement weight such that the mix comprises a unit number of bags of cement.

Mixing shall be carried out by first introducing the water into the mixer followed by the superplasticizer and the dry bentonite. The water bentonite mixture shall be thoroughly mixed for three minutes before the cement is added. Mixing shall then continue for sufficient time to give a stable, uniform slurry.

Grout shall be continuously agitated during pumping and grouting.

S7.8.14 Trial Mixes

The grout mixes given are provisional mixes. Trials shall be carried out using the mixers and a standard batch size to verify that the mix gives the required grout quality. The Engineer shall require changes to the mix if required so that the specified grout viscosity and bleed parameters are obtained.

All grout shall have less than 5% bleed (bleed shall be measured over a two-hour period and shall comprise the decantation of clear water at the top of a 500 mL grout cylinder).

S7.8.15 Modifying Grout During Injection

The grout mix may be modified as grouting of a hole progresses depending on ground response and as directed by the Engineer. Mix A shall generally be used.

Modifications will most likely occur if high take zones are encountered and will likely comprise first the omission of the superplasticizer from the grout mix (to achieve an approximately 35 second Marsh cone grout), followed by an increase in bentonite content using the previously established standard mixes.

Possible modified mixes shall be batched and tested prior to the start of grouting.

S7.8.16 Grout Injection

The rate of injection shall be controlled by the rotation speed of the pump (*i.e.* using a dial-pot voltage regulator to vary or control the rotational speed of the positive displacement helical screw).

Pumping of the grout mix shall be at a steady flow rate of no more than 2 L/min./m, which results in a gradual pressure increase as the mix penetrates into rock discontinuities.

Grout shall be injected at the pressures and mix proportions specified.

Grouting shall take place continuously until grout refusal occurs or the instructed volume limit of 1,500 L for that stage is reached, unless otherwise instructed by the Engineer.

Grout refusal for a given stage shall be a flow rate of less than 2.5 L/min per 5 m stage and measured over a 10 minute period (or 0.5 L/min/m for 10 minutes) at the target pressures for the stage, unless otherwise as directed by the Engineer.

Any sudden loss of pressure or a sudden increase in grout take shall be immediately reported to the Engineer.

S7.8.17 Pressure Control

Grout injection shall be carried out by pressure control.

Grout shall be injected at a gradually increasing flow rate to a maximum of 10 L/min per 5 m stage or less until the target pressure is reached, at which time the flow rate shall be progressively reduced to maintain the target pressure with continued grout injection until refusal, as defined above.

Injection pressures shall be measured adjacent to the hole collar.

Initial specified target pressures at the mid-point of a stage are calculated as 0.2 bar per meter measured vertically from the working platform to the top of bedrock, plus 0.5 bar per meter from the bedrock surface. The minimum pressure required at mid-stage is 1 bar above the hydrostatic head from the water level, and the maximum is 20 bar.

Target pressures shall be evaluated by the Engineer based on the results of the water pressure tests and the ground response to grout and the target pressures shall be modified to suit the ground conditions.

S7.8.18 Grout Volume Limit

The maximum volume of grout injected per 5 m stage shall be 1,500 L unless otherwise instructed by the Engineer.

If the target pressure mentioned in Section 4.8.19 is not attained, or if the final grout flow rate when the volume limit of 1,500 L is reached is greater than 2.5 L/min, then:

- work shall stop on that hole,
- a period of 6 hours allowed to elapsed; and
- the same stage should then be re-injected.

S7.8.19 Additional Grout Holes

Secondary and higher order grout holes shall be required on either side of an existing grout hole if the grout take of any one stage in that hole is higher than 200 L/m. Additional grout holes should be completed to a depth of one stage beyond the noted high take, unless otherwise directed by the Engineer.

S7.8.20 Communication Between Grout Holes

Grouting of any hole resulting in connection to an un-grouted hole shall be immediately reported to the Engineer. Multi-point injection shall then proceed in the connected holes.

S7.9 Tube-a-manchette Grouting

Systematic tube-a-manchette grouting will be used to grout the upper bedrock and contact between the base of the Cutoff Wall and the bedrock interface or by suitable method approved by the Engineer, subject to a field trial. The following procedure or equivalent approved by the Engineer will apply. Tube-a-manchette casings shall be installed on

minimum of 1.5 m centres, regardless of whether or not both primary and secondary grout holes in bedrock are required.

As such, permeation grouting below the slurry Cutoff Wall will be carried out as outlined below:

- A 115 mm diameter casing will be installed through the Cutoff Wall, the zone of closely fractured bedrock, and a minimum of 200 mm into "competent" bedrock.

- Drilling, water pressure testing and bedrock grouting activities (using stable grout mixes) will be carried out within an approximately 90 mm grout hole, through the casing and to a depth of a minimum of 10 m vertical distance below the soil/bedrock interface.

Across the Cutoff Wall/foundation soil/bedrock interface, permeation grouting will be carried out as follows:

- Upon completion of each grout hole within the "competent" bedrock, a 50 mm diameter, Sch. 40 PVC, tube-a-manchette (TAM) will be installed from the top of the grout column, through the fractured zone and foundation soils and across the Cutoff Wall/bedrock or Cutoff Wall/soil interface, a distance of 0.5 m above the base of the slurry Cutoff Wall. The portion of the TAM above the noted required overlap with the slurry Cutoff Wall shall be comprised of solid (i.e., un-perforated) 50 mm diameter PVC.

- The annular space between the tube-a-manchette and the wall of the grout hole shall be backfilled with the specified Casing Grout, through the bottom port of the installed TAM (i.e., using the TAM itself as the tremmie tube).

- The installed casing shall be extracted once the grout hole has been backfilled with the Casing Grout. Following extraction, the annular space shall be re-topped up through the bottom port, until Casing Grout exits the collar of the grout hole. It may be necessary to carry out backfill grouting in several stages depending if the drilled materials cave into the grout hole during extraction of the casing.

- Grout (including Casing Grout) shall be flushed from any installed TAM, by deflating the packer(s) and flushing with clean water, at the completion of any stage of injection. Once the flush water returning to the collar is clean, the next stage above (or upstage) of the previously grouted interval may be injected.

- At the completion of grouting operations in any installed TAM, because of the potential for standing water to freeze within the TAM, the remaining water shall be air-lifted from the installed TAM and the interior of the TAM blown dry.

- The casing grout of each completed TAM installation shall be allowed to cure for a minimum of three (3) days before breaking of the cured casing grout.

- Water pressure testing and TAM grouting (using Type III cement and microfine cements if necessary) will be carried out via the installed sleeve port pipe, **after** the bedrock grout curtain has been completed.

Following the completion of both the bedrock and TAM grouting, inclined confirmation grout holes, orientated such that they cross the zones of highest takes, will be cored, water pressure tested and pressure grouted (if necessary).

S7.10 QC and QA

The Work shall be completed in conformance with the QC and QA Requirements Specification.

The Contractor is responsible for QC of his Work. The QA Manager will continuously observe all grouting activities.

The Owner shall provide facilities and labour as required, if available, to assist in conducting tests and sampling for QC and QA.

S8 INSTRUMENTATION

S8.1 Scope

This Specification describes the requirements for installation of instrumentation for the Bay-Goose Dike. The requirements include equipment and application software for the data acquisition, transmission and processing system.

All instrumentation will be supplied by the Contractor. The main items include installation of:

- vibrating wire piezometers, specifically "Model 4500MLP Piezometer" by Geokon, or equivalent;
- multiple bead thermistor strings;
- survey monuments and survey prisms along the crest of the dike;
- survey control monuments;
- Slope Indicator brand inclinometer casings 85 mm in diameter with CPI couplers; and
- prefabricated cabins for housing instrumentation terminals and data acquisition equipment.

The Contractor has the option of supplying alternate piezometers and readout instruments, subject to approval by Engineer prior to mobilization of equipment to site.

The work shall include the installation and testing of instrumentation, including all labour, materials and equipment to complete the design as shown on the Drawings. The Contractor will be responsible for protection of all instruments, leads, and connectors from damage and displacement during progress of the work, and shall provide markers and barricades as necessary.

S8.2 General

S8.2.1 Location and Installation Procedures for Instrumentation

The locations for the dike instrumentation are shown on the Drawings. Installation procedures are provided in this Section. The location of all instruments and installation will be subject to approval by the QA Manager.

Installation of the instruments shall be carried out in accordance with the Drawings, Specifications and the instructions of the equipment manufacturer. The Contractor shall be responsible for proper installation, testing, protection, and maintenance of instrumentation during construction.

Readings of each instrument shall be taken to verify correct functioning, and an initial set of readings shall be taken immediately after installation. Fill shall not be placed over the instruments or leads until the instruments have been tested and initial readings have been taken.

All cable conduits shall be marked with identification tags at intervals of 15 m, or closer if required. In addition, each instrument shall be marked with the identification given to it on the Drawings or as identified by the Engineer. Cable conduits shall be installed in maximum practicable lengths to minimize joints. Any necessary cutting, splicing and coupling shall be performed in accordance with the recommendations of the manufacturer.

Open ends of all incomplete lines of tubing, conduits and casing shall be sealed to keep the inside of tubes, conduits and casings free from foreign matter.

No traffic or equipment shall pass over any part of any instrument, leads or connections until at least 600 mm thickness of compacted material cover has been installed. The Contractor shall be responsible for protection of all instruments, leads and connections from damage and displacement during the progress of the Work, and shall provide markers and barricades as necessary.

S8.2.2 Electrical Protection and Safety

New and existing instrumentation shall be connected to the data acquisition system and it shall be confirmed that the system provides the following minimum protection for all electrical equipment:

- Over-voltage peak suppressor;
- Alternating current filter to eliminate interference; and
- Grounding system for lightning protection.

S8.2.3 Cabins and Accessories

All cabins, supports and accessories necessary for installation and protection of instruments shall be supplied by the Contractor.

All cabin and support structures shall be protected from corrosion and shall be finished and painted.

S8.2.4 Voltage and Electrical Frequency

Facilities requiring permanent electrical power, including battery chargers, shall be configured to operate at 110 V alternating current at 60 Hz.

S8.3 Equipment and Installation

All equipment shall be provided by the Contractor to install, operate and maintain the instrumentation. The instrumentation shall be protected with end caps and protective casing. All grouting equipment shall be provided by the Contractor including but not limited to tremie lines, grout pump and grout mix.

S8.3.1 Grout Mix

The vibrating wire piezometers, inclinometers and thermistors shall be installed using the following grout mix:

Water	660 L
Cement	100 kg
Bentonite	40 kg

The above quantities shall be adjusted to match the cement weight such that the mix comprises a unit number of bags of cement.

Mixing shall be carried out by first introducing the water into the mixer followed by the cement. The water cement mixture shall be thoroughly mixed before the bentonite is added. Mixing shall continue until a stable, uniform slurry is achieved.

Grout shall be continuously agitated during pumping and grouting.

S8.3.2 Geokon Multi-Level Vibrating Wire Piezometers (MLP)

S8.3.2.1 General

Vibrating wire piezometers shall include all equipment, leads, connection boxes, tubes, fluids, cement-bentonite grout, grout pump, grout tremie pipe, conduits and

accessories necessary for installation and operation. The piezometer, leads and connection boxes shall be provided by Geokon Inc. and the piezometer shall be specifically "Model 4500MLP Piezometer" (MLP) by Geokon, or equivalent. Data reading shall be carried out manually during construction of the Work and automatically thereafter.

Each MLP shall be capable of measuring water pressure over a range between 0 and 350 kPa, with a resolution of 0.025%, and accuracy of 0.1% over its entire range.

The spring loaded mechanism of the MLP shall be suitable for a nominal borehole size of 100 mm.

The connector boxes shall have capacity for simultaneous installation of all leads from the piezometers shown on the Drawings.

S8.3.2.2 Installation

MLP shall be installed according to the manufacturer's instructions, within the dike fill and foundation at elevations shown on the Drawings or as directed by the Engineer. Prior to installation, the piezometer shall be immersed in de-aired water in accordance with the manufacturer's instructions.

Prior to installation of MLP, a 100 mm diameter borehole shall be drilled at the location and to the elevations shown on the Drawings. The MLP shall be placed in the hole to the elevation shown on the Drawings. After the spring has been triggered the hole shall be grouted with cement-bentonite.

Leads from the instruments to the connector boxes shall be routed through PVC conduits installed into trenches, as shown on the Drawings or as required by the Engineer. The PVC conduit shall be protected from impact and damage during construction by hand-tamped sand backfill.

Installation of the piezometers shall be completed by connecting the leads to the connector boxes within the instrumentation cabin.

S8.3.3 Inclinometers

S8.3.3.1 General

The inclinometer casings shall be Slope Indicator brand, 85 mm diameter casing with CPI couplers. Inclinometer installations shall include inclinometer casing with self-aligning coupling, and all necessary materials and equipment for installation and operation in accordance with the manufacturer's specifications. Readings shall be taken with a probe and dedicated mobile read-out unit equipped with memory and software for subsequent data acquisition and processing by microcomputer.

The measurement probe shall be of stainless steel, metric, with a distance of 500 mm between wheels, with a detection range of plus or minus 50 degrees from vertical, with a maximum error of plus or minus 0.02 degrees over its entire range. The probe shall be provided with a 50 m length of cable, mounted on a cable reel, marked each 0.5 m. A pulley assembly shall be used to facilitate readings.

The dedicated mobile read-out unit shall be powered by rechargeable batteries. The unit shall include storage for at least 10,000 data points and an outlet for connection to a computer or printer.

The top of the completed inclinometer shall be equipped with a locked steel protective cover, to prevent entry of foreign matter into the inclinometer casing.

Inclinometer casings will be filled with non-toxic antifreeze to lake level.

S8.3.3.2 Installation

Inclinometer shall be installed within the Cutoff Wall as shown on the Drawings, and the annulus shall be grouted using a tremie line from the base of the installation, until grout return is observed at surface.

S8.3.4 Survey Monuments and Prisms

S8.3.4.1 General

Survey monuments and prisms shall be installed on the crest of the dike, as shown on the Drawings. Each survey monument shall be equipped with a pin or point, to facilitate reading by total station equipment. Readings shall be taken manually.

Survey control monuments shall be installed at locations specified on the Drawings. Survey control monuments shall be Type D monuments detailed in US Army Corps of Engineers EM1110-1-1002 Engineering and Design Survey Markers and Monumentation.

S8.3.5 Themistor Strings

S8.3.5.1 General

Thermistor strings shall include all equipment, leads, connector boxes, conduits and accessories necessary for installation and operation. Data readings shall be carried out manually during construction of the Work and automatically thereafter. Each thermistor string shall have the following:

- Length of each thermistor cable as shown on Drawings;
- Node located on each thermistor string as shown on Drawings;
- Cable to be heavy duty, direct burial rated 22 gauge, water-blocked instrumentation cable;
- Thermistor to be rated for a temperature range of at least -50°C to 50°C; and
- Thermistor to be accurate to within 0.2°C.

The connector boxes shall have capacity for simultaneous installation of all thermistor leads shown on the Drawings.

S8.3.5.2 Installation

Themistor strings shall be installed according to the manufacturer's instructions, within the dike fill and foundation at locations and elevations shown on the Drawings.

Leads from the instruments to the connector boxes shall be routed through PVC conduits installed into trenches, as shown on the Drawings. The PVC conduit shall be protected from impact during construction by hand-tamped sand backfill.

The installation of the thermistor string shall be completed by connecting the lead to the connector boxes within the instrumentation cabin.

S8.3.6 Instrumentation Cabins

The instrumentation cabin shall be installed at instrumentation section locations shown in the Drawings. Such cabins shall be suitable for relocation.

S8.3.7 Data Acquisition and Processing Equipment

S8.3.7.1 Scope

The data acquisition system and processing system for the instrumentation shall be supplied. The personnel selected by the CM to handle and operate the equipment and software shall be trained for operation and maintenance.

S8.3.7.2 Functional Requirements

The equipment must allow:

- Acquisition, verification, processing and display of the data obtained from the geotechnical instruments; and
- Sequential data recording complete with date and time, to allow retrieval of all data from any time.

S8.3.7.3 Data Acquisition and Storage Unit

The data acquisition and storage unit will receive data from the geotechnical instrumentation at time intervals selected by the operator. The unit shall be installed within the instrumentation cabin. Data shall be stored for subsequent transfer to a computer for processing. Data shall be recorded with corresponding legend, date and time.

S8.3.7.4 Computer Equipment and Software

A PC notebook computer system and a colour printer complete with system software and specialized software used for data transfer, evaluation, storing, processing and display shall be provided.

S8.4 QC and QA

The Work shall be completed in conformance with the QC and QA Requirements Specification.

Copies of instrument calibration test sheets provided by the manufacturer shall be provided to the Owner and the Engineer.

Testing of each instrument shall be undertaken by the Contractor immediately prior to and following installation. Readings will be recorded and submitted in the Daily Summary Report.

QA inspection shall be carried out by the QA Manager and/or personnel as required to confirm the QC results including whether the specified location and construction materials meet the Specifications and Drawings.

The Owner shall provide facilities and labour as required to assist in conducting tests and sampling for QC and QA.

S9 QC AND QA REQUIREMENTS

S9.1 Scope

This Specification defines the requirements for the QC and QA for the construction of the Bay-Goose Dike.

The Specification includes:

- Equipment list for the field laboratory;
- Minimum QC site inspections and testing requirements;
- Minimum QA site inspections and testing requirements;
- Documentation requirements for QC and QA activities;
- Checklists for QC/QA of the major construction activities; and
- Corrective action procedures for non-conforming materials.

S9.2 Site Inspection and Testing

The responsibilities of the Contractor, CM, and the QC and QA Managers for construction activities are listed in Table 9-1. Specific tasks are listed in Table 9-2.

TABLE 9-1: QC/QA Responsibilities

Activities	Tasks		
	Contractor	**Engineer**	**Owner**
Turbidity Barrier	• Perform QC testing including turbidity measurements.	• Perform QA testing including visual inspection; • Review survey data provided by CM; and • Documentation including photographic records.	• Ensure turbidity curtain is installed correctly and is not damaged; • Ensure curtain is anchored; and • Survey location of turbidity curtain.

Activities	Tasks		
	Contractor	**Engineer**	**Owner**
Survey	• Provide qualified surveyor and modern equipment in good repair. Survey as required to layout the Work and as requested by the QC/QA Managers to verify Work; • Bathymetry quantity surveys by singlebeam sonar; • Instrumentation of excavation equipment with high resolution GPS;and • Process survey data and provide to CM and Engineer.	• Review survey lines and chainage and layout; • Review survey data provided by Contractor; • Determine need for adjustments in field; • Approve quantities; • Approve layout for fill placement and grout holes; and • Manual soundings and readings to QA Contractor's survey.	• survey for layout of the work and for QA of the Contractor's work.
Borrow Source Materials Sources and Storage	• Ensure materials meet specifications; • Perform QC testing as per Table 9-2 • Surface water management; and • Control material segregation.	• Perform QA testing as per Table 9-2; • Perform visual inspection of materials; • Approve suitability of borrow material and storage area for construction; • Approve quantities; • Documentation including photographic records; and • QA of crushed materials.	• All classification and testing for PAG, NPAG; and • QC of crushed materials.
On Land Foundation Preparation and Excavations	• Specify removal methods for unsuitable materials; • Surface water management; • Prepare sumps, pumps and lines for dewatering; • Report unusual conditions; • Survey lines conform with Drawings; • Plan excavation and waste material disposal; • Provide excavation records; • All in-situ material loosened from excavation removed from Cutoff trench; and • Bathymetry survey.	• Review proposed waste storage areas; • Check surficial features to determine ground ice conditions; • Observe foundation preparation; • Documentation including photographic records; • Review survey lines and locations; • Review proposed excavation methods and blasting methods/pattern; • Observe foundation excavation; • Inspect trench and prepared foundation area prior to fill placement; • Report problems; • Review as-built survey report; and • Documentation including photographic records.	• Identify storage areas for waste materials.

Activities	Tasks		
	Contractor	**Engineer**	**Owner**
Dike Fill Placement	• Ensure placement and extent as per Drawings; • Provide on-land topography; • Plan material storage and waste material disposal; • Ensure fill materials conform with specifications; • Ensure core fill material compaction achieved acceptable level of compaction by performing dynamic cone test or other equivalent test; • Report any unusual conditions; • Survey extent of any unusual conditions; • Surface water management; • Perform as-built survey; and • Perform underwater survey and inspection prior to and after placement of Coarse Filter on downstream slope of excavation.	• Review survey lines and locations; • Manual soundings to QA underwater survey; • Inspect excavation and prepared foundation area prior to fill placement; • Inspect fill surface prior to subsequent fill placement; • Perform QA testing including gradations of placed material, moisture content; • Inspection of excavation following placement of Coarse Filter, prior to placement of core backfills; • Inspect fill quality and extents; • Approval of suitability of fill materials prior to placement; • Report problems; • Review as-built survey report and approve quantities; and • Documentation including photographic records.	• Perform tasks listed in Table 9-2.
Foundation Preparation	• Specify removal methods for unsuitable materials; • Provide soundings of lake bed surface; and • Report unusual conditions.	• Review and approve survey data for lake bottom; and • Confirm and approve bedrock surface by visual inspection.	• Identify storage areas for waste materials.
Cutoff Wall Construction	• Ensure placement and extent as per Drawings; • Plan material storage and waste material disposal; • Ensure Cutoff Wall materials conform with specifications; • Perform QC testing and provide results; • Report any unusual conditions or problems and provide resolutions; • Survey extent of any unusual conditions; and • Perform as-built survey.	• Review survey lines and locations; • Perform QA testing; • Inspect Cutoff Wall material; • Report problems; • Review as-built survey report; and • Documentation including photographic records.	
Drilling and Grouting	• Plan material storage and waste material disposal; • Perform QC testing; • Ensure grouting equipment and	• Review survey lines and locations; • Perform QA testing; • Inspect grouting equipment and materials;	•

Activities	Tasks		
	Contractor	**Engineer**	**Owner**
	materials conform with specifications; • Provide real-time pressure, injection rates and volume records for grouting process; • Report any unusual conditions; • Survey extent of any unusual conditions; and • Perform as-built survey and grout hole orientation surveys.	• Monitor injection process including real-time pressures, injection rates and volume; • Report problems; • Review as-built survey report; and • Documentation including photographic records.	
Instrumentation Installation	• Provide instrumentation, supporting equipment and software, operating manuals, and demonstration to mine staff; • Provide instrumentation casings; • Provide energy sources for applicable instrumentation; • Report any unusual conditions; • Survey extent of any unusual conditions; and • Perform as-built survey.	• Review survey lines and locations; • Inspect instrumentation, supporting equipment and software; • Report problems; • Review as-built survey report; and • Documentation including photographic records.	
Final Site Clean Up			• Inspection.

S9.2.1 Field Laboratory

The Owner shall provide a proper facility/location for performing the required testing in addition to suitable testing equipment, maintained in good repair, properly calibrated at all times.

The following should be provided in the field laboratory as a minimum:

- ASTM Gradation Sieves and shaker;
- Hydrometer and Hydrometer jar -2;
- Oven for moisture content and density;
- Running water and appropriate waste water disposal as approved by AEM Environment;
- Aluminium moisture boxes- 4;
- Stainless steel mixing bowls – 3 large round and 3 large rectangular;
- Scale for density and moisture content;

- Sample splitter – 1 large and 1 standard;
- Split Standard Proctor mold with hammer and straight edge;
- Tool set including screwdrivers, chisels, hammers, etc;
- Brush, soft bristle;
- Wash bottle;
- Mortars and pestles – 2;
- Round bottom scoops – 1 large and 1 small;
- Timers – 2 – 1s resolution to 24 hours, electronic;
- Mechanical analysis stirrer for hydrometer testing;
- Concrete cylinder casings for grout strength testing (50 mm dia. x 100 mm height);
- 10 L Sample buckets and lids;
- Crates for shipping samples, or equivalent;
- Marsh funnel and cup – 1 set per grout plant;
- Mud balance – 1 per grout pant;
- Lombardi cohesion plate – 1 per grout plant;
- Thermometer- 2 per grout plant, graded in Celsius;
- 500 mL - Graduated cylinders - 5 per grout plant;
- 250 mL – Graduated cylinders – 3 per grout plant;
- Electronic, digital scale – 1,000 g max. weight, accuracy ± 0.1 - 1 per grout plant;
- pH tape – 1 set;
- Slump cone and rod – 1 set; and
- Sand Cone and/or nuclear densometer.

In addition the Owner shall provide calibration certificates to the QC and QA Manager.

The Slurry Trench Specialist will provide his own equipment for testing bentonite slurry and SB and/or CB Backfill.

S9.2.2 Minimum Field Testing for QC/QA

The QA and QC minimum testing requirements and frequency are listed in Table 9-2. At a minimum, all the required testing to document the construction quality shall be performed.

Characterization of different rock types, segregation, and placement during construction with respect to geochemistry is the responsibility of the Owner.

TABLE 9-2: QC/QA Activity with Testing and Frequency

	Quality Control			Quality Assurance	
Work	**Test and Criteria***	**Frequency**	**Responsible**	**Test and Frequency**	**Responsible**
Pre-Construction					
Care of Water	Visual Observation	Continuously	Owner	Continuously	QA Manager
	Water Quality	- see EMP	Owner		
Turbidity Barrier	Visual Observation	Continuously	Owner	Continuously	QA Manager
Borrow Material Storage	Visual Observation	Continuously	Owner	Continuously	QA Manager
Foundation Preparation and Excavation					
Location and extents - on-land	Survey	Pre- and post-placement	Contractor	1 every 5 QC survey by GPS	Owner
	Visual Observation	Continuously	Contractor	Continuously	QA Manager
Location and extent - underwater	Single beam bathymetric survey	Continuously	Contractor	Manual soundings every 5 metres	QA Manager
	GPS instrumentation of excavation equipment	Continuously	Contractor		
Fill Placement					
Rockfill					
Gradation	Visual observation of gradation of stockpile and as placed	Continuously	Owner	Continuously	QA Manager
Location and Extent	Observation of placement	Continuously	Owner	Visual inspection twice per shift	QA Manager
	Single beam bathymetric survey on 1 m spacing	Pre-placement	Owner	Manual soundings on 50 m spacings	QA Manager
	Crest survey	Post-placement	Owner	Manual measurement	QA Manager
Coarse Filter (on slope)					
Gradation	Gradation of stockpile and as placed (ASTM C136)	1 every 3,000 m^3	Contractor	1 every 5 QC tests	QA Manager
	Visual observation as placed	Continuously	Contractor	Visual inspection twice per shift	QA Manager
Location and extent	Single beam sonar bathymetric on 1 m spacing	Pre- and post-placement	Contractor	Manual soundings every 5 m	QA Manager

	Quality Control			Quality Assurance	
Work	**Test and Criteria***	**Frequency**	**Responsible**	**Test and Frequency**	**Responsible**
	GPS instrumentation of placement equipment	during placement	Contractor		
Core Backfill					
Gradation	Gradation of stockpile and as placed (ASTM C136)	1 every 1,000 m^3	Contractor	1 every 5 QC tests	QA Manager
	Visual observation as placed	Continuously	Contractor	Visual inspection twice per shift	QA Manager
Location and Extent	Observation of placement	Continuously	Contractor	Continuous observation	QA Manager
Density	Sand cone or densometer	1 every 500 m3	Contractor	Observe 1 of every 5 QC tests	QA Manager
Strength	Dynamic cone penetration test	Every 25 linear m	Contractor	Observe	QA Manager
Coarse Filter (dike core)					
Gradation	Gradation of stockpile and as placed (ASTM C136)	1 every 3,000 m^3	Contractor	1 every 5 QC tests	QA Manager
	Visual observation as placed	Continuously	Contractor	Visual inspection twice per shift	QA Manager
Till (stockpile)					
Gradation	Gradation (ASTM D 422-63)	1 every 500 m^3	Contractor	1 every 5 QC tests	QA Manager
	Visual inspection	Continuously	Contractor	Continuously	QA Manager
Moisture Content	Laboratory test (ASTM D2216)	1 every 500 m^3	Contractor	1 every 5 QC tests	QA Manager
Compaction of Core Backfill and Till					
Density	Densometer or sand cone	1 per 50 linear m	Contractor	Observe 1 in 5 tests	QA Manager
	Survey for volumetric comparison	Prior to and following compaction and fill placement			
Cutoff Wall Construction					
Water for Slurry Mixing					
pH	6 to 9 (API RP 13B-1)	1 per source	Contractor	Observe QC testing method	QA Manager
Hardness	< 250 ppm (API RP 13B-1)	1 per source	Contractor	Observe QC testing method	QA Manager

	Quality Control			Quality Assurance	
Work	**Test and Criteria***	**Frequency**	**Responsible**	**Test and Frequency**	**Responsible**
Total Dissolved Solids	< 500 ppm (EPA 600)	1 per source	Contractor	Observe QC testing method	QA Manager
Bentonite	Certificate of compliance with the Specification shall be obtained from the Manufacturer	1 per shipment of bentonite delivered to the site			
New Bentonite Slurry					
Viscosity	45 to 55 Marsh seconds (API RP 13B-1, ASTM D6910)	1 per 500 m^3	Contractor	Observe 1 every 5 QC tests	QA Manager
Density	> 1025 kg/m3 (ASTM D4380)	1 per 500 m^3	Contractor	Observe 1 every 5 QC tests	QA Manager
Bentonite content (demonstrate)	> 4% (Weight-Volume)	1 per 500 m^3	Contractor	Observe 1 every 5 QC tests	QA Manager
In-Trench Bentonite Slurry					
Density	1025 to 1250 kg/m^3 (ASTM D4380)	2 per shift, with samples obtained from the mid-depth of the trench near the toe of backfill slope	Contractor	Observe 1 every 5 QC tests	QA Manager
Viscosity	> 40 Marsh seconds (API RP 13B-1, ASTM D6910)	2 per shift, with samples obtained from the mid-depth of the trench near the toe of backfill slope	Contractor	Observe 1 every 5 QC tests	QA Manager
SB Backfill					
Slump	50 to 150 mm (ASTM C143)	greater of 1 per shift or 1 per 500 m^3	Contractor	Observe 1 every 5 QC tests	QA Manager
Gradation	Per design mix (ASTM D1140)	1 per 1,000 m^3	Contractor	1 every 5 QC tests	QA Manager
Density	240 kg/m^3 > In-trench Slurry (ASTM C138 or D4380)	greater of 1 per shift or 1 per 500 m^3	Contractor	Observe 1 every 5 QC tests	QA Manager
Permeability	$<10^{-9}$ m/s (ASTM D5856)	1 per 1,000 m^3	Contractor	1 every 5 QC tests	QA Manager
CB Backfill					
Permeability	$<10^{-8}$ m/s (ASTM D5084) when fully set	1 per 1,000 m^3	Contractor	1 in 5 QC tests	QA Manager
Density	1120 to 1200 kg/m^3	1 per 1,000 m^3	Contractor	1 in 5 QC tests	QA Manager

	Quality Control			Quality Assurance	
Work	**Test and Criteria***	**Frequency**	**Responsible**	**Test and Frequency**	**Responsible**
Strength	172 kPa compressive strength	1 per 1,000 m^3	Contractor	1 in 5 QC tests	QA Manager
Trench and Backfill					
Trench Continuity	Trench continuity by excavator bucket	Continuous	Contractor	Observe 1 every 5 QC tests	QA Manager
Cutoff Wall surface	Manual sounding	1 every 5 m		Observe soundings	QA Manager
SB Backfill slope	Manual sounding	Start and end of shift	Contractor	Observe soundings	QA Manager
Drilling and Grouting					
Location and Extents	Grout Hole Collar Survey	Each Hole	Contractor	1 every 10 QC tests	QA Manager
Equipment Calibration	Calibration Checks (pressure transducer and gauges)	1 per week against a reference pressure gauge	Contractor	1 every 5 QC tests	QA Manager
	Calibration Checks (flow meters)	1 per week against a known volume container.	Contractor	1 every 5 QC tests	QA Manager
Grout Mix					
Viscosity	Marsh Funnel*	1 at the initiation of injection of every stage, and thereafter, at every change of mix.	Contractor	1 every shift, per grout plant carrying out injection grouting (day shift and night shift)	QA Manager
Shear Strength	Vane Shear	1 at the initiation of injection of every stage, and thereafter, at every change of mix.	Contractor	1 every shift, per grout plant carrying out injection grouting (day shift and night shift)	QA Manager
Mud Balance	See Note*	1 at the initiation of injection of every stage, and thereafter, at every change of mix.	Contractor	1 every shift, per grout plant carrying out injection grouting (day shift and night shift)	QA Manager

	Quality Control			Quality Assurance	
Work	**Test and Criteria***	**Frequency**	**Responsible**	**Test and Frequency**	**Responsible**
Bleed	Less than 5% as measured over 2hr period as clear water at the top of a 500 mL cylinder	1 at the initiation of injection of every stage, and thereafter, at every change of mix.	Contractor	1 every shift, per grout plant carrying out injection grouting (day shift and night shift)	QA Manager
Mix Water and Grout Mix Temperature	See Note*	1 at the initiation of injection of every stage, and thereafter, at every change of mix.	Contractor	1 every shift, per grout plant carrying out injection grouting (day shift and night shift)	QA Manager
Strength Testing	See Note*	2 sets of 6 cylinders per grout mix used per week.	Contractor	1 every 5 QC tests	QA Manager
Grout Injection and Water Pressure Testing					
Pressure and volume monitoring	Real time monitoring and data acquisition	Continuous	Contractor	Continuous Visual Monitoring	QA Manager
Instrumentation					
Calibration	Test Readings	Pre and Post Installation	Contractor	Visual observation during installation, review of test readings	QA Manager

*Testing procedures shall follow the Standards listed in Table 1-1, with exceptions to standard procedures noted on each test sheet. Gradation testing results shall comply with the gradation limits provided in Fill Placement Specification. Grout testing results shall comply with the Drilling and Grouting Specification.

Increased testing frequencies shall be instituted if observations of normal testing frequency results indicate potential problems. Additional testing may be warranted when:

- The material repeatedly fails to meet specifications;
- The degree of compaction is doubtful;
- The materials appear to differ from those specified;
- Less than the required number of compaction equipment passes are made;
- The material moisture content differs from those specified;
- The lift thicknesses differ from those specified; and/or
- Adverse weather conditions occur.

S9.2.3 Survey Requirements

As part of the QC, important survey information has to be taken throughout the construction. Survey requirements include:

- Survey of rockfill crest limits at 20 m stationing;
- Survey of trench excavation crest on upstream and downstream side at 10 m stationing;
- Detailed bathymetry survey of lakebed prior to fill placement;
- Detailed bathymetry of trench excavation prior filter placement;
- Limits of the excavation as determined by the readings from instrumentation of the Contractor's equipment, including sections on 5 m stations including the bottom of the trench at centreline, at the toe of the excavation slopes, at midway up the slopes, and at the crest;
- Survey of trench crest on downstream side slope after Coarse Filter placement at 10 m stationing;
- Detailed bathymetry survey of trench excavation after Coarse Filter placement, in addition to readings from instrumentation of the Contractor's equipment;
- Survey of Core Backfill offset limits on the dike crest on upstream and downstream sides during placement of Core Backfill at 10 m stationing;
- Survey of excavated slurry trench excavation offset limits on the dike crest on upstream and downstream side on 10 m stationing. This survey shall be completed prior to backfilling of the slurry trench;
- Survey, at centerline, of the top of Cutoff Wall at 10 m stationing prior to covering the wall;
- Survey of limits of the granular cap at 20 m stationing;
- Survey of limits of the thermal cap at 20 m stationing;
- Survey of all grout casings at both the collar and at casing bottom at maximum depth; and

- For the Slurry Trench;
    - it shall be demonstrated by the Contractor to the satisfaction of the Engineer that the trench is continuous and the minimum specified depth. The Engineer or representative will be available onsite to verify these measurements. Trench continuity shall be assured by the action of movement of the trench excavation equipment such that the digging tools can be passed vertically from top to bottom of the trench as well as moved horizontally along the axis of the trench without encountering unexcavated material. Depth of the final excavated trench shall be demonstrated by direct measurement to the satisfaction of the Engineer.
    - Soundings shall be taken every 5 m along the trench centerline using a weighted tape, cable or other device.
    - Soundings shall be recorded to the nearest 0.15 m.
    - Soundings shall record the following:
    - Bottom of Excavation: The elevation of the trench bottom shall be determined subject to approval by the Engineer.
    - Bottom of Excavation Prior to Backfilling: Soundings shall be used to monitor for sidewall collapse and accumulation of sediments.
    - Elevation: of sounding reference to establish the bedrock elevation.
    - Profile of Backfill Slope: The SB backfill slope and trench bottom shall be sounded at the beginning and end of each shift and converted to an as-built drawing. This drawing shall be reviewed daily as an indication of trench collapse, excessive settlement or sloughing.

The Contractor shall instrument his excavation equipment with real time, high resolution GPS to allow recording of the position of the excavator bucket.

S9.3 Documentation

The QA Manager shall document all testing and that all QA requirements have been addressed and satisfied. Further, the QC Manager shall provide field reports, data sheets and checklists to substantiate that requisite monitoring tasks have been implemented. The QC and QA Managers shall maintain a job site file of plans, specifications, checklists, test procedures, daily and weekly reports, logs and other project relevant documents.

S9.3.1 Daily Summary Report

Daily record keeping by the QC Manager shall at a minimum include:

- Date, project name and location;
- Parties on-site participating in meetings and discussions;
- Daily summary, reporting meetings and/or discussions with the CM summarizing QC daily activities;
- Daily Construction activities;
- Daily weather observations including precipitation and temperature;
- Compaction equipment (type and weight) and typical number of passes;
- Equipment used to place and spread materials;
- Daily field test results data sheets;
- Laboratory test results data sheets;
- Equipment calibration or recalibration forms as applicable; and
- Design and specification modification/clarification documentation.

For Cutoff Wall construction, the Daily Summary Report will include:

- Results of all tests performed shall be recorded on forms acceptable to the Engineer and signed by the Slurry Trench Specialist. These forms will be available to the Engineer at all times for inspection. Copies of all QC documents will be submitted daily to the QA Manager;
- A record of soundings taken during construction including the depth of the trench, key, and backfill slope obtained each morning, evening and continuously kept to ensure that the trench remains open. The soundings used to generate an as-built profile of the trench, as constructed. Soundings should reference a fixed datum;
- As-Built profile drawing of the trench bottom and backfill slope shall be continuously maintained by the Contractor. The profile shall indicate the extent of excavation and backfill at the end of each working day. The daily profile shall be drawn in an electronic format or by hand, as directed by the QA Manager;
- A record of plant-mixed bentonite slurry quantities, proportions, properties, and admixtures made during construction, including any adjustments to the slurry mixture;
- A record of in-trench bentonite slurry properties made during construction, and also procedures and admixtures used to modify slurry properties;
- A record of backfill material quantities, properties, and mix adjustments made during construction;
- The location of backfill samples taken for laboratory testing; and

- A record of QC samples, tests and test results including values exceeding Specifications.

For Drilling and Grouting, the Daily Summary Report will include:

- Drill hole number, length drilled, size and orientation, drills used, and observations on location, estimated quantity of water inflow intercepted, drilling action and zones of hole instability or voids;

- Orientation survey results for drilled curtain grout holes;

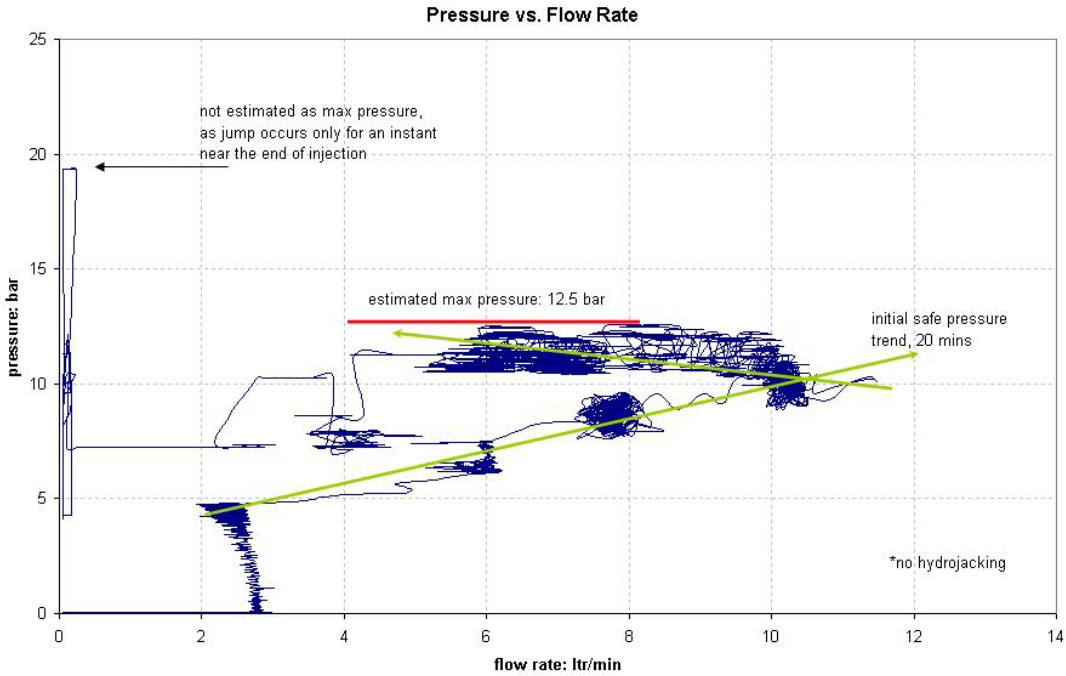
- Grouting records, including quantity, mix, location and injection pressures of all grout placements;

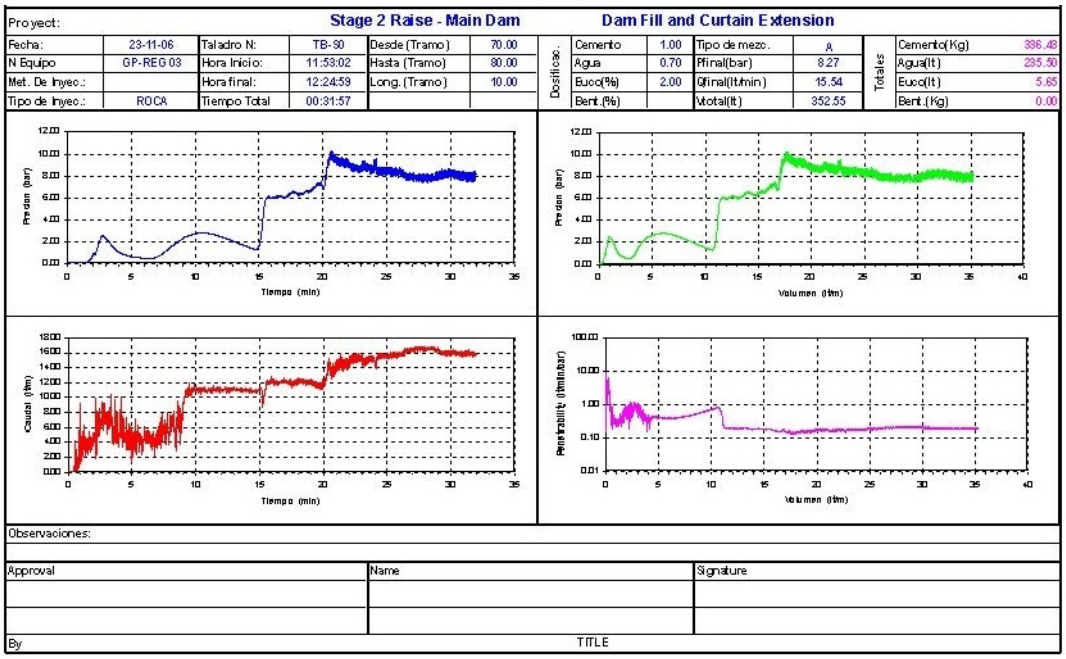
- Results for all grout tests, including details of shift, hole, stage and mix designation for each test. Forms to be used for reporting test results shall be approved by the Engineer prior to the beginning of field activities;

- Water test and grout injection data comprising record time, pressure, and flow rate for each stage at one second intervals shall be provided to the Engineer as comma separated ("csv") files readable by a laptop computer within 12 hours of completion of the shift;

- Digital records (time, flow rate and pressure at 1 second intervals) of each water pressure test or grout injection; and

- Graphical records per stage of ground response during grout injection, including one plot showing pressure vs. time, volume vs. time, pressure vs. volume, and penetrability vs. volume, and another plot showing just pressure vs. flow rate as shown on the attached example screen dumps below:





S9.3.2 QA Weekly Summary Report

The QA Weekly Reports are prepared by the QA Manager and summarize the daily activities and, where applicable, will include:

- Date, project name and location;
- Parties on-site participating in meetings and discussions;
- Summary of meetings and discussions attended;
- Identification of borrow source and the associated optimum moisture content/maximum dry density;
- Documentation of all observations of construction and QC/QA activities and test results;
- Methods used to correct construction deficiencies;
- Summary of construction progress;
- Summary of QC/QA activities and test results, including an indication of passing and failing tests; and
- Summary of problems and their resolutions.

S9.3.3 Construction Deficiency Resolution Forms

The extent and nature of deficient work or materials shall be determined through additional tests, observations, review of records and test results or other means that are deemed appropriate. The identifier of the deficient work and materials shall fill out a deficiency resolution document. The CM shall hold a deficiency resolution meeting. After the extent and nature of the deficiency has been ascertained, the CM shall institute corrective actions required to meet the Specifications and Drawings. Areas that have been reworked shall be further retested. All retests must verify that the entire defective area has been corrected prior to additional work being performed in that area.

Construction problem and resolution documents shall reference specific observations and test result data forms. These documents shall include the following information:

- A detailed description of the problem, non-conformance or deficiency;
- A location identified by co-ordinates and probable cause for the problem;
- Detailed description of how and when the problem was identified;
- Detailed description of how the problem, non-conformance or deficiency was solved or corrected;
- Reference to results of any retests performed; and
- Detailed description of measures implemented to prevent recurrence of the problem.

These documents shall be incorporated as part of the Daily Summary Report. Any modifications or to the design plans or specifications shall be by the Engineer. Any resulting modification or clarification to procedures used to complete the Work shall be approved by the CM.

S9.3.4 Site Checklists

QC checklist forms shall be used for documenting the construction activities. The QC checklist shall be signed by the CM and the QC Manager. The checklists shall include the following information:

- Date;
- Shift inspected;
- Tests performed;
- Location inspected with chainage;
- Fill material;
- As-built survey conducted;
- Dewatering measures provided;
- Remarks; and
- Deviations and rectifications.

The following examples are attached:

- Bay-Goose Dike Construction Checklist – Foundation Preparation and Excavation;
- Bay-Goose Dike Construction Checklist – Fill Placement;
- Bay-Goose Dike Construction Checklist – Drilling and Grouting; and
- Bay-Goose Dike Construction Checklist – Instrumentation.

Foundation Preparation and Excavation

BAY-GOOSE DIKE CONSTRUCTION CHECKLIST - FOUNDATION PREPARATION and EXCAVATION

From Sta. Offset	SHIFT: NIGHT : ☐ DAY : ☐	DATE :	SHEET OF
To Sta. Offset	LOCATION: :		
EQUIPMENT:			

DESCRIPTION

NO.	ITEMS TO BE INSPECTED	INSPECTED BY QC Manager	INSPECTED BY QA Manager
1.	Survey lines and layout checked to ensure the locations conform with the Drawings		
2.	Storage areas planned for disposal of removed materials		
3.	Occurrence of snow and ice removal method in place		
4.	Occurrence of boulders and removal method in place		
5.	Occurrence of hummocks and scalping method in place		
6.	Occurrence of surface and ground water and its impact mitigation in place		
7.	Presence of other unsuitable materials and removal method in place		
8.	Soil frozen or thawed and measures taken		
9.	Blasting requirement to remove unsuitable material and safety measure checked		
10.	Adjustment made to suit design in field		
11.	Final walkover inspection before re-sloping or fill placement		
12.	“As-excavated” survey conducted		
13.	Final sounding conducted of lake bottom surface		

REMARKS :

DEVIATIONS : (Attach list if necessary)

DATE OF RECTIFICATION :

SURVEY VERIFICATION	ACCEPTED BY QA Manager :	ACCEPTED BY OWNER :
NAME: _____	NAME: _____	NAME: _____
SIGNATURE : _____	SIGNATURE : _____	SIGNATURE : _____
DATE _____	DATE _____	DATE _____

Fill Placement

BAY-GOOSE DIKE CONSTRUCTION CHECKLIST- FILL PLACEMENT				
From Sta. Offset		SHIFT: NIGHT :☐ DAY : ☐	DATE :	SHEET OF
To Sta. Offset		LOCATION:		
EQUIPMENT :				
DESCRIPTION :				
NO.	ITEMS TO BE INSPECTED		INSPECTED BY Construction Manager	INSPECTED BY QA Manager
1.	Survey lines and layout conform with the Drawings			
2.	Fill materials stockpiled meet the specification requirements			
3.	Dewatering measure provided			
4.	Required soil tests performed			
5.	Required visual inspection of stockpiled materials performed			
6.	Required visual inspection of placed materials performed			
7.	Snow and loose materials removed from the surface			
8.	Weather condition meets the requirements during fill placement and compaction			
9.	Fill materials contain no frozen chunks			
10.	Adequate control of segregation of fill materials			
11.	No snow or ice trapped during placement			
12.	Final trench inspection performed before backfill			
13.	As-built survey conducted			
REMARKS :				
DEVIATIONS : (Attach list if necessary) DATE OF RECTIFICATION :				
SURVEY VERIFICATION NAME: _____ SIGNATURE : _____ DATE _____		ACCEPTED BY QA Manager : NAME: _____ SIGNATURE : _____ DATE _____		ACCEPTED BY OWNER : NAME: _____ SIGNATURE : _____ DATE _____

Drilling and Grouting

BAY-GOOSE DIKE CONSTRUCTION CHECKLIST- DRILLING AND GROUTING				
From Sta. Offset		SHIFT: NIGHT : ☐ DAY : ☐	DATE :	SHEET OF
To Sta. Offset		LOCATION:		
EQUIPMENT :				
DESCRIPTION :				
NO.	ITEMS TO BE INSPECTED		INSPECTED BY QC Manager	INSPECTED BY QA Manager
1.	Survey lines and layout conform with the Drawings			
2.	Dewatering measures provided for surface and groundwater			
3.	Required grouting tests performed			
4.	As-built survey conducted			
REMARKS :				
DEVIATIONS : (Attach list if necessary) DATE OF RECTIFICATION :				
SURVEY VERIFICATION NAME: _____ SIGNATURE : _____ DATE _____		ACCEPTED BY QA Manager : NAME: _____ SIGNATURE : _____ DATE _____		ACCEPTED BY OWNER : NAME: _____ SIGNATURE : _____ DATE _____

Instrumentation

BAY-GOOSE DIKE CONSTRUCTION CHECKLIST- INSTRUMENTATION				
From Sta. Offset		SHIFT: NIGHT :☐ DAY : ☐	DATE :	SHEET OF
To Sta. Offset		LOCATION:		
EQUIPMENT :				
DESCRIPTION :				
NO.	ITEMS TO BE INSPECTED		INSPECTED BY Construction Manager	INSPECTED BY QA Manager
1.	Survey lines and layout conform with the Drawings			
2.	Instrumentation equipment and methods acceptable			
3.	Instrumentation details provided in as built			
4.	As-built survey conducted			
REMARKS :				
DEVIATIONS : (Attach list if necessary) DATE OF RECTIFICATION :				
SURVEY VERIFICATION NAME: _____ SIGNATURE : _____ DATE _____		ACCEPTED BY QA Manager : NAME: _____ SIGNATURE : _____ DATE _____		ACCEPTED BY OWNER : NAME: _____ SIGNATURE : _____ DATE _____