Attachment 2

Civil Design Report

GOLDER

REPORT

WRF Pond Expansion Drainage System

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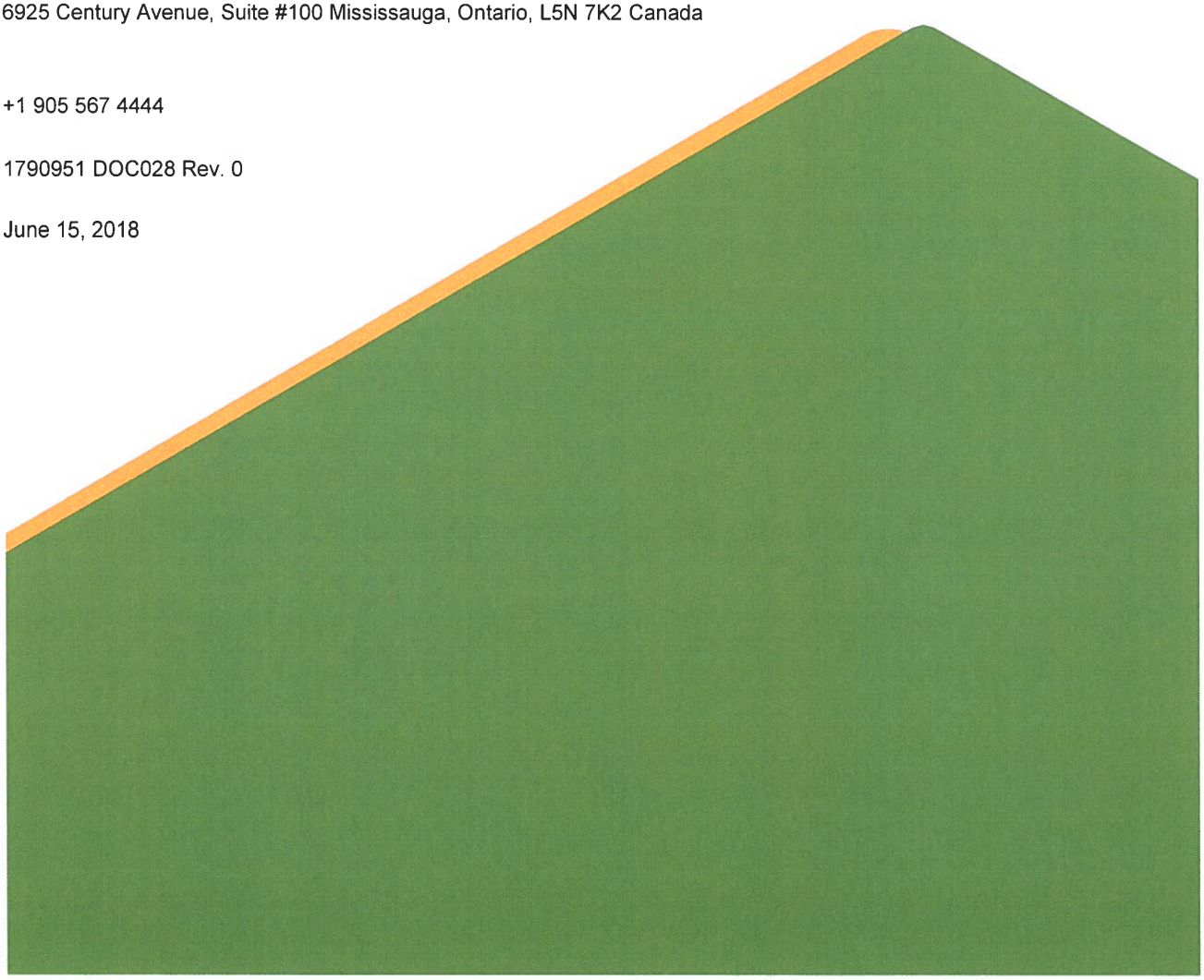

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1.0 INTRODUCTION

Golder Associates (Golder) has been retained by Baffinland Iron Mines Corporation (BIM) to provide input into the design and operation of the Waste Rock Facility (WRF) at its Mary River Project. The Mary River Project is an operational iron mine on Baffin Island in Canada's Nunavut territory. Ore is mined from the open pit, crushed onsite, and hauled to the Milne Port (approximately 100 km from site) where it is stockpiled and shipped off-site for processing. Waste rock from the open pit is disposed of at the WRF which is located to the north of the open pit.

Golder recently carried out a review of the proposed WRF expansion considering waste rock production through the year 2022 (Golder 2018a). Expansion of the WRF pond is required to collect and manage the runoff generated over the expanded WRF footprint. This report provides the detailed design for the WRF Pond expansion drainage system.

2.0 BACKGROUND

Waste rock produced from the open pit mining operation is managed at the WRF. The WRF currently consists of a waste rock stockpile, a sedimentation pond (referred to herein as the "WRF Pond"), and perimeter ditches. Surface runoff and seepage from the WRF is currently collected in ditches and directed to the WRF Pond. Containment for the WRF Pond is provided by a berm (referred to herein at the "WRF Pond Berm") in conjunction with natural topography. The WRF Pond utilizes a geomembrane as the low permeability element. The existing WRF Pond was constructed from September 2015 to May 2016.

The WRF Pond was originally designed as a sedimentation pond. Once clarified, the collected flow was intended to be discharged directly to the environment without treatment. BIM recently identified that the WRF is potentially generating acid rock drainage (ARD). BIM is currently constructing a water treatment system (WTS) to treat and discharge the impacted water collected at the WRF Pond. While actions are currently being undertaken to reduce the future potential for continued ARD, at this time, forward planning of the WRF expansion considers that the requirement to collect and treat ARD may continue in the near-term.

It is noted that seepage out of the existing WRF Pond Berm has been identified. An inspection was carried out in September 2017 to identify the seepage source (Hatch 2017). No damage to the existing WRF Pond geomembrane was noted during the inspection, and the source of seepage was not conclusively determined. A more detailed inspection of the WRF Pond will be carried out at the time of the proposed expansion, and any required repair or remediation carried out.

3.0 SITE CONDITIONS

The following sections provide a discussion on the site conditions.

3.1 Geotechnical

Two boreholes, located approximately 2 km from the WRF, were drilled during a 2016 investigation (KPC 2006). The results of the investigation identified that the foundation conditions likely consist of 6.5 - 13.5 m of glacial till underlain by bedrock. The groundwater table was not record at the time of the investigation. The glacial till was typically a sand and gravel with some silt, though the composition varied with depth and by borehole. Refer to Appendix A for the relevant borehole logs.

It has been assumed that the site conditions from Appendix A are applicable to the WRF Pond. This assumption will be reviewed at the time of construction.

3.2 Climate and Hydrology

The project is located in the North Baffin Region of Baffin Island. Based on regional data collected by Knight Piesold (2012), the mean annual precipitation ranges from 200 mm to 400 mm and the mean annual temperature is approximately -15ºC. The monthly average temperatures are mostly above freezing between June and August.

Golder carried out a hydrological study (Golder 2018b) to support the design of water collection and water treatment facilities based on local hydrometric and meteorological data collected on-site. The hydrometric station H07 with 11 available years of record, was selected as the most representative for the hydrological conditions around the WRF. A statistical analysis was carried out to estimate runoff for the return periods from 2 to 100 years and durations ranging between 1-day to 105-days.

Table 1 provides a summary of the estimated runoff values generated for various durations and return periods. As the return periods were assessed based on actual measured stream-flow data at station H07, the values in Table 1 account for varying hydrological events (i.e., including both rainfall events and freshet flows).

Table 1: Estimated Runoff (mm) by Return Period and Event Duration

Return Period (Years)	Flood Event Duration (Days)																	
	1	2	3	4	5	6	7	8	9	10	15	20	30	45	60	75	90	105
2	21	38	52	66	79	92	105	117	129	140	186	217	264	309	327	348	359	362
5	26	47	63	82	98	114	129	143	157	169	229	265	326	369	397	425	438	440
10	32	57	74	96	114	131	146	161	175	188	258	298	358	398	430	463	476	478
25	41	73	94	119	140	157	171	185	199	211	294	342	392	425	464	501	514	515
50	50	90	116	141	163	180	192	204	216	228	321	376	414	442	484	524	538	538
100	61	113	146	168	190	206	215	223	234	244	349	410	433	457	502	544	558	558

Golder (2018) recommended to apply a safety factor of 1.2 to the values presented in Table 1 due to the limitations of the study (e.g., data extrapolated from 11 years of data and runoff calculated from natural ground).

The short-term rainfall intensity-duration-frequency curves recommended by Knight Piesold (2012) for the Mary River Project site and established in the civil design criteria (Hatch 2013) are based on rainfall data from the Environment Canada Clyde River (ID 2400800) and Pond Inlet Airport (ID 2403201) climate Stations. The intensity-duration-frequency values in Table 2 present rainfall statistics for durations between 5 minutes and 24 hours for return periods between 2 years and 200 years.

Table 2: Short-term intensity-duration-frequency values for various return periods (KPC, 2012)

Duration	Return Periods								
	2-yr	5-yr	10-yr	15-yr	20-yr	25-yr	50-yr	100-yr	200-yr
5 min	0.8	1.0	1.2	1.3	1.3	1.4	1.5	1.7	1.8
10 min	1.2	1.5	1.7	1.9	2.0	2.1	2.3	2.5	2.7
15 min	1.5	1.9	2.2	2.4	2.5	2.6	2.9	3.1	3.4
30 min	2.5	3.1	3.6	3.9	4.1	4.3	4.8	5.2	5.7
1 hr	4.0	5.2	6.1	6.6	7.0	7.3	8.1	9.0	9.9
2 hr	6.0	7.7	9.1	9.9	10.5	10.9	12.2	13.5	14.8
6 hr	11.9	16.3	19.8	21.8	23.2	24.3	27.6	30.8	34.1
12 hr	15.9	21.8	26.4	29.1	30.9	32.4	36.7	41.1	45.4
24 hr	24.8	34.0	41.3	45.4	48.3	50.6	57.4	64.2	71.0

Local precipitation records from the meteorological station installed at the Mary River Mine site are only available for the last four years. The local records were compared against regional records for coastal sites operated by Environment and Climate Change Canada (Pond Inlet and Clyde River climate stations). A reliable correlation between the precipitation data on the coastal sites and the Mary River Mine site meteorological data was not observed. Additionally, given the short period of concurrent (or near-concurrent) rainfall data available and the rarity of high-intensity events, a statistically acceptable relationship between elevation and extreme rainfall could not be developed at this time. The rainfall intensity-duration-frequency statistics presented in the Hatch (2013) design criteria report and developed by Knight Piesold (2012) are considered valid. No update is recommended at this time, however, as the length of rainfall record at the Mary River climate station increases, it is recommended that the new data be used to verify every two or three years the adequacy of the rainfall intensity-duration-frequency statistics used for design.

4.0 PROPOSED SCOPE OF WORK

The WRF Expansion involves the following scope of work:

- Raise the WRF Pond Berm to crest elevation 579.7 meters above sea level (masl);
- Excavate the East Ditch;
- Excavate the West Ditch; and,
- Line the WRF Pond with a geomembrane.

Raising of the WRF Pond Berm will generally involve:

- Stripping of organic and deleterious materials over the expanded footprint;

- Placing fill materials in the berm and compacting layer by layer;
- Construction of the emergency spillway;
- Placing of the geomembrane bedding materials; and,
- Installation of the geomembrane.

BIM has observed seepage from the existing WRF Pond Berm. The existing geomembrane condition will be examined, and an attempt will be made to identify the source of the seepage. The existing geomembrane will be repaired, if possible, or replaced.

The East and West Ditches will be excavated to an approximate 1.0 m depth through the existing ground. Riprap will be provided, as necessary, to reduce observed erosion.

5.0 DESIGN BASIS

The following sections describe the WRF Pond expansion design basis. Refer to Appendix B for the Issued for Construction (IFC) drawings.

5.1 General

The WRF Pond expansion has been designed in accordance with the recommendations provided by the Canadian Dam Association (CDA). Applicable documents include:

- Canadian Dam Association Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams (CDA 2014); and,
- Canadian Dam Association's Dam Safety Guidelines, (CDA 2007).

As well, the design is in accordance with provisions of Water Licence No. 2AM-MRY1325-Amendment No.1.

5.2 Dam Classification

The CDA recommends a dam classification system based on the consequence of failure. The dam classification is a measure of the greatest incremental losses that could result from the uncontrolled release of water or stored contents behind a dam, due to failure of the dam or its appurtenances based on the worst-case but realistic failure condition. Incremental losses are defined as losses from dam failures which are above and beyond those which may be expected to occur under the same natural conditions (e.g. flood, earthquake, or other event) with the dam in place, but without failure of the dam. The dam classification guidelines from the CDA are reproduced in Figure 1 below.

Dam class	Population at risk	Incremental Losses		
		Loss of life	Environmental and cultural values	Infrastructure and economics
Low	None	0	Minimal short-term No long term loss	Low economic losses; area contains limited infrastructure or services
Significant	Temporary only	Unspecified	No significant loss or deterioration of fish or wildlife habitat Loss of marginal habitat only Restoration or compensation in kind highly possible	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes
High	Permanent	10 or fewer	Significant loss or deterioration of *important* fish or wildlife habitat Restoration or compensation in kind is highly possible	High economic losses affecting infrastructure, public transportation, and commercial facilities
Very high	Permanent	100 or fewer	Significant loss or deterioration of *critical* fish or wildlife habitat Restoration or compensation in kind possible but impractical	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities, for dangerous substances)
Extreme	Permanent	More than 100	Major loss of *critical* fish or wildlife habitat Restoration or compensation in kind impossible	Extreme losses affecting critical infrastructure or services, (e.g., hospital, major industrial complex, major storage facilities for dangerous substances
See Table 2-1 in the CDA 2007 Guidelines for notes related to population at risk and implications of loss of life.				

Figure 1: Dam Classification (CDA 2014)

It is expected that a failure of the WRF Pond Berm and release of the contained water would have low impact. There is no potential for loss of life resulting from a dam failure, except for employees that may be working immediately downstream of the berm at the time of failure. Given the relatively low volume of water contained (~50,000 m^3), and that the retained flows will be continuously treated and discharged to the environment (i.e. the WRF Pond will be continuously drawn down), the uncontrolled release of the retained water does not pose significant or long-term environmental losses. The WRF Pond hazard classification is therefore considered "Low".

5.3 Environmental Design Flood

The Environmental Design Flood (EDF) is defined as the most severe flood that is to be managed without release of untreated water to the environment. The existing WRF Pond is designed to manage (i.e., to contain) the 1:10 year 24 hr event. For the expanded WRF, the EDF has been selected as the 1:10 year 15-day event. The use of a longer duration, more severe design event is proposed as a result of the requirement for the WRF Pond to temporarily function as a treatment pond. The 1:10 year 24-hr design event used for the original pond design was selected based on the expectation that the WRF Pond would solely act as a sedimentation pond.

The CDA specifies for the EDF to be determined on a site-specific basis, though return periods of 1:50 to 1:200 years are identified as typical (CDA 2007). These higher return periods are considered appropriate for Life of Mine structures that have typical service lives of >30 years, and often for perpetuity. Given the expected temporary nature of the proposed WRF Pond expansion (a new Life of Mine sedimentation pond, or additional expansion of the existing WRF pond, will be required to manage expansion of the WRF beyond the 585,000 m^2 footprint), the use of a 1:100 year return period event is not justified. The WRF Pond design criteria will be reviewed and revised if necessary, prior to expansion of the WRF beyond the proposed 585,000 m^2 footprint.

5.4 Flood Routing

The Inflow Design Flood (IDF) is defined as the most severe inflow flood for which a dam is designed. While the WRF Pond has been sized to store the EDF, it is proposed that the IDF be safely conveyed through the emergency spillway and discharged to the environment.

The IDF is selected on the basis of the Dam Classification and the consequence of failure of the structures. Based on the dam classification of "Low", the IDF recommended by the CDA is a storm event with a 1:100 year return period. Consistent with the previously developed civil design criteria (Hatch 2013), the IDF adopted for the WRF Pond expansion is the 1:200 year 24-hr event (71 mm of rainfall over 24 hours). The WRF Pond spillway has been sized to pass this flow. It was conservatively assumed that there will be no remaining storage capacity within the WRF Pond at the onset of the IDF occurrence.

5.5 Freeboard Requirements

The WRF Pond is designed to maintain a minimum freeboard requirement to reduce potential for overtopping of the berm during the IDF, or as a result of wave action. The CDA guidelines recommend a minimum freeboard of 95% of the waves caused by the most critical wind at the maximum design pond elevation (CDA 2007). A frequency analysis was performed for the hourly wind velocity from Pond Inlet A climate station (1976 – 2017). The data from 2009 to 2012 were removed from the analysis due to more than half of their data missing from the record. Table 3 presents the wind velocity associated with various return periods.

Table 3: Frequency analysis of the wind velocity measured at the Pond Inlet A Climate Station

Return Period	Wind Velocity (m/s)	95% Confidence Interval (m/s)
5	20.1	21.2 – 21.2
10	22.5	22.9 – 22.9
50	24.0	20.8 – 27.1
100	25.0	21.1 – 29.2
500	27.4	21.6 – 34.4
1,000	28.4	21.7 – 36.9

The maximum windspeed recorded at the Mary River Mine site meteorological data from 2013 – 2017 was 28.4 m/s.

Assuming the maximum fetch of 250 m across the pond, the 1,000 year wind velocity (upper value of the 95% confidence interval) and a pond depth of 5.3 m, the significant wave height is estimated to be 0.51 m.

5.6 WRF Pond Capacity

The existing WRF Pond has a design capacity of approximately 9,000 m^3 at the maximum operating water level (MOWL) of 575.8 masl. The existing berm has a crest elevation of 577.0 masl and the geomembrane installed to elevation 575.8 masl. The emergency spillway is set at elevation 576.0 masl. The WRF Pond is currently sized to retain the 1:10 year 24 hour storm event (Hatch 2013). The existing pond has a surface area of approximately 9,900 m^2 at a water elevation of 575.8 masl.

Figure 2 provides the volume of inflow to the WRF pond less treatment for the 1:10 year event with varying durations. The runoff values are those from Table 1 applied to a catchment area of 585,000 m^2. The predicted pond inflow considers a water treatment rate of 280 m^3/h.

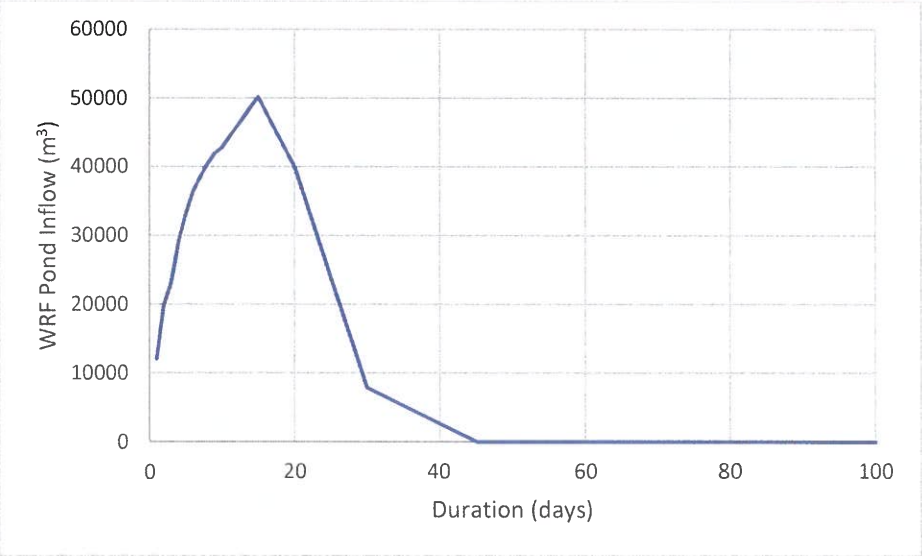


Figure 2: Predicted WRF Pond Inflow

The maximum WRF Pond inflow of 50,130 m^3 is predicted to occur for the 15 day event (the EDF), and is the design capacity for the current expansion. The predicted inflow for the 1:10 year 24 hour event (current design criteria) is 12,000 m^3. Where the WRF Pond capacity is 0 m^3, the rate of treatment of 280 m^3/h is predicted to exceed the rate of pond inflow.

Figure 3 below provides the struck level curve for the proposed expanded WRF Pond.

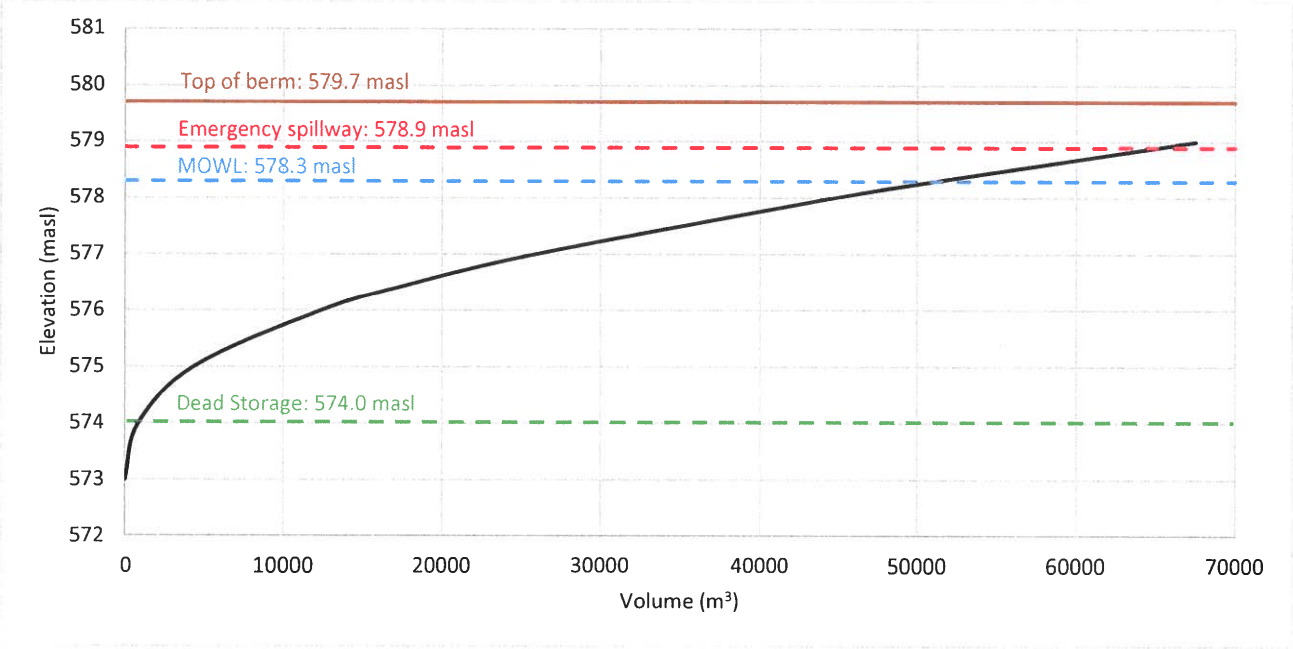


Figure 3: Proposed WRF Pond Struck Level Curve

The WRF Pond capacity at the MOWL (elevation 578.3 masl) will be approximately 51,000 m^3. To accommodate uncertainties in the hydrological data a minimum factor of safety of 1.2 has been applied to the pond capacity (Golder, 2018). The geomembrane is therefore proposed to be installed to elevation 579.3 masl, corresponding to a total storage volume of 65,000 m^3 (27% increase in volume over the 51,000 m^3 design capacity) at the spillway invert of 578.9 masl, and providing 0.2 m of additional freeboard above the IDF water level of 579.1 (see Section 5.8). The WRF Pond surface area at elevation 579.3 masl is approximately 25,000 m^2 (15,000 m^2 increase over the existing condition).

Inflow into the WRF Pond will be treated and discharged to the environment on a continuous basis. The water treatment system (WTS) intake will be located at the deepest section of the WRF Pond to minimize the dead storage volume. The dead storage volume below elevation 574.0 m is 900 m^3.

5.7 WRF Pond Berm Stability

The WRF Pond Berm is designed to be stable under the expected loading conditions, including: rapid drawdown of the pond, surcharge in the pond water level, wind and wave action, and seismic loading.

The following minimum Factors of Safety (FOS) for the WRF Pond Berm slopes have been adopted (CDA 2007):

- End of Construction: 1.3
- Long-term steady state: 1.5
- Seismic loading: 1.0

Based on the dam classification of "Low", the design earthquake recommended by the CDA is the 1:100 year return event. The Peak Ground Acceleration (PGA) based on the 2015 National Building Code and determined by Earthquakes Canada is 0.019g for the 1:100 year return period.

The WRF Pond Berm is a homogeneous rockfill berm with a geomembrane installed on the upstream slope as the low permeability element. Refer to Appendix B for the detailed design. Table 4 below provides a summary of the material strength parameters input into the slope stability model. Refer to Section 5.7.2 for further discussion on the material strength parameters.

Table 4: Material Strength Parameters

Material	Unit Weight (kN/m^3)	Friction Angle (°)	Cohesion (kPa)
Rock Fill	20	40	0
Till	20	34	0
Bedrock	Impenetrable		

5.7.1 Stability Analysis Results

The WRF Pond Berm slope stability was analyzed using Slope/W 2018 version 9.0.4.15639 developed by GEO-SLOPE International Ltd. This software uses the limit equilibrium method for the stability analysis. The Morgenstern-Price method was used where the interslice shear forces were represented with a half-sine function.

The FOS, defined as the ratio of the forces tending to resist failure over the forces tending to cause failure, was computed for a series of potential failure surfaces. A range of potential slip surfaces were analysed:

- Static loading conditions for the upstream and downstream face; and,
- Seismic loading conditions for the upstream and downstream face.

For each loading condition, the lowest FOS was determined for the slip surface within the berm slope, and also for a deep-seated foundation failure. The slip surface was analyzed using both the grid and radius and entry/exit definition methods.

The Hynes-Griffin and Franklin (1984) procedure was used for the pseudo-static analysis. This procedure recommends that horizontal acceleration input into the stability analysis be half the predicted bedrock PGA. Based on this method, a horizontal acceleration of 0.0095 g, which is half the PGA of 0.019g for a 1:100 year event, was input into the stability analysis model.

The results of the stability analysis are provided as Figure 4 below.

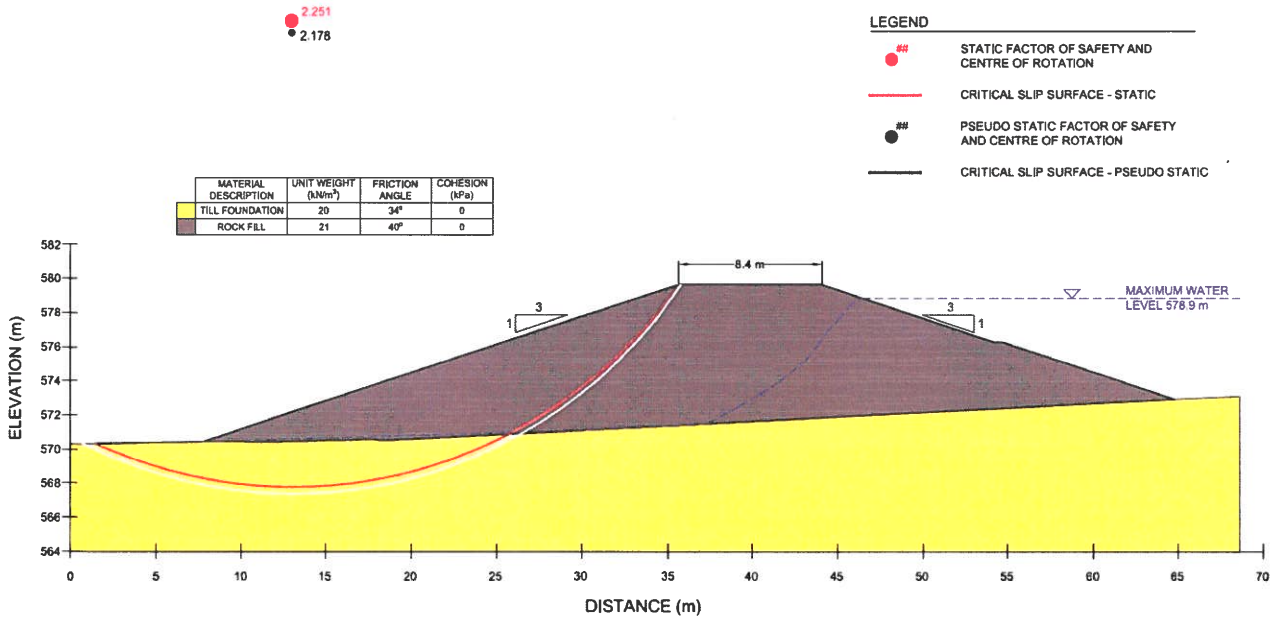


Figure 4: WRF Pond Berm Stability Analysis Results

The minimum FOS for the static and pseudo-static condition is 2.25 and 2.18, respectively. These FOS exceed the minimum requirements specified under Section 5.7.

Rapid draw down of the WRF Pond is not expected to have significant impact on the WRF Pond berm stability. At a treatment rate of 280 m^3/hr the maximum WRF Pond drawdown rate varies from 0.13 – 0.33 m/hr depending on the pond elevation. It is expected that the rockfill WRF Pond Berm will drain at a similar rate.

5.7.2 Limitations

The material strength parameters and foundation conditions input into the slope stability model are assumed based on professional judgement. No laboratory testing has been carried out to verify the strength parameters.

The foundation conditions have been assumed based on the results of the two boreholes located approximately 2.0 km from the WRF Pond (KPC 2006). No additional information is available on the foundation conditions at the WRF Pond Berm. It is recommended that test pitting be carried out along the WRF Pond Berm expanded foundation, prior to construction of the berm, if ground conditions permit. The foundation conditions should then be verified against the material strength parameters assumed in Table 4. The presence of weak foundation materials may require removal or result in the requirement to flatten or buttress the WRF Pond Berm downstream slope. The presence of continuous layers of ground ice within the foundation may also result in creep of the WRF Pond Berm slopes. If test pitting is not feasible due to frozen ground conditions, it is recommended that survey monitoring pins be installed along the WRF Pond Berm downstream slope.

5.8 WRF Pond Emergency Spillway

The WRF Pond emergency spillway will be located at the north east abutment of the WRF Pond Berm. The spillway has been sized to safely pass the 200-yr 24-hr IDF. Refer to Section 5.4 for discussion on the IDF selection and definition. The Hydrologic Engineering Centre Hydrologic Modelling System (HEC-HMS) software

(USACE 2013) was used for the flood routing. Losses along the flow path upstream of the WRF Pond were simulated using the SCS Curve Number (CN). A CN of 97 was assumed for the waste rock (based on recommended CN values for prepared ground). The CN value for waste rock accounts for direct runoff plus interflow (i.e., flow which infiltrates into the waste rock but later reports as toe seepage); however the lag effects associated with the interflow are ignored, making this value more conservative.

The spillway design elements include the following:

- Total drainage area of 585,000 m^2;
- Invert elevation of 578.9 m (0.8 m below the WRF Pond Berm crest);
- Base width of 5.0 m with 10H:1V side slopes at the berm crest for truck trafficability;
- The spillway channel will be approximately 50 m long;
- The spillway channel will have a slope of 12% (i.e. 8.5H:1V);
- The spillway channel will be protected with riprap.

Refer to Drawing C-200 (Appendix B), for the spillway detailed design.

The spillway peak discharge for the 200-yr 24-hr storm event is predicted to be 1.35 m^3/s. The maximum water surface elevation above the spillway invert under the design storm event conditions would be 579.11 m, which is 0.59 m below the berm crest elevation, thus satisfying the freeboard requirements of 0.51 m described in Section 5.5. An overflow spillway channel will be constructed on the downstream face of the WRF Pond Berm with adequate riprap (400 mm riprap, minimum D_{50} of 200 mm) to withstand the design peak flow velocity of 2.0 m/s. The spillway channel will have a bottom width of 5 m, a total depth of 0.5 m (including a 0.3 m freeboard) and will transition from 10H:1V side slopes at the berm crest into 2H:1V side slopes at the outlet. The spillway channel will have a 5 m long energy dissipation area at the toe.

The riprap placed within the spillway invert will be covered by a 200 mm thick sacrificial layer of granular to permit vehicle access through the spillway. This granular wearing layer is expected to washout during activation of the spillway, and would subsequently have to be replaced to restore vehicle access.

5.9 Diversion Ditches

The WRF design includes the design of contact water collection ditches surrounding the facility. As shown on Drawing G-200 (Appendix B), two perimeter ditches are proposed, one on either side of the WRF. It has been assumed that the ditches will generally drain north, discharging the collected runoff into the WRF Pond.

The following design criteria have been established for the ditches:

- Ditches convey the 1:25 year (Hatch 2013) 10-min event with an intensity of 12.4 mm/hr (based on the time of concentration calculated for each ditch) including 0.3 m of freeboard;
- Flood events up to the 1:100 year storm event would be fully contained within the ditches, but ditch erosion would likely require ditch maintenance works after such an event;

- Provide riprap erosion protection for sections of the ditch with velocities greater than 1.5 m/s (Hatch 2013). Riprap to be extended a minimum of 3.0 m into sections where riprap is not required to create a stilling basin;
  - Riprap may not be placed at the time of ditch excavation. The requirement for riprap will be assessed by BIM based on site observations and performance monitoring.
- Reduce potential for collection of non-contact runoff;
- Trapezoidal channel with a base width of 1.0 m and minimum depth of 1.0 m; and,
- Side slopes of 2H:1V or flatter as required by ground conditions.

Spoil from the ditch excavation will be utilized to construct a berm on the outside of the ditch (the side opposite from the WRF) to reduce potential for collection of non-contact water. The geometry of the clean water diversion berm shown on Drawing C-130 (Appendix B) may be modified in the field, at the time of construction, based on the material conditions.

The peak flow rates were calculated for the ditches using the Rational Method and assuming a runoff coefficient of 0.9 for the catchments draining to the ditches (0.26 km^2 and 0.27 km^2 for the west and east ditch respectively). The calculated peak flows are 0.82 m^3/s and 0.86 m^3/s for the west and east ditches respectively. The hydraulic capacity of the ditch was determined using Manning's Equation. The ditches will be protected with riprap at locations where the flow velocity exceeds 1.5 m/s.

Table 5 below provides the location, slope, water depth, the flow velocity and the riprap requirements under the design storm event. The minimum riprap thickness shall be twice the riprap D_{50} value. The requirement for riprap will be assessed by BIM based on site observations and performance monitoring.

Table 5: Collection Ditch Design Parameters

	Upstream Station	Downstream Station	Slope (%)	Flow Depth (m)	Flow Velocity (m/s)	Minimum Riprap D_{50} (mm)
West Ditch	0+000	0+022	0.08%	0.7	0.5	Not required
	0+022	0+102	1.5%	0.4	1.3	Not required
	0+102	0+150	2.5%	0.3	1.6	200
	0+150	0+293	1.6%	0.4	1.4	Not required
	0+293	0+393	1.6%	0.4	1.4	Not required
	0+393	0+518	1.4%	0.4	1.3	Not required
	0+518	0+587	0.9%	0.4	1.1	Not required
	0+587	0+710	1.6%	0.4	1.4	Not required
	0+710	0+755	3.7%	0.3	1.8	200
	0+755	0+795	4.0%	0.3	1.9	200
	0+795	0+830	4.4%	0.3	2.0	200
	0+830	0+865	4.5%	0.3	2.0	200
	0+865	0+913	5.4%	0.3	2.1	300
	0+913	0+946	5.7%	0.3	2.2	300

	Upstream Station	Downstream Station	Slope (%)	Flow Depth (m)	Flow Velocity (m/s)	Minimum Riprap D_{50} (mm)
	0+946	0+990	5.9%	0.2	2.2	300
	0+990	1+037	5.8%	0.3	2.2	300
	1+037	1+081	6.6%	0.2	2.3	300
East Ditch	0+000	0+014	6.6%	0.2	1.5	300
	0+014	0+048	4.1%			CSP Culvert Riprap to be provided at outlet
	0+048	0+135	2.0%	0.3	1.5	Not required
	0+135	0+178	3.2%	0.3	1.8	200
	0+178	0+215	2.4%	0.3	1.6	200
	0+215	0+280	1.1%	0.4	1.2	Not required
	0+280	0+427	4.0%	0.3	1.9	200
	0+427	0+559	5.0%	0.3	2.1	300
	0+559	0+665	4.7%	0.3	2.0	300
	0+665	0+742	4.7%	0.3	2.0	300
	0+742	0+828	5.2%	0.3	2.1	300
	0+828	0+906	4.9%	0.3	2.1	300
	0+906	0+932	5.4%	0.3	2.2	300
	0+932	0+962	5.8%	0.3	2.2	300
	0+962	0+991	5.3%	0.3	2.1	300
	0+991	1+034	5.7%	0.3	2.2	300
	1+034	1+068	5.1%	0.3	2.1	300

5.9.1 Culvert Crossing

A culvert will be installed in the East Ditch between station 0+014 and 0+048 to accommodate a proposed road to access the water treatment system pad. The Federal Highway Administration (FHWA) HY-8 software (FHWA 2012) was used for sizing the culvert based on a peak flow of 0.86 m^3/s.

The following assumptions were considered in the model:

- The culverts were assumed to be located at the bottom of the cross-sections and installed on the grade provided in Table 5.
- The culvert "roughness" (i.e. Manning's n value) corresponds to that of corrugated steel pipe (CSP).
- The culverts are free of debris.

Considering a slope of 4%, one circular CSP culvert of 900 mm of diameter is recommended to convey the 0.86 m^3/s peak flow at this intersection.

6.0 CONSTRUCTION

6.1 Construction and Operating Considerations

The construction considerations related to the WRF Pond include the following:

- Test pitting to be carried out along the footprint of the expanded WRF Pond Berm prior to any fill placement, if ground conditions permit. The requirement for survey monitoring pins installed along the WRF Pond Berm downstream slope will be considered if ground conditions do not permit test pit excavation.
- The pond shall be completely drained and the condition of the existing geomembrane inspected prior to construction of the WRF Pond expansion;
- Sedimentation and erosion mitigation measures, as required, shall be in place before commencing construction;
- A temporary water management plan shall be developed and implemented prior to construction;
- All materials shall be placed in horizontal lifts with a nominal compacted thickness of 1.0 m or less;
- Each lift shall be compacted by dozer tracking across the entire width of the lift;
- Culverts should be placed on a 0.3 m thick layer of prepared sand and gravel foundation;
- The minimum depth of cover to be provided over any culvert at a road crossing should be determined to withstand heavy load from traffic using the road;
- Culverts should be extended at least 1.5 m from the embankment at the inlet and the outlet to avoid blockage from any falling debris from the road; and,
- An as-built survey shall be collected to document all construction activities.

The operating conditions related to the WRF Pond include:

- Inflow into the WRF Pond will be continuously treated and discharged to the environment. The water level will be maintained at the lowest practical level.
- The WRF Pond water level must not be drawn down from above elevation 575.8 m when ice is present due to the potential for ice to damage the geomembrane on the upstream slope at the elevation 575.8 m bench.
- The WTS feed pump will be located on the WRF Pond Berm crest at approximate station 0+300, at the deepest location of the WRF Pond to reduce the dead storage volume.
- The WTS Feed pump discharge line will be routed along the upstream edge of the WRF Pond Berm crest.

6.2 Construction Materials

The following sections provide the gradation for the proposed fill materials.

6.2.1 500 mm minus Rock Fill

Rock fill for the WRF Pond Berm construction shall be obtained from an approved construction material source, as required under Water Licence No. 2AM-MRY1325-Amendment No.1. The material shall be well graded within the limits defined in Table 6 below.

Table 6: 500 mm Minus Rock Fill Gradation

Sieve (mm)	% Passing by Weight	
	Lower	Upper
500	100	100
150	100	50
75	40	20
37.5	23	15
19	15	8
4.75	5	0
2	5	0
0.075	5	0

6.2.2 Intermediate Bedding Material

The Intermediate Bedding Material shall be placed be placed as a transition material between the geomembrane bedding layer and the underlying rock fill. The bedding material shall be produced from an approved construction material source as required under Water Licence No. 2AM-MRY1325-Amendment No.1. The material shall be well graded within the limits defined in Table 7 below.

Table 7: Intermediate Bedding Material Gradation

Sieve (mm)	% Passing by Weight	
	Lower	Upper
32	100	100
19	100	85
13.2	100	70
9.5	100	50
4.75	70	30
1.18	40	10
0.3	22	5
0.075	8	0

6.2.3 Fine Bedding Material

The Fine Bedding Material shall be placed be placed as a transition material between the geomembrane and underlying Intermediate Bedding Material. The fine bedding material shall be produced from an approved construction material source as required under Water Licence No. 2AM-MRY1325-Amendment No.1. The material requirements are defined as follows:

- The material shall be well graded;
- The maximum particle size shall be 2.0 mm.
- The fines content (% passing the #200 sieve) shall not exceed 5%.

Alternatively, the fine bedding material can be replaced by a non-woven geotextile.

6.2.4 Riprap

Riprap shall be placed as erosion protection at the emergency spillway and the within the East and West Diversion Ditches in the reaches noted in Table 5. Riprap within the spillway channel shall be sourced from an approved construction material source as required under Water Licence No. 2AM-MRY1325-Amendment No.1. Riprap placed within the East and West Diversion Ditches can be produced from waste rock. The requirement for Riprap within the East and West Diversion Ditches will be assessed by BIM based on performance monitoring (i.e., the riprap may not be placed at the time of ditch excavation).

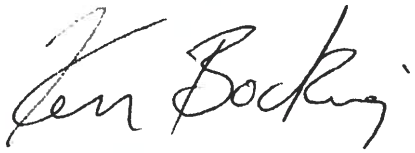
The riprap requirements are defined as follows:

- The material shall be well graded;
- The maximum riprap particle gradation shall not exceed 2 times the specified D_{50} value;
- The fines content (% passing the #200 sieve) shall not exceed 5%

Signature Page

Golder Associates Ltd.

Brian Andruchow,
Geotechnical Specialist



Ken De Vos, P.Geo.
Principal, Project Director

Ken Bocking, P.Eng.
Principal

BA/KB/ba

https://golderassociates.sharepoint.com/sites/22103g/technical work/phase 2000/2003 pond upgrade/1790951_design brief/1790951-2000-doc028_bimwasterockfacilitypondupgrade_15jun2018.docx

7.0 REFERENCES

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APPENDIX A

Historical Borehole Logs

Project: Mary River Project	Drill Hole No. **MWD 003**	PAGE	1 of 3
Drilling Co: Boart Longyear	In Situ Sampler: HQ Core Barrel	Date Started:	4 Jul 06
Drilling Method: Rotary Coring - Longyear Fly 38	Elevation: 519 m	Date Completed:	5 Jul 06
Location: Mary River, Baffin Island	Total Depth: 31.6 m	Logged by:	RLV/RBK/ACK
Coordinates: 7,915,196 N , 564,290 E	Inclination: -90	Reviewed by:	KEH

DEPTH (m)	ELEVATION (m)	DESCRIPTION OF MATERIALS	RUN RECOVERY (%)	FROZEN SOIL DESCRIPTION	SAMPLE RECOVERY (%)	SAMPLES	SAMPLE NO.
0	518.0	**2 - TILL** (0 to 13.5) Reddish brown, well graded sand and gravel with trace silt and cobble and boulder fragments (up to 10cm dia). Poor fines (sand and silt) recovery in areas was due to thawing and washing of soil matrix by drilling fluid.	39	Nbe Vx			
2	516.0	Frozen soils were recovered below 3.0m depth and were typically well bonded with and without excess ice with some ice and soil stratification and 5cm to 10cm massive ice lenses. Total visible ice within the stratum was less than 2 percent.					1
4	514.0	Sample 1 (3.7m to 4.0m) - Well graded silty sand with some gravel.					2
6	512.0	Sample 2 (5.4m to 5.8m) - Gap graded sand and gravel with trace silt.	100	Nbe Vx			3
8	510.0	Sample 3 (6.8m to 7.2m) - Poorly graded gravelly sand with trace silt.					4
10	508.0	Sample 4 (7.9m to 8.1m) - Poorly graded sand with trace gravel and trace silt.	100	Nbn. Vs			5
12	506.0	Sample 5 (9.6m to 10.0m) - Well graded, ice rich, gravelly sand with some silt.	65	Nbn			6
14		Sample 6 (11.0m to 11.4m) - Poorly graded, ice rich, gravelly sand with some silt.					
		5B - HIGHLY FRACTURED GNEISS (13.5 to 22) Dark gneissic bedrock with white specks. Highly fractured with extensive weathering.					

BLOW COUNT/ RQD (%)	SPT 'N' VALUE/ RMR	FIELD VANE SHEAR STRENGTH Remould (▲) Peak (△) SPT TEST DATA 'N' VALUES Uncorrected (✕) Corrected (□) PL MC LL 20 40 60 80	INSTRUMENTATION DEPTHS (m)	INSTRUMENTATION DETAILS

FROZEN SOIL DESCRIPTIONS:

NI - POORLY BONDED
Nbn - WELL BONDED, NO EXCESS ICE
Nbe - WELL BONDED, EXCESS ICE
Vx - INDIVIDUAL ICE INCLUSIONS
Vc - ICE COATINGS ON PARTICLES
Vr - RANDOM OR IRREGULARLY ORIENTED ICE FORMATIONS
Vs - STRATIFIED OR DISTINCTLY ORIENTED ICE FORMATIONS
I+C - ICE WITH SOIL INCLUSIONS
ICE - ICE WITHOUT SOIL INCLUSIONS

SAMPLE SYMBOL:

AUGER, SPLITSPOON, THERMISTOR, CORE, SHELBY TUBE

Baffinland
Mary River Project

Knight Piésold CONSULTING

Project No	Ref. No.	Rev.
NB102-00181/3	2	0

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Project:	Mary River Project	Drill Hole No.	**MWD 003**	PAGE	2 of 3
Drilling Co:	Boart Longyear	In Situ Sampler:	HQ Core Barrel	Date Started:	4 Jul 06
Drilling Method:	Rotary Coring - Longyear Fly 38	Elevation:	519 m	Date Completed:	5 Jul 06
Location:	Mary River, Baffin Island	Total Depth:	31.6 m	Logged by:	RLV/RBK/ACK
Coordinates:	7,915,196 N , 564,290 E	Inclination:	-90	Reviewed by:	KEH

DEPTH (m)	ELEVATION (m)	GRAPHIC LOG	DESCRIPTION OF MATERIALS	RUN RECOVERY (%)	FROZEN SOIL DESCRIPTION	SAMPLE RECOVERY (%)	SAMPLES	SAMPLE NO.	BLOW COUNT/ RQD (%)	SPT 'N' VALUE/ RMR	FIELD VANE SHEAR STRENGTH Remould (▲) Peak (△) / SPT TEST DATA 'N' VALUES Uncorrected (×) Corrected (□) PL MC LL 20 40 60 80	INSTRUMENTATION DEPTHS (m)	INSTRUMENTATION DETAILS
16				87	Nbn I+S								
	502.0												
18				92	Nbn								
	500.0												
20				89	N/R				33				
	498.0												
22			**6B - GNEISSIC BEDROCK** (22 to 31.6) Dark blueish grey gneissic bedrock with white specks. Strong and hard with some fracturing.										
	496.0			99	N/R				93				
24													
	494.0												
26				86	N/R				73				
	492.0												
28													
	490.0												

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Baffinland
Mary River Project

Knight Piésold CONSULTING

Project No.	Ref. No.	Rev.
NB102-00181/3	2	0

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Project:	Mary River Project	Drill Hole No.	MWD 003	PAGE	3 of 3
Drilling Co:	Boart Longyear	In Situ Sampler:	HQ Core Barrel	Date Started:	4 Jul 06
Drilling Method:	Rotary Coring - Longyear Fly 38	Elevation:	519 m	Date Completed:	5 Jul 06
Location:	Mary River, Baffin Island	Total Depth:	31.6 m	Logged by:	RLV/RBK/ACK
Coordinates:	7,915,196 N , 564,290 E	Inclination:	-90	Reviewed by:	KEH

DEPTH (m)	ELEVATION (m)	GRAPHIC LOG	DESCRIPTION OF MATERIALS	RUN RECOVERY (%)	FROZEN SOIL DESCRIPTION	SAMPLE RECOVERY (%)	SAMPLES	SAMPLE NO.	BLOW COUNT/ RQD (%)	SPT 'N' VALUE/ RMR	FIELD VANE SHEAR STRENGTH Remould (▲) Peak (△) / SPT TEST DATA 'N' VALUES Uncorrected (×) Corrected (□) PL MC LL 20 40 60 80	INSTRUMENTATION DEPTHS (m)	INSTRUMENTATION DETAILS
	488.0			69	N/R				50				
			End of Drillhole: 31.6 m										
32	486.0												
34	484.0												
36	482.0												
38	480.0												
40	478.0												
42	476.0												
44													

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AUGER, SPLITSPOON, THERMISTOR, CORE, SHELBY TUBE

Baffinland
Mary River Project

Knight Piésold CONSULTING

Project No.	Ref. No.	Rev.
NB102-00181/3	2	0

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Project:	Mary River Project	Drill Hole No.	MWD 004	PAGE	1 of 2
Drilling Co:	Boart Longyear	In Situ Sampler:	HQ Core Barrel	Date Started:	30 Jun 06
Drilling Method:	Rotary Coring - Longyear Fly 38	Elevation:	473 m	Date Completed:	3 Jul 06
Location:	Mary River, Baffin Island	Total Depth:	31.6 m	Logged by:	RLV/ACK
Coordinates:	7,915,488 N , 564,716 E	Inclination:	-90	Reviewed by:	KEH

DEPTH (m)	ELEVATION (m)	GRAPHIC LOG	DESCRIPTION OF MATERIALS	RUN RECOVERY (%)	FROZEN SOIL DESCRIPTION	SAMPLE RECOVERY (%)	SAMPLES	SAMPLE NO.	BLOW COUNT/ RQD (%)	SPT 'N' VALUE/ RMR	FIELD VANE SHEAR STRENGTH Remould (▲) Peak (△) / SPT TEST DATA 'N' VALUES Uncorrected (×) Corrected (□) PL MC LL 20 40 60 80	INSTRUMENTATION DEPTHS (m)	INSTRUMENTATION DETAILS
0	472.0		**2 - TILL** (0 to 6.5) Reddish brown, well graded sand and gravel with trace silt and cobble and boulder fragments (up to 10cm dia). Low recovery of fines (sand and silt) due to thawing and washing of soil matrix by drilling fluid. Frozen soils were recovered below 0.4m depth and were typically well bonded soils with some ice and soil stratification and a 5cm massive ice lens. Total visible ice within the stratum was less the 2 percent total visible ice.	42	Nbn								
2	470.0												
4	468.0			86	Nbn Vx								
6	466.0		**5B - HIGHLY FRACTURED GNEISS** (6.5 to 12.5) Dark gneissic bedrock with white specks. Highly fractured with extensive weathering.										
8	464.0			96	N/R				40				
10	462.0												
12	460.0		**6B - GNEISSIC BEDROCK** (12.5 to 31.6) Dark blue gneissic bedrock with white specks. Strong and hard with reduced fracturing with depth.	98	N/R				56				
14	458.0			98	N/R				66				

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Baffinland
Mary River Project

Knight Piésold CONSULTING

Project No.	Ref. No.	Rev.
NB102-00181/3	2	0

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Project: Mary River Project | Drill Hole No. **MWD 004** | PAGE 2 of 2

Drilling Co: Boart Longyear | In Situ Sampler: HQ Core Barrel | Date Started: 30 Jun 06

Drilling Method: Rotary Coring - Longyear Fly 38 | Elevation: 473 m | Date Completed: 3 Jul 06

Location: Mary River, Baffin Island | Total Depth: 31.6 m | Logged by: RLV/ACK

Coordinates: 7,915,488 N , 564,716 E | Inclination: -90 | Reviewed by: KEH

DEPTH (m)	ELEVATION (m)	GRAPHIC LOG	DESCRIPTION OF MATERIALS	RUN RECOVERY (%)	FROZEN SOIL DESCRIPTION	SAMPLE RECOVERY (%)	SAMPLES	SAMPLE NO.	BLOW COUNT/ RQD (%)	SPT 'N' VALUE/ RMR	FIELD VANE SHEAR STRENGTH Remould (▲) Peak (△) / SPT TEST DATA 'N' VALUES Uncorrected (×) Corrected (□) PL MC LL 20 40 60 80	INSTRUMENTATION DEPTHS (m)	INSTRUMENTATION DETAILS
18	456.0												
				99	N/R				83				
	454.0												
20													
	452.0			97	N/R				78				
22													
	450.0												
24				100	N/R				80				
	448.0												
26													
	446.0			100	N/R				80				
28													
	444.0												
30				100	N/R				66				
	442.0												
			End of Drillhole: 31.6 m										

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Mary River Project

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APPENDIX B

Issued for Construction Drawings

Baffinland

MARY RIVER PROJECT
WRF POND EXPANSION DRAINAGE SYSTEM
DETAILED DESIGN

DRAWINGS INDEX				
PLAN NO.	TITLE	REV.	DESCRIPTION	DATE
G-100	COVER PAGE	A	ISSUED FOR CONSTRUCTION	2018-06-15
G-200	WRF POND EXPANSION - GENERAL ARRANGEMENT	A	ISSUED FOR CONSTRUCTION	2018-06-15
C-100	WRF POND EXPANSION - PLAN & PROFILE	A	ISSUED FOR CONSTRUCTION	2018-06-15
C-120	WRF POND EXPANSION - SECTIONS AND DETAILS	A	ISSUED FOR CONSTRUCTION	2018-06-15
C-130	WRF POND EXPANSION - SECTIONS AND DETAILS	A	ISSUED FOR CONSTRUCTION	2018-06-15
C-200	WRF POND EXPANSION - SPILLWAY - PLAN, PROFILE & SECTIONS	A	ISSUED FOR CONSTRUCTION	2018-06-15

PERMIT TO PRACTICE
GOLDER ASSOCIATES LTD.
Signature
Date 15 June 2018
PERMIT NUMBER: P 049
NT/NU Association of Professional Engineers and Geoscientists

ISSUED FOR CONSTRUCTION

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2018-06-15	ISSUED FOR CONSTRUCTION	SEC	BA	MT	KAB

SEAL

CLIENT: Baffinland

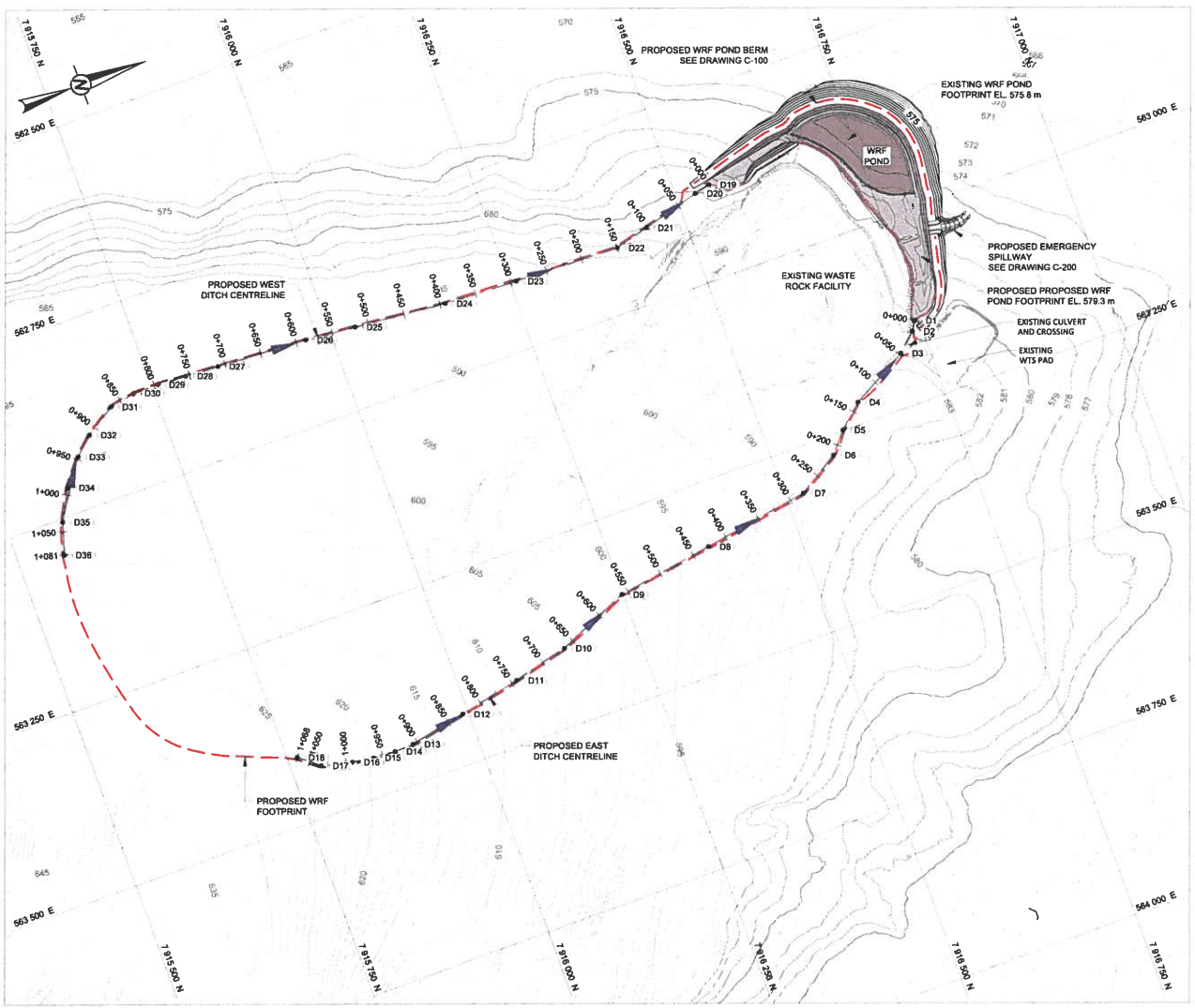
CONSULTANT: GOLDER

MISSISSAUGA OFFICE
6925 CENTERY AVENUE, SUITE 100
MISSISSAUGA, ON
CANADA
905-567-444
www.golder.com

PROJECT
MARY RIVER PROJECT
WRF POND EXPANSION
DRAINAGE SYSTEM

TITLE
COVER PAGE

PROJECT NO.	PHASE	REV.	of	DRAWING
1790951	2003	A		G-100



LEGEND

- EXISTING GROUND CONTOURS (1 m INTERVAL)
- PROPOSED GROUND CONTOURS (1 m INTERVAL)
- DITCH CENTRELINE AND FLOW DIRECTION
- PROPOSED WRF EXPANSION FOOTPRINT

NOTE(S)

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. COORDINATE SYSTEM IS UTM (NAD83) ZONE 17.
3. THE GROUND SURFACE IS APPROXIMATE AND MAY VARY FROM THAT SHOWN.
4. THE CONTRACTOR SHALL CARRY OUT AN AS-BUILT SURVEY OF THE EXISTING CONDITION AND ALL NEW CONSTRUCTION.

REFERENCE(S)

1. TOPOGRAPHY PROVIDED BY BAFFINLAND.
2. AS-BUILT CONTOURS PROVIDED BY BAFFINLAND ON MAY 17, 2018.

WEST DITCH POINTS SETOUT TABLE

POINT No.	EASTING (m)	NORTHING (m)	ELEVATION (m)
D19	562875.20	7916546.74	579.300
D20	562880.21	7916525.74	579.483
D21	562900.92	7916448.04	580.189
D22	562913.04	7916402.12	581.357
D23	562908.71	7916259.07	583.664
D24	562904.21	7916159.03	585.297
D25	562891.98	7916034.34	587.065
D26	562885.47	7915966.03	587.688
D27	562877.94	7915842.89	589.702
D28	562875.38	7915797.80	591.359
D29	562873.31	7915758.26	592.935
D30	562872.84	7915723.34	594.457
D31	562880.10	7915688.84	596.063
D32	562905.87	7915648.59	598.634
D33	562928.75	7915624.15	600.583
D34	562963.06	7915596.53	603.188
D35	563004.45	7915574.53	605.913
D36	563046.32	7915561.87	608.795

EAST DITCH POINTS SETOUT TABLE

POINT No.	EASTING (m)	NORTHING (m)	ELEVATION (m)
D1	563143.03	7916744.05	579.300
D2	563155.21	7916736.76	579.985
D3	563177.93	7916711.89	581.400
D4	563220.33	7916635.24	583.122
D5	563248.84	7916603.40	584.504
D6	563276.56	7916579.64	585.386
D7	563311.08	7916524.10	586.118
D8	563334.50	7916379.54	592.006
D9	563354.66	7916248.35	598.661
D10	563396.03	7916151.18	603.586
D11	563415.08	7916076.07	607.237
D12	563433.09	7915992.12	611.678
D13	563448.27	7915915.51	615.518
D14	563448.97	7915889.46	616.934
D15	563446.77	7915859.54	618.658
D16	563442.57	7915830.80	620.182
D17	563432.50	7915789.89	622.592
D18	563411.19	7915763.25	624.315

0 100 200
1:3,000 METRES

ISSUED FOR CONSTRUCTION

PERMIT TO PRACTICE
GOLDER ASSOCIATES LTD.
Signature
Date 15 JUNE 2018
PERMIT NUMBER: P 049
NT/NU Association of Professional Engineers and Geoscientists

REV	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2018-06-15	ISSUED FOR CONSTRUCTION	SEC	BA	MT	KAB

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CLIENT
Baffinland

CONSULTANT
GOLDER

MISSISSAUGA OFFICE
6925 CENTERY AVENUE, SUITE 100
MISSISSAUGA, ON
CANADA
905-567-444
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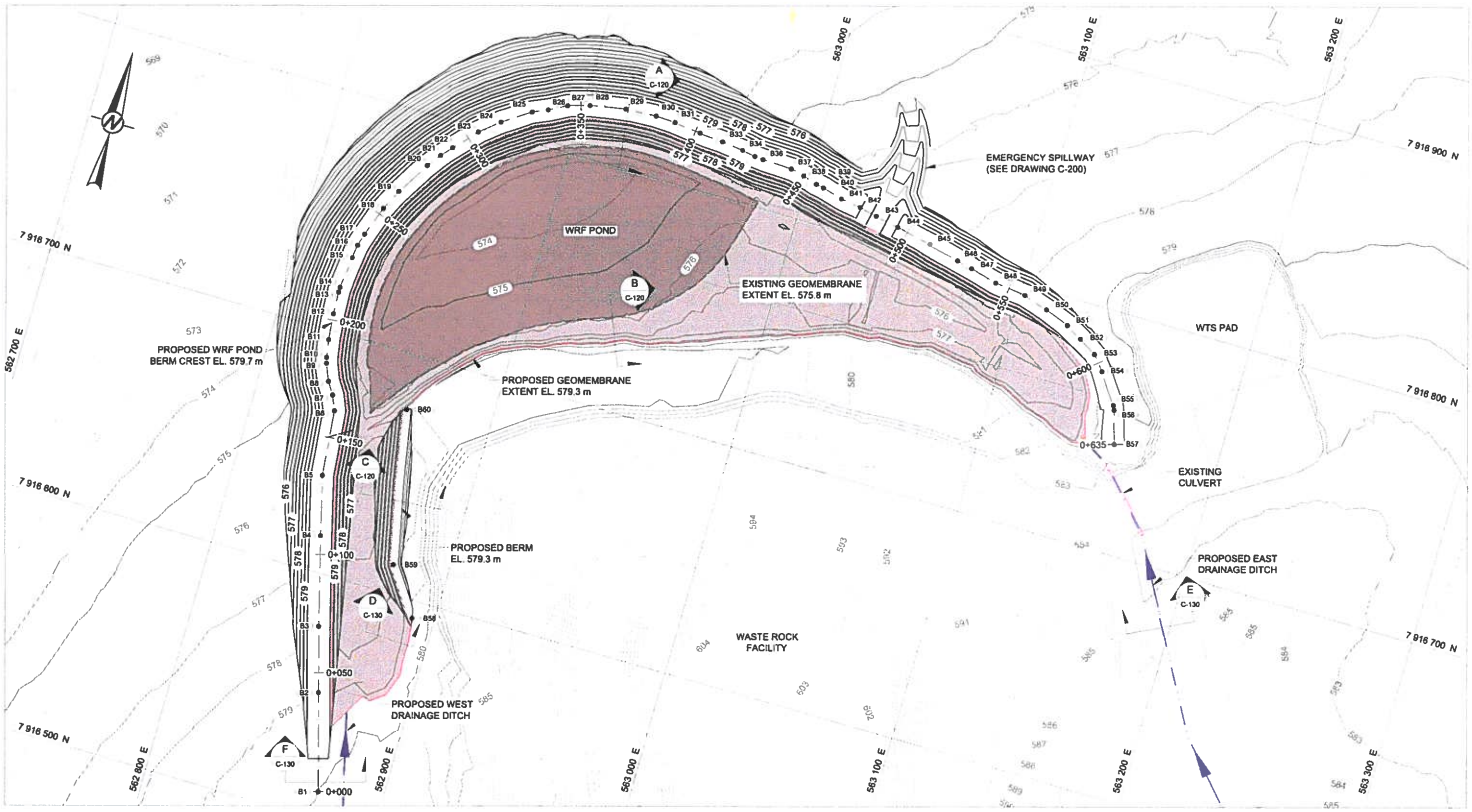
PROJECT
MARY RIVER PROJECT
WRF POND EXPANSION
DRAINAGE SYSTEM

TITLE
WRF POND EXPANSION - GENERAL ARRANGEMENT

PROJECT NO.	PHASE	REV.	of	DRAWING
1790951	2003	A		G-200



LEGEND

- PROPOSED DESIGN CONTOURS (0.5 m INTERVAL)
- EXISTING GROUND CONTOURS (1.0 m INTERVAL)
- EXISTING WRF POND
- PROPOSED WRF POND EXPANSION
- PROPOSED EXTENT OF GEOMEMBRANE
- DRAINAGE DITCH AND FLOW DIRECTION

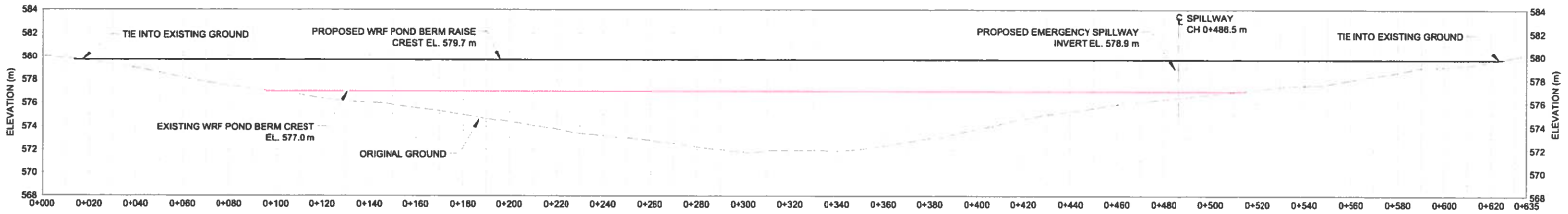
NOTE(S)

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. COORDINATE SYSTEM IS UTM (NAD83) ZONE 17.
3. THE GROUND SURFACE IS APPROXIMATE AND MAY VARY FROM THAT SHOWN.
4. THE WRF POND SHALL BE DEWATERED AND THE CONDITION OF THE EXISTING GEOMEMBRANE INSPECTED PRIOR TO RAISING OF THE WRF POND BERM.
5. REFER TO DRAWING C-120 FOR THE WRF POND BERM SETOUT POINTS. SETOUT POINTS TO BE VERIFIED AT TIME OF CONSTRUCTION.

REFERENCE(S)

1. TOPOGRAPHY PROVIDED BY BAFFINLAND.
2. ASBUILT CONTOURS PROVIDED BY BAFFINLAND ON MAY 17, 2018.

0 50 100
1:1,000 METRES



PROFILE - BERM RAISE

HORIZONTAL SCALE 1:1000 VERTICAL SCALE 1:200

ISSUED FOR CONSTRUCTION

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GOLDER ASSOCIATES LTD.
Signature
Date 15 Sept 2018
PERMIT NUMBER: P 049
NT/NU Association of Professional Engineers and Geoscientists

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2018-06-15	ISSUED FOR CONSTRUCTION	SEC	BA	MT	KAB

SEAL

CLIENT: Baffinland

CONSULTANT: GOLDER

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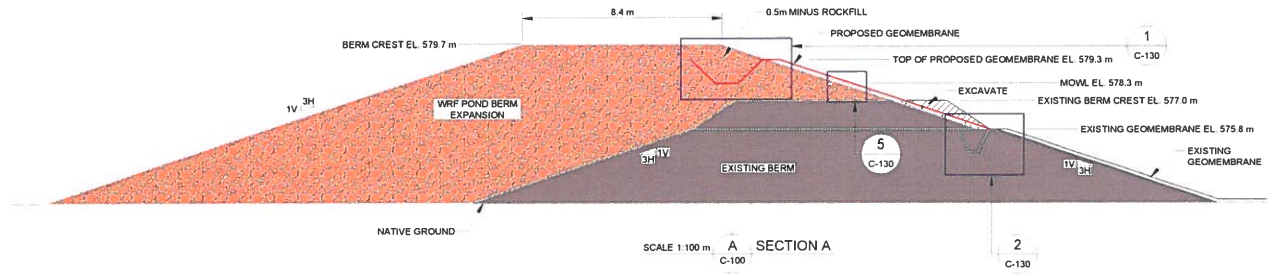
www.golder.com

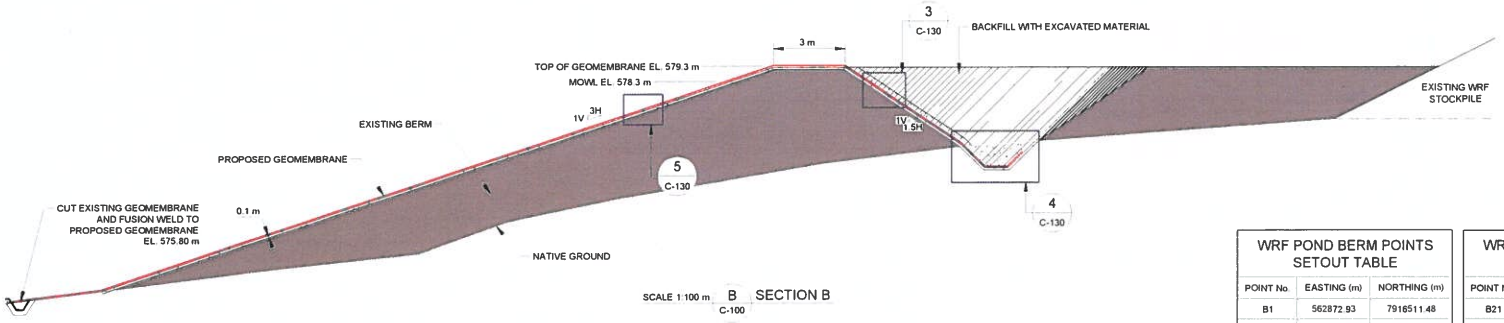
PROJECT:
MARY RIVER PROJECT
WRF POND EXPANSION
DRAINAGE SYSTEM

TITLE:
WRF POND EXPANSION - PLAN & PROFILE

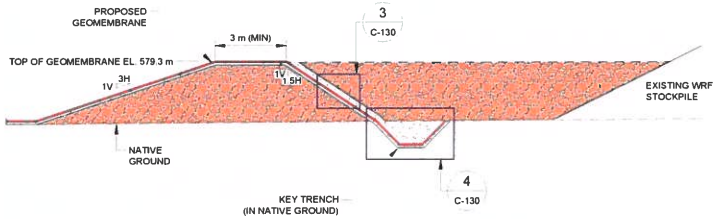
PROJECT NO.	PHASE	REV.	DRAWING
1790951	2003	A	C-100



SCALE 1:100 m A C-100 SECTION A



SCALE 1:100 m B C-100 SECTION B



SCALE 1:100 m C C-100 SECTION C

LEGEND

- 0.5m MINUS ROCKFILL
- INTERMEDIATE BEDDING
- EXCAVATION AREA
- EXISTING BERM
- PROPOSED
- RIPRAP
- GEOMEMBRANE
- NON-WOVEN GEOTEXTILE

NOTE(S)

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. ORGANIC AND DELETERIOUS MATERIALS TO BE STRIPPED FROM FOUNDATION PRIOR TO FILL PLACEMENT.
3. NON-WOVEN GEOTEXTILE MAY BE REPLACED BY 0.1 m THICKNESS OF FINE BEDDING MATERIAL.
4. GEOMEMBRANE TO BE LAYFIELD ENVIROLINER 6060 OR APPROVED EQUIVALENT. GEOTEXTILE TO BE LAYFIELD LP7 OR APPROVED EQUIVALENT.

WRF POND BERM POINTS SETOUT TABLE

POINT No.	EASTING (m)	NORTHING (m)
B1	562872.93	7916511.48
B2	562861.51	7916551.38
B3	562853.75	7916578.52
B4	562843.84	7916615.40
B5	562837.50	7916640.25
B6	562834.77	7916668.09
B7	562832.26	7916674.06
B8	562828.95	7916679.04
B9	562826.05	7916686.18
B10	562825.44	7916688.47
B11	562824.21	7916695.95
B12	562823.12	7916706.90
B13	562822.64	7916716.32
B14	562822.67	7916718.41
B15	562824.17	7916732.07
B16	562824.93	7916737.70
B17	562826.42	7916743.06
B18	562830.88	7916755.85
B19	562835.20	7916764.69
B20	562843.70	7916778.38

WRF POND BERM POINTS SETOUT TABLE

POINT No.	EASTING (m)	NORTHING (m)
B21	562847.90	7916784.06
B22	562852.02	7916788.72
B23	562860.54	7916798.22
B24	562868.55	7916804.78
B25	562879.93	7916812.45
B26	562886.35	7916815.24
B27	562893.74	7916819.21
B28	562902.79	7916821.94
B29	562917.74	7916824.63
B30	562930.97	7916825.38
B31	562939.38	7916824.99
B32	562950.67	7916823.65
B33	562960.80	7916822.75
B34	562970.01	7916821.50
B35	562975.83	7916820.44
B36	562979.45	7916820.10
B37	562992.06	7916819.61
B38	562997.85	7916818.35
B39	563003.93	7916816.39
B40	563007.21	7916815.78

WRF POND BERM POINTS SETOUT TABLE

POINT No.	EASTING (m)	NORTHING (m)
B41	563015.98	7916813.34
B42	563024.69	7916812.02
B43	563032.25	7916810.35
B44	563042.22	7916808.42
B45	563057.26	7916805.22
B46	563070.57	7916801.69
B47	563077.20	7916800.08
B48	563088.70	7916797.04
B49	563102.00	7916795.47
B50	563112.54	7916792.24
B51	563122.88	7916788.21
B52	563129.70	7916784.31
B53	563137.21	7916779.66
B54	563142.27	7916773.66
B55	563150.80	7916761.44
B56	563151.64	7916759.62
B57	563155.79	7916746.01
B58	562890.67	7916592.75
B59	562876.82	7916612.24
B60	562863.96	7916677.09

PERMIT TO PRACTICE
GOLDER ASSOCIATES LTD.
Signature
Date 15 JUNE 2018
PERMIT NUMBER: P 049
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ISSUED FOR CONSTRUCTION

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2018-06-15	ISSUED FOR CONSTRUCTION	SEC	BA	MT	KAB

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Baffinland

CONSULTANT
GOLDER

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CANADA
905-567-444
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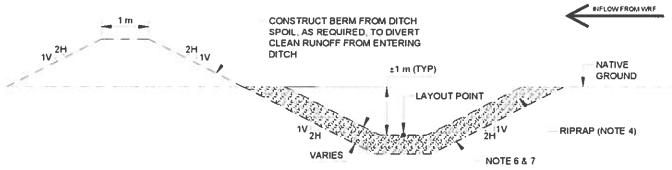
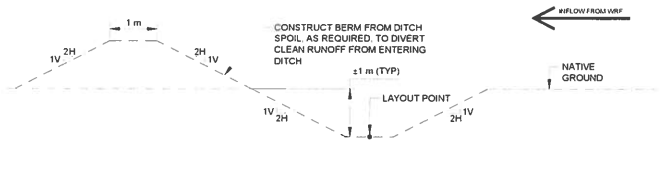
PROJECT
MARY RIVER PROJECT
WRF POND EXPANSION
DRAINAGE SYSTEM

TITLE
WRF POND EXPANSION - SECTIONS AND DETAILS

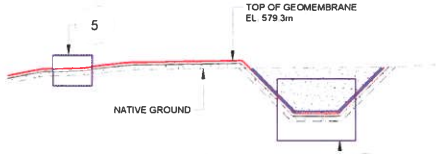
PROJECT NO.	PHASE	REV.	DRAWING
1790951	2003	A	C-120



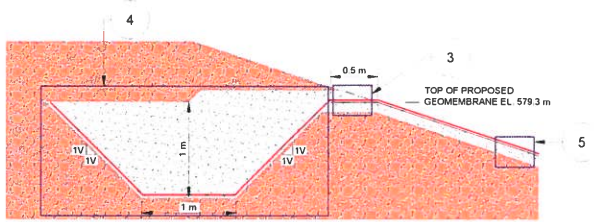
SCALE 1:50 m E C-100 TYPICAL DIVERSION DITCH WITH RIP-RAP



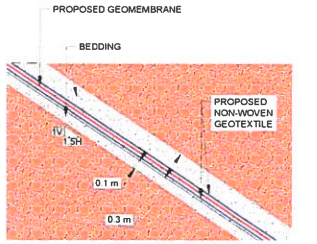
SCALE 1:50 m F C-100 TYPICAL DIVERSION DITCH WITHOUT RIP-RAP



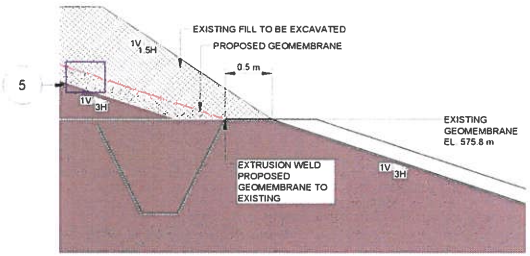
SCALE 1:50 m D C-100 SECTION D



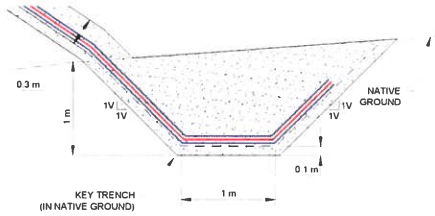
SCALE 1:25 m 1 DETAIL 1



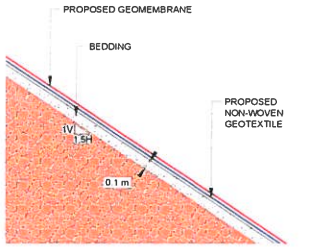
SCALE 1:25 m 3 TYPICAL BEDDING DETAIL



SCALE 1:25 m 2 DETAIL 2



SCALE 1:25 m 4 DETAIL 4



SCALE 1:25 m 5 TYPICAL BEDDING DETAIL 2

PERMIT TO PRACTICE
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Date 15 Dec 2018
PERMIT NUMBER: P 049
NT/NU Association of Professional Engineers and Geoscientists

LEGEND

- 0.5m MINUS ROCKFILL
- INTERMEDIATE BEDDING
- EXCAVATION AREA
- EXISTING BERM
- PROPOSED
- RIPRAP
- GEOMEMBRANE
- NON-WOVEN GEOTEXTILE

NOTE(S)

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. ORGANIC AND DELETERIOUS MATERIALS TO BE STRIPPED FROM FOUNDATION PRIOR TO FILL PLACEMENT.
3. NON-WOVEN GEOTEXTILE MAY BE REPLACED BY 0.1 m THICKNESS OF FINE BEDDING MATERIAL.
4. REFER TO TABLE FOR RIPRAP GRADATION, THICKNESS, AND LOCATIONS WHERE REQUIRED.
5. GEOMEMBRANE TO BE LAYFIELD ENVIROLINER 6060 OR APPROVED EQUIVALENT. GEOTEXTILE TO BE LAYFIELD LP7 OR APPROVED EQUIVALENT.
6. RIPRAP MAY NOT BE INSTALLED AT THE TIME OF DITCH EXCAVATION. REQUIREMENT FOR RIPRAP TO BE DETERMINED BASED ON PERFORMANCE MONITORING.
7. RIPRAP SHALL BE EXTENDED 3.0 m INTO THE DITCH SECTION WHERE RIPRAP IS NOT REQUIRED.

RIP-RAP SETOUT TABLE

	Upstream Station	Downstream Station	Slope (%)	Flow Depth (m)	Flow Velocity (m/s)	Minimum Riprap D_{50} (mm)
West Ditch	0+000	0+022	0.08%	0.7	0.5	Not required
	0+022	0+102	1.50%	0.4	1.3	Not required
	0+102	0+150	2.50%	0.3	1.8	200
	0+150	0+293	1.80%	0.4	1.4	Not required
	0+293	0+393	1.60%	0.4	1.4	Not required
	0+393	0+518	1.40%	0.4	1.3	Not required
	0+518	0+587	0.80%	0.4	1.1	Not required
	0+587	0+710	1.60%	0.4	1.4	Not required
	0+710	0+755	3.70%	0.3	1.8	200
	0+755	0+795	4.03%	0.3	1.9	200
	0+795	0+830	4.43%	0.3	2	200
	0+830	0+865	4.50%	0.3	2	200
	0+865	0+913	5.40%	0.3	2.1	300
	0+913	0+946	5.70%	0.3	2.2	300
	0+946	0+990	5.90%	0.2	2.2	300
	0+990	1+037	5.62%	0.3	2.2	300
	1+037	1+081	6.07%	0.2	2.3	300
East Ditch	0+000	0+014	8.60%	0.2	1.5	300
	0+014	0+048	4.10%			CSP Culvert Riprap to be provided at outlet
	0+048	0+135	2.00%	0.3	1.5	Not required
	0+135	0+178	3.20%	0.3	1.8	200
	0+178	0+215	2.40%	0.3	1.6	200
	0+215	0+280	1.10%	0.4	1.2	Not required
	0+280	0+427	4.00%	0.3	1.9	200
	0+427	0+559	5.00%	0.3	2.3	300
	0+559	0+665	4.70%	0.3	2	300
	0+665	0+742	4.70%	0.3	2	300
	0+742	0+828	5.20%	0.3	2.1	300
	0+828	0+906	4.90%	0.3	2.1	300
	0+906	0+932	5.40%	0.3	2.2	300
	0+932	0+962	5.80%	0.3	2.2	300
	0+962	0+991	5.30%	0.3	2.1	300
	0+991	1+034	5.70%	0.3	2.2	300
	1+034	1+068	5.10%	0.3	2.1	300

RIPRAP THICKNESS SHALL BE TWICE THE D50 VALUE

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REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2018-06-15	ISSUED FOR CONSTRUCTION	SEC	BA	MT	KAB

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CLIENT: Baffinland

CONSULTANT: GOLDER

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905-567-444
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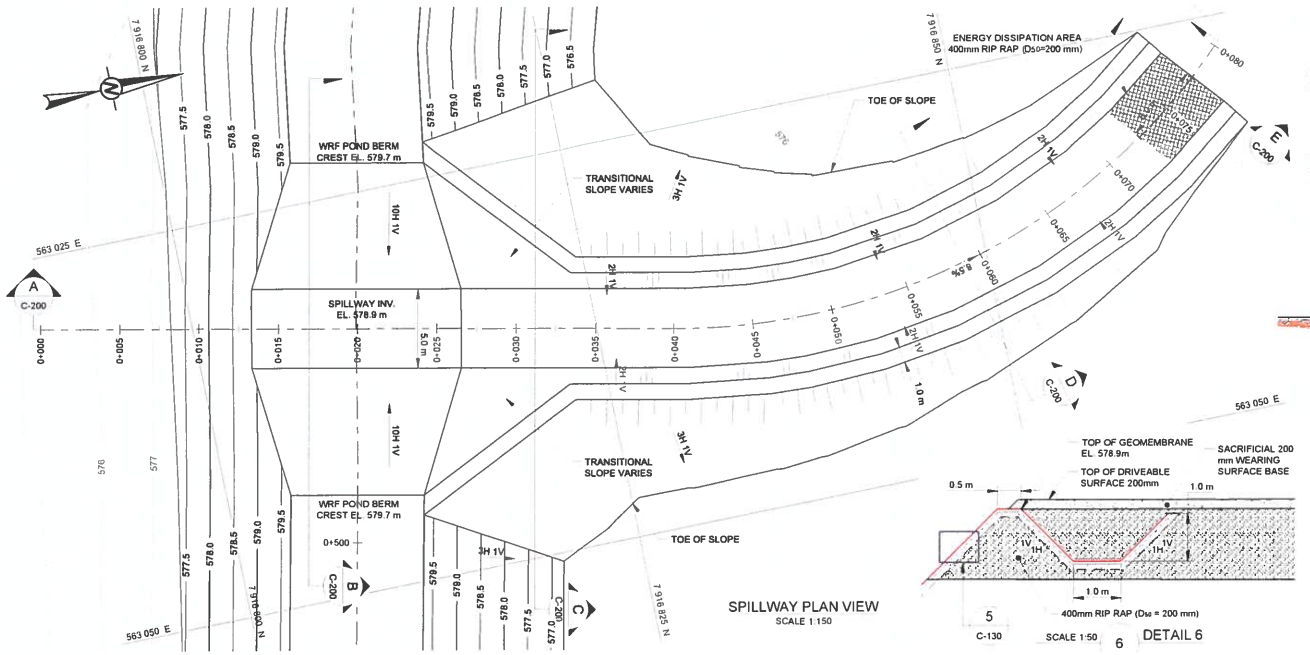
PROJECT
MARY RIVER PROJECT
WRF POND EXPANSION
DRAINAGE SYSTEM

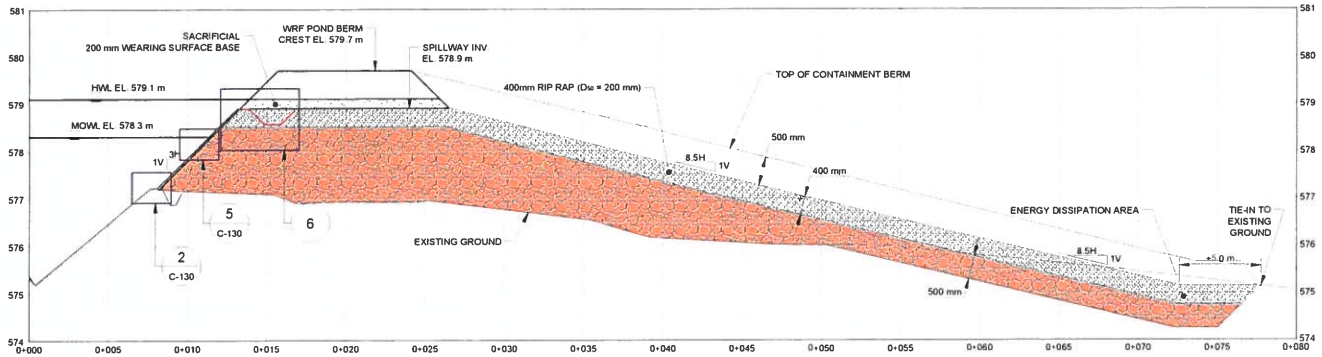
TITLE
WRF POND EXPANSION - SECTIONS AND DETAILS

PROJECT NO.	PHASE	REV.	of	DRAWING
1790951	2003	A		C-130



SPILLWAY PLAN VIEW
SCALE 1:150

5 C-130 SCALE 1:50 6 DETAIL 6



HORIZONTAL SCALE 1:150 VERTICAL SCALE 1:50 A C-200 SPILLWAY LONGITUDINAL SECTION

LEGEND

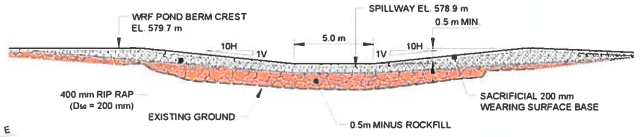
- 0.5m MINUS ROCKFILL
- INTERMEDIATE BEDDING
- PROPOSED
- RIPRAP
- 576 EXISTING CONTOURS
- 579.0 PROPOSED CONTOURS
- GEOMEMBRANE
- NON-WOVEN GEOTEXTILE

NOTE(S)

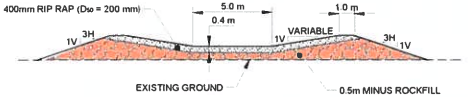
1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. COORDINATE SYSTEM IS UTM (NAD83) ZONE 17.
3. THE GROUND SURFACE IS APPROXIMATE AND MAY VARY FROM THAT SHOWN.
4. THE CONTRACTOR SHALL CARRY OUT AN AS-BUILT SURVEY OF THE EXISTING CONDITION AND ALL NEW CONSTRUCTION
5. GEOMEMBRANE TO BE LAYFIELD ENVIROLINER 6060 OR APPROVED EQUIVALENT. GEOTEXTILE TO BE LAYFIELD LP7 OR APPROVED EQUIVALENT.
6. NON-WOVEN GEOTEXTILE MAY BE REPLACED BY 0.1 m THICKNESS OF FINE BEDDING MATERIAL.

REFERENCE(S)

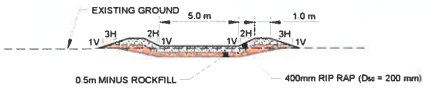
1. TOPOGRAPHY PROVIDED BY BAFFINLAND.
2. AS-BUILT CONTOURS PROVIDED BY BAFFINLAND ON MAY 17,2018.



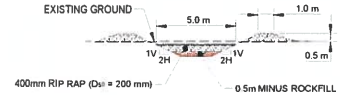
SCALE 1:150 B C-200 SPILLWAY CREST SECTION



SCALE 1:150 C C-200 SPILLWAY CHUTE SECTION IN FILL



SCALE 1:150 D C-200 SPILLWAY CHUTE SECTION IN CUT



SCALE 1:150 E C-200 ENERGY DISSIPATOR

0 2 4
1:50 METRES

0 5 10
1:150 METRES

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PERMIT TO PRACTICE GOLDER ASSOCIATES LTD.
Signature
Date
PERMIT NUMBER: P 049
NT/NU Association of Professional Engineers and Geoscientists

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CLIENT: Baffinland

CONSULTANT: GOLDER

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PROJECT
MARY RIVER PROJECT
WRF POND EXPANSION
DRAINAGE SYSTEM

TITLE
WRF POND EXPANSION - SPILLWAY - PLAN, PROFILE & SECTIONS

PROJECT NO.	PHASE	REV.	of	DRAWING
1790951	2003	A		C-200

REV	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2018-06-15	ISSUED FOR CONSTRUCTION	SEC	BA	MT	KAB

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