Golder Associates

TECHNICAL MEMORANDUM

DATE December 18, 2014 **REFERENCE No.** 1313280041-E14076-TM-Rev0-2020

TO Mats Heimersson
Dominion Diamond Ekati Corporation

FROM John Cunning and Ermanno Rambelli **EMAIL** john_cunning@golder.com; ermanno_rambelli@golder.com

THERMAL ASSESSMENT FOR MISERY PIT LAKE

1.0 INTRODUCTION

Dominion Diamond Ekati Corporation (Dominion Diamond) has retained Golder Associates Ltd. (Golder) to develop a pre-feasibility level design for the mining of the Jay kimberlite pipe deposit (Jay Project) at its Ekati Diamond Mine (Ekati Mine) in the Northwest Territories (NWT). The existing Ekati Mine is located approximately 200 kilometres (km) south of the Arctic Circle and 300 km northeast of Yellowknife in the NWT (Figure 1-1).

The Jay Project involves the development of the Jay kimberlite pipe, which is located beneath Lac du Sauvage, northeast of the existing Misery Pit Operations. The dewatering of part of Lac du Sauvage (diked area) and the diversion of headwater flows are required before mining activities commence. The dewatered area will be maintained throughout the life of the mining operations by pumping.

The kimberlite will be mined from the Jay pipe using an open-pit mining method. The kimberlite from the Jay pipe will be processed at the existing Ekati Mine facilities. The current mine plan indicates that up to approximately five million tonnes of kimberlite will be processed annually from the Jay pipe over a nominal 10-year mine life.

Figure 1-2 presents the general location plan of the existing Ekati Mine and includes the locations of the proposed Jay Dike and Pit. The main proposed mine facilities in the Jay Project area include a dewatering dike, an open pit, roads, pumping and pipeline systems, ore transfer pads, a waste rock storage area, and a diversion channel. As part of the Jay Project pre-feasibility study, Golder has developed a mine water management plan. The mine water management plan describes the strategies proposed for water and sediment management throughout the main stages of project development: construction, operations, and closure/post-closure.

The Jay Project development footprint during operations is presented in Figure 1-3. As part of the Jay Project, the Misery Pit will be utilized as a water management facility (Golder 2014). The mined-out Misery Pit will be used as a total suspended solids (TSS) management facility during the diked area dewatering phase and as a total dissolved solids (TDS) management facility during mine operations. Once the Misery Pit has reached its maximum operational capacity, water will be discharged from the Misery Pit Lake to Lac du Sauvage through a pumping system and a diffuser.

To provide input to the hydrogeological study for the proposed water management facility, Golder carried out thermal analyses for the Misery Pit and Misery Pit Lake to assess the ground thermal regime as the pit is flooded. The thermal assessment consisted of a review of the original Misery Lake talik formation estimation, current ground thermal conditions in the Misery Pit area, expected ground thermal conditions for the mined-out Misery Pit, and thermal changes during and after back-flooding the Misery Pit with minewater from Jay Project area. This memorandum summarizes the results of the thermal assessment for the proposed Misery Pit Lake.

2.0 BACKGROUND

The Jay Project is located within a region of continuous permafrost. In this region, the layer of permanently frozen subsoil and rock is generally deep and overlain by an active layer that thaws during summer. The depth of the active layer in the Misery Pit area ranges from approximately 1.0 to 2.7 metres (m). Based on available thermistor data collection and interpretation, the depth of permafrost at the site is estimated to be about 320 to 485 m under locations that are not affected by waterbodies. Unfrozen ground (talik zones) occurs beneath waterbodies (Dominion Diamond 2014, Annex IV).

The Misery Pit is located in the area of the original Misery Lake. The 2014 topography in the pit area and the bathymetry of the original Misery Lake are shown in Figure 2-1.

Based on the bathymetric data, the original Misery Lake has the following characteristics:

- lake elevation at approximately 443.4 metres above sea level (masl);
- maximum lake depth to about 28 m, at the southwest portion;
- maximum lake length from northeast to southwest at about 590 m; and,
- maximum lake width from northwest to southeast at about 320 m.

Schlumberger Water Services (Canada) Inc. (Schlumberger) reported that a full talik probably exists beneath the Misery Pit within the footprint of the original Misery Lake (Schlumberger 2010).

Dominion Diamond started development of the Misery Pit in 2001 and diamond production in 2002. Misery Pit mining stopped in 2005. Dominion Diamond restarted mining in the Misery Pit in 2014. The current pit floor is at about elevation 276 masl based on the 2014 topography, and the design ultimate pit floor is about elevation 150 masl (Figure 2-1).

Based on the proposed schedule for the Jay Project, starting in 2019, the mined-out Misery Pit will be used as a water management facility, starting as a settling facility for TSS laden water during the final dewatering of the diked area of Lac du Sauvage. The Misery Pit has an estimated ultimate storage capacity of approximately 40 million cubic metres (m^3). Approximately 7.9 million m^3 of TSS laden water will be pumped to the Misery Pit during the dewatering phase of Jay Project.

During the Jay Project mine operation phase, which is proposed to be between 2020 and 2029, the Misery Pit will be used to manage minewater from the Jay Pit and diked area. Open-pit minewater (TDS laden water) will be pumped to the base of the Misery Pit; surface minewater will be pumped to the top of the Misery Pit. This method of back-flooding is expected to facilitate the creation of a TDS profile within the Misery Pit Lake, resulting in lower TDS concentrations in the upper part and higher TDS concentrations in the lower part of the Misery Pit Lake. Minewater will be contained in the Misery Pit Lake until approximately Year 4.5 of Jay Pit mine life (2024), when the water level in the Misery Pit Lake is expected to reach the maximum operational water level. At this point, water will be pumped from the top of the Misery Pit Lake to Lac du Sauvage for discharge through a diffuser outfall. Between 2024 and 2029, the maximum operational water level in the Misery Pit Lake is set to an elevation of 430 masl, approximately 10 m below the pit outlet elevation.

Between 2030 and 2031, the Misery Pit Lake will be pumped down to transfer higher TDS concentration water into the mined-out Jay Pit. Water pumped from Lac du Sauvage to Misery Pit Lake will be used to establish a freshwater cap, which is expected to maintain a water elevation of 440 masl in the long term with overflow to Lac de Gras through the existing drainage channel. The proposed Misery Pit back-flooding schedule is presented in Figure 2-2.

3.0 THERMAL MODEL

Two-dimensional thermal modelling was carried out using the finite element program Temp/W of GeoStudio 2007 (Version 7.21), developed by GEO-SLOPE international Ltd. (GEO-SLOPE 2010). This section presents the model scenarios, input parameters, assumptions, and limitations.

3.1 Model Scenarios

The modelling scenarios were developed using the following steps to simulate the pit operation history and the proposed Misery Pit back-flooding plan:

- Step 1 – a steady state model to estimate initial thermal conditions beneath the original Misery Lake;
- Step 2 – a transient model with the 2014 Misery Pit configuration to estimate ground thermal conditions when Misery Pit mining restarted, using Step 1 model results as the initial conditions;
- Step 3 – a transient model with the ultimate Misery Pit configuration to estimate the ground thermal conditions before the back-flooding of the Misery Pit with minewater from the Jay Project, using Step 2 model results as the initial conditions;
- Step 4 – a transient model with the ultimate Misery Pit configuration, with the pit being back-flooded with minewater during Jay Project operations and into closure, to estimate ground thermal conditions as the pit lake develops between 2019 and 2031 (13 years), using Step 3 model results as the initial conditions; and,
- Step 5 – a transient model running for 100 years (Jay Project post-closure) with the Misery Pit Lake at an elevation of 440 masl to estimate ground thermal conditions and talik conditions over the long term, using Step 4 model results as the initial conditions.

These thermal model scenarios are illustrated in Figure 3-1 and include the estimated boundary conditions for each stage. Each transient model was run starting from January of that year, using daily time steps.

In addition, a steady state model was run that included both Misery Lake and Lac de Gras, for two scenarios: (a) with the original Misery Lake, and (b) with the back-flooded Misery Pit Lake. An elevation of 415.9 masl was used for Lac de Gras. The purpose of this model was to estimate the long-term ground thermal conditions between the Misery Pit Lake and Lac de Gras after back-flooding, as compared to the original Misery Lake. The model results were prepared to provide input to the hydrogeological study for the Misery Pit (Dominion Diamond 2014, Appendix 8C, Section 8C2).

3.2 Material Properties

The ground in this region typically consists of glacial till and bedrock (Dominion Diamond 2014, Annex IV). For these thermal analyses, it is expected that the material properties of bedrock will have the more significant effect on thermal conditions than the soil due to the depth included in the model. Each model assumed a uniform thickness of 3 m of till overlying bedrock, under the lake and outside the pit. No soil layers were included within the pit. No lakebed sediment materials were included below the lake. Material properties and depths used in the thermal models are summarized in Table 1.

Table 1: Summary of Material Properties and Depths for Thermal Model

Material	Volumetric Water Content	Thermal Conductivity (W/m-°C)		Volumetric Heat Capacity (MJ/m^3-°C)		Assumed Depth
		Frozen	Unfrozen	Frozen	Unfrozen	m
Glacial till	19.4%	2.05	1.73	1.88	2.25	3
Bedrock	2.5%	3.0	3.0	1.94	1.99	>3

W/m-°C = watts per metre degrees Celsius; MJ/m^3-°C = megajoules per cubic metre degrees Celsius; m = metre; % = percent; > = greater than.

3.3 Boundary Conditions

3.3.1 Ground Surface Temperatures

The Hydrology Baseline Report for the Jay Project includes mean monthly air temperatures, which were obtained from derived site climate data of 1959 to 2013 (Dominion Diamond 2014, Annex X). A mean monthly temperature function was estimated using these monthly air temperatures (Figure 3-2). Based on a review of deep thermistor data, the Permafrost Baseline Report (Dominion Diamond 2014, Annex IV) presents an estimated mean annual ground surface temperature of -6 degrees Celsius (°C) in the Misery Pit area. The mean monthly temperature function was estimated using n-factors to achieve the -6°C annual average temperature as shown in Figure 3-2. Varying n-factors were used for transition times from positive to negative or from negative to positive temperatures. This ground surface temperature function was obtained using an average thawing n-factor of 1.83 and an average freezing n-factor of 0.88.

3.3.2 Original Misery Lake and Misery Pit Lake Bottom Temperatures

Typically, a mean annual lake bottom temperature is related to water depth in a permafrost region: the deeper the lake, the higher the expected mean annual lake bottom temperature. The mean annual lake bottom temperature is typically higher than the mean annual ground surface temperature in a permafrost region. A typical range of +2°C to +4°C is presented in the Permafrost Baseline Report (Dominion Diamond 2014, Annex IV).

The original Misery Lake was assumed to have a constant temperature in the model to estimate the talik formation before pit development. The lake bottom temperatures of +2°C and +4°C were used for the models to observe differences in the resulting talik formations.

The Misery Pit Lake was assumed to have a constant mean annual lake bottom temperature of +4°C in all models. This was simplified without considering monthly variations and potentially lower lake terrace temperatures. It is understood that the temperature of the minewater pumped from the Jay Pit area may vary with such factors as initial in situ water temperature at Lac du Sauvage, pumping distance and method, discharge season, and water quality (TSS or TDS).

Due to depth of the Misery Pit and high TDS water to be stored, a meromictic condition (stratification) is expected to develop in the pit lake (Golder 2014). This condition inhibits the mixing with surface portion of water and results in a stable bottom temperature. Deep pit lake temperatures tend to stabilize near the +4°C at which maximum density occurs, which is similar for both saline and fresh water. A detailed assessment of the variation of the pit lake water temperature has not been carried out at this stage. A review of measured pit lake bottom temperatures from Pieters and Lawrence (2014) and Crusius et al. (2002) indicates the following:

- +3.5°C at about 110 m depth for Zone 2 Pit Lake at Colomac Mine located 250 km north of Yellowknife, NWT;
- +5°C at about 90 m depth for Faro Pit Lake at Faro Mine near Faro, Yukon;
- +4.5°C at about 60 m depth for Grum Pit Lake at Faro Mine near Faro, Yukon;
- +4.2°C at about 50 m depth for Vangorda Pit Lake at Faro Mine near Faro, Yukon;
- +5.2°C at about 120 m depth at Main Zone Pit Lake at Equity Mine near Houston, BC; and,
- +5.5°C at about 40 m depth at Waterline Pit Lake at Equity Mine near Houston, BC.

Based on the literature review, site location, and the depth of the Misery Pit Lake, it is considered reasonable to assume a mean annual bottom temperature of +4°C for the pit lake for this thermal modelling.

3.3.3 Geothermal Gradient

A geothermal gradient of 0.012°C/m was applied to the lower boundary of each model based on previous thermistor data in the Misery Pit area (Schlumberger 2010; Dominion Diamond 2014, Annex IV).

3.4 Model Assumptions and Limitations

This simplified modelling exercise was intended to estimate the current ground thermal conditions and predict the future ground thermal conditions as a result of the Misery Pit back-flooding with minewater from the Jay Project under the estimated schedule. Due to limited site-specific data, a number of necessary assumptions were made for the models. The results of the models, therefore, may not be representative of current and future field conditions. The study focuses on obtaining the trending of the evolution of the thermal regime under the impact of the back-flooding in the Misery Pit.

Additional assumptions for the study include the following:

- Model calibration was not carried out.
- Existing ponded water remaining within the current and future Misery Pit is not considered in the model.

- Simplified pit back-flooding stages and pit development stages for setting up the thermal boundary were used.
- No latent heat during phase change between water and ice was considered (simplified model in Temp/W).
- No freezing point depression was considered in the model.
- No climate change effects were considered.

4.0 MODEL RESULTS AND DISCUSSION

The results of the thermal modelling provide the estimated ground thermal regime in the two-dimensional section adopted for this assessment. A summary of the model steps, conditions, and results is presented in Table 2. For the modelling steps 1 to 5, vertical temperature profiles taken from the centreline and crest of the pit at different times are shown in Figure 4-7. Model results are all presented at the December 31 time step for comparison. It is understood thermal conditions at other times of the year will be different for only the upper portion of the ground, which is small compared to the deep extent in the model.

Table 2: Summary of Model Scenarios and Results

Step	Description	Model	Lake Temperature	Ground Surface Temperature	Topography	Results	Figure
1	Initial conditions with original Misery Lake	Steady state	Constant +2°C and +4°C	Constant -6°C	Topography with original Misery Lake bathymetry, with El. 443 masl	Open talik under +4°C; used for subsequent models	4-1
2	2014 pit topography (10 years after initial conditions)	Transient – run 10 years after initial	N/A	Function shown in Figure 3-2	2014 pit topography, pit floor El. 276 masl	Freeze-back portion along pit surface	4-2
3	Ultimate pit topography (13 years after initial conditions)	Transient – run 3 years	N/A	Function shown in Figure 3-2	Design ultimate pit topography – pit floor El. 150 masl	Freeze-back portion along pit surface	4-2
4	Back-flooding with minewater from Jay Project	Transient – run 13 years following pit back-flooding schedule (2019 – 2031)	Constant +4°C	Function shown in Figure 3-2	Design ultimate pit topography – pit lake rises from El. 294 to 440 masl	Ground thawing with rising pit lake elevation	4-3 and 4-4
5	Long-term thermal conditions with Misery Pit Lake	Transient – run 100 years (2032 – 2131)	Constant +4°C	Function shown in Figure 3-2	Design ultimate pit topography – constant pit lake El. 440 masl	Continue thawing/warm-up of ground around pit	4-5 and 4-6
N/A[a]	Model section with Lac de Gras: (a) with original Misery Lake and (b) with ultimate Misery Pit Lake	Steady state	Constant +4°C	Constant -6°C	Design ultimate pit topography – (a) original Misery Lake El. 443 masl and (b) constant pit lake El. 440 masl	Ultimate conditions under with original Misery Lake or pit lake; minor impact to Lac de Gras	4-8

a) Additional model independent of previous model steps.

°C = degrees Celsius; El. = elevation; masl = metres above sea level; N/A = not applicable.

4.1 Original Misery Lake Talik Formation

The Step 1 model results show that open talik exists under the original Misery Lake under the constant +4°C lake bottom temperature, and closed talik exists under the constant +2°C lake bottom temperature without considering the basal cryopeg. The thermal conditions are shown in Figure 4-1. With the constant +2°C lake bottom temperature, the permafrost beneath the lake talik has a thickness of about 60 m, but is warm with negative temperatures close to 0°C. Potential freezing point depression induced by groundwater salinity may result in a layer of basal cryopeg for all of the permafrost, and thus an open lake talik. This supports the hypothesis that the original Misery Lake was likely underlain by an open talik formation.

The subsequent transient models were run using the open talik case from the +4°C lake bottom temperature as the initial conditions.

Compared with thermistor data presented in Schlumberger (2010), the modelled open talik size is considered to be larger and the modelled permafrost base elevations in the pit area are considered to be higher. It should be noted that this single model section cutting through the north portion of the original lake may not reflect the real three-dimensional talik conditions. Calibration of the talik shapes was not carried out, as the thermistor data from Schlumberger (2010) were obtained on the topography after several years of mining and detailed installation information is not available.

4.2 Ground Thermal Regime Before Pit Back-Flooding

The Step 2 and 3 models were run to estimate thermal conditions before Misery Pit back-flooding with minewater from the Jay Project. The model results show that following the development of the pit, part of the talik beneath the original Misery Lake would freeze back from top down. For the 2014 pit topography, there is about 45 m deep of frozen ground beneath the pit floor at 10 years after initial conditions with the original Misery Lake (Figure 4-2). The future advance towards the design ultimate pit elevation of 150 masl will continue to approach the existing lake talik and continue to freeze back for the surface portion. The estimated freeze-back depth under the ultimate topography the pit floor is about 25 m at 13 years after initial conditions (Figure 4-2).

4.3 Ground Thermal Regime During Back-Flooding with Minewater from the Jay Project

The Step 4 model shows that once the Misery Pit back-flooding with minewater from the Jay Project starts in 2019, thawing at the pit wall and floor will occur along the rising water level with warmer water temperatures than the ground surface. The first year (2019) of back-flooding will thaw the majority of the freeze-back portion at the pit floor. The thawing continues to push the zero degree isolines away from the pit surface. After completion of the back-flooding in year 2031 of Jay Project closure, a portion of talik will develop along the pit wall and floor (Figures 4-3 and 4-4).

4.4 Ground Thermal Regime After Pit Back-Flooding

The Step 5 model shows that during the post-closure period of the Jay Project after the pit back-flooding, thawing of permafrost around the Misery Pit and warming of the talik zone will continue over time. Thermal conditions are shown in Figures 4-5 and 4-6. During the 100 years after completed back-flooding (2031 to 2131), the talik temperatures beneath the pit floor warm from about 1°C to 4°C to about 2°C to 4°C.

The vertical temperature profile below the pit centreline shown in Figure 4-7 indicates a clear warming trend with time below the pit lake. It is expected that the pit lake talik expansion and warm-up will continue until a regional thermal regime equilibrium is reached, which is expected to require more than 100 years. At year 2131, the vertical temperatures below the pit crest are still below 0°C, indicating permafrost remains after 100 years into Jay Project post-closure (Figure 4-7).

4.5 Steady State Models with Lac de Gras

The results of the steady state thermal model for the original Misery Lake and for the Misery Pit Lake after back-flooding, both modelled with Lac de Gras, are shown in Figure 4-8. The Misery Pit Lake is larger and deeper than the original Misery Lake, and in the long term will increase the width of the open talik and result in a minor decrease to the zone of permafrost in areas adjacent to the pit lake. The temperatures in the talik zone are expected to increase. The long-term temperatures below the pit floor are estimated to be in the range of about 4°C to 6°C (Figure 4-8). The unfrozen deep ground beneath the permafrost between the pit lake and Lac de Gras will increase due to the gradual thawing induced by the pit back-flooding. The thermal regime between the Misery Pit Lake and Lac de Gras appears to receive only a minor impact from the pit lake.

5.0 SUMMARY

Two-dimensional thermal modelling was carried out to assess the impact from Misery Pit back-flooding with minewater from the proposed Jay Project. The model results indicate the following:

- An open talik existed beneath the original Misery Lake modelled with a constant 4°C bottom temperature, and a closed talik existed beneath the original Misery Lake modelled with a constant 2°C lake bottom temperature without considering the potential basal cryopeg. The open talik condition was considered the conservative case and selected as the initial condition for the subsequent transient models.
- There will be an ongoing freeze-back process during and after the pit excavation. The estimated frozen ground depth is about 25 m under the ultimate pit before the pit back-flooding starts.
- Once the pit back-flooding starts, thawing with time and warming of talik zone around the pit floor and walls will occur. The talik will expand over the long term below the pit lake and an open talik zone will be maintained beneath the ultimate pit lake, with about 1°C to 2°C temperature increase over 100 years.
- The final steady state thermal condition under the constant ultimate pit lake water elevation of 440 masl was estimated and indicates that the permafrost size adjacent to the pit lake will decrease. The ultimate temperatures below the pit lake are estimated to be in the range of about 4°C to 6°C.
- As the Misery Pit Lake is larger and deeper than the original Misery Lake, the unfrozen ground at depth beneath the permafrost between the pit lake and Lac de Gras will increase due to the gradual thawing induced by the pit lake. The thermal regime between the Misery Pit Lake and Lac de Gras appears to receive only a minor impact from the pit lake.

6.0 CLOSURE

The reader is referred to the Study Limitations, which follows the text and forms an integral part of this report. We trust that the above meets your current needs. Should you have any questions, please feel free to contact us.

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PERMIT NUMBER
P 049
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Dec 2014

JFC/JC/ER/rs/ls

Attachment: Study Limitations
Figures 1-1 to 4-8

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Pieters R, Lawrence GA. 2014. Physical Processes and Meromixis in Pit Lakes Subject to Ice Cover. Canadian Journal of Civil Engineering. 41(6):569-578.

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STUDY LIMITATIONS

Golder Associates Ltd. (Golder) has prepared this document 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 document. No warranty, express or implied, is made.

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LEGEND

- JAY PROJECT
- EXISTING MINE OR PROJECT
- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- ALL-SEASON ROAD
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- TREELINE
- WATERCOURSE
- WATERBODY

150 0 150

SCALE 1:6,000,000 KILOMETRES

REFERENCE

WATER OBTAINED FROM ATLAS OF CANADA
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
PROJECTION: CANADA LAMBERT CONFORMAL CONIC

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

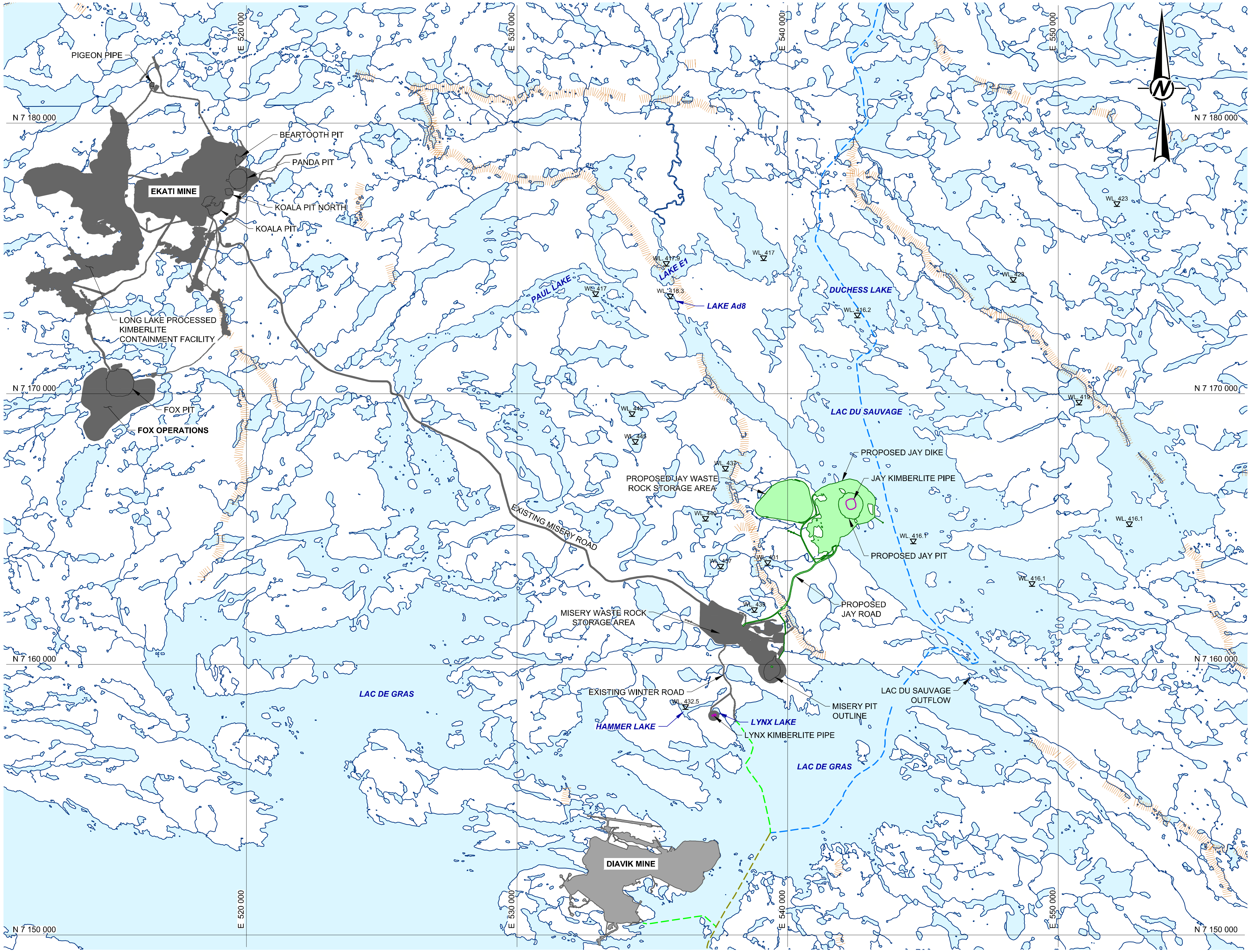
LOCATION OF THE JAY PROJECT

Golder Associates

PROJECT 13-1328-0041/2020/30			FILE No. TS_J_001_GIS	
DESIGN	JC	21/10/14	SCALE AS SHOWN	REV. 0
GIS	ANK	18/12/14		
CHECK	JFC	18/12/14		
REVIEW	JCC	18/12/14		

FIGURE 1-1

G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\Figures\13-1328-0041 Jay & Lynx EA\Engineering\Jay Project Thermal Study Memo\TS_J_001_GIS.mxd



LEGEND

- WATERBODY
- WATERCOURSE
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- WINTER ROAD
- APPROXIMATE ESKER
- KIMBERLITE PIPE LOCATION
- WL — WATER LEVEL ELEVATION
- PROPOSED JAY FOOTPRINT
- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT

NOTES

1. ALL UNITS ARE IN METRES UNLESS OTHERWISE NOTED.
2. ELEVATIONS ARE IN METRES ABOVE SEA LEVEL.
3. COORDINATES ARE SHOWN IN DATUM: NAD 83, PROJECTION: UTM ZONE 12.

REFERENCES

1. JAY PIPE LOCATION RECEIVED FROM DOMINION DIAMOND CORPORATION, FILE: jay_kimberlite_pipe_OL.dxf, DATED: JULY 19, 2013.
2. LYNX PIPE LOCATION RECEIVED FROM DOMINION DIAMOND CORPORATION, FILE: lynx_polyline.dxf, DATED: JUNE 25, 2013.

NOT FOR CONSTRUCTION

0 3,000 6,000 9,000

SCALE METRES

REV	DATE	REVISION DESCRIPTION	DES	CADD	CHK	RVW
A	2014-12-18	ISSUED FOR FINAL	JFC	JD	JFC	JCC

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

GENERAL LOCATION PLAN

Golder Associates

PROJECT No.	13-1328-0041.2020.30		FILE No.	1313280041_2020_30_1-2
DESIGN	JFC	2014-10-21	SCALE	AS SHOWN
CADD	JD	2014-10-21	FIGURE	
CHECK	JFC	2014-12-17		1-2
REVIEW	JCC	2014-12-17		

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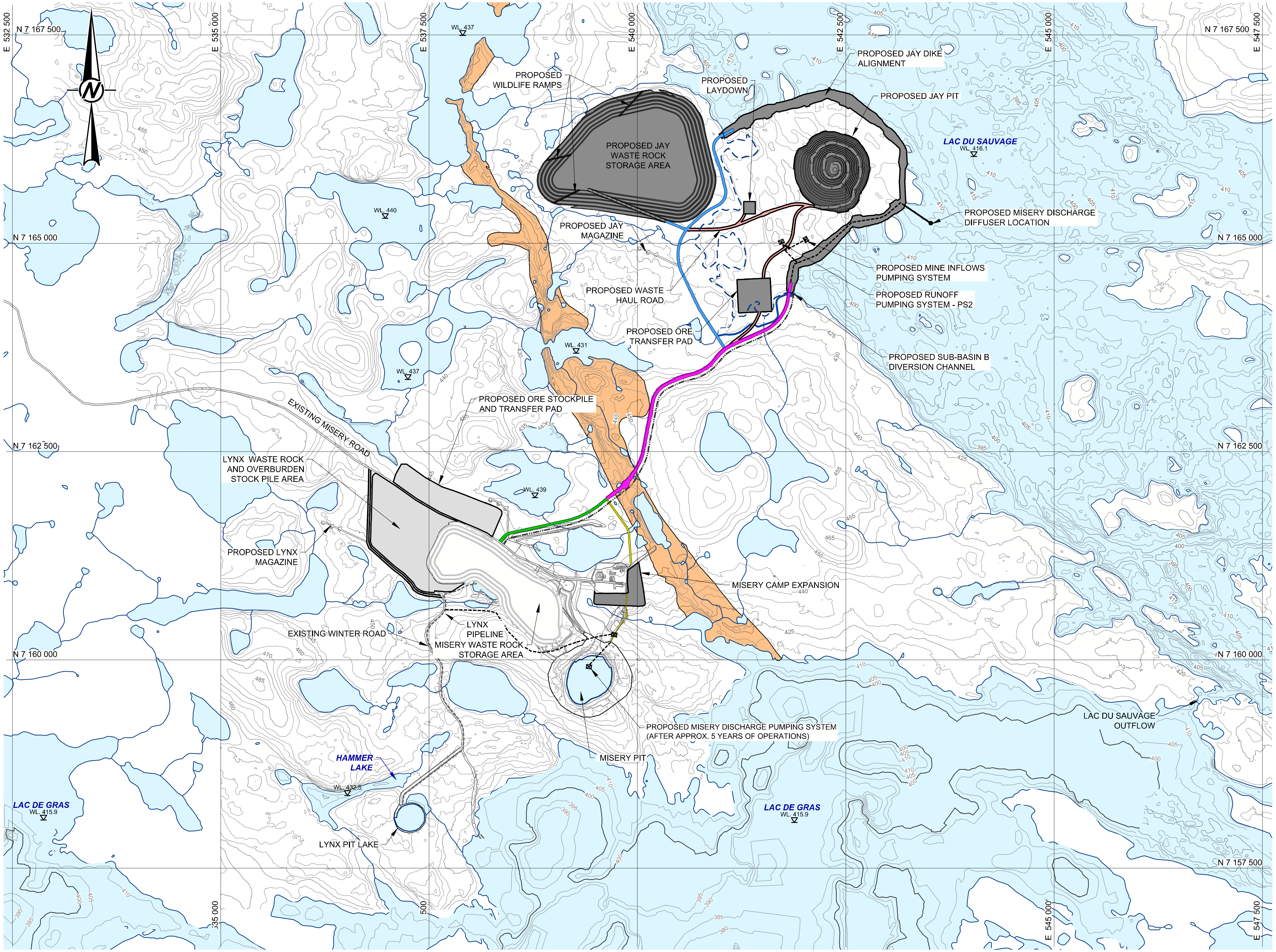


LEGEND

- WATERBODY
- WATERCOURSE
- EXISTING SHORELINE OF DEWATERED AREA
- ROAD
- WINTER ROAD - YEARLY CONSTRUCTION
- PROPOSED PUMPING SYSTEM
- PROPOSED POWER LINE
- WL WATER LEVEL ELEVATION
- ESKER (APPROXIMATE)

JAY PROJECT FOOTPRINT

- PROPOSED SUB-BASIN B DIVERSION CHANNEL
- PROPOSED JAY PROJECT INFRASTRUCTURE
- PROPOSED JAY ROAD NORTH (HAUL ROAD)
- PROPOSED JAY ROAD (HAUL ROAD AND POWER LINE)
- PROPOSED JAY ROAD (HAUL ROAD, PIPELINE AND POWER LINE)
- PROPOSED JAY PIPELINE ROAD (ACCESS ROAD AND PIPELINE)
- PROPOSED WASTE AND ORE HAUL ROADS

LYNX PROJECT FOOTPRINT

- LYNX PROJECT INFRASTRUCTURE

NOTES

1. ELEVATIONS ARE IN METERS ABOVE SEA LEVEL (masl).
2. GROUND SURFACE AND BATHYMETRY CONTOURS ARE SHOWN AT 5 m INTERVALS.
3. COORDINATES ARE SHOWN IN DATUM: NAD 83, PROJECTION: UTM ZONE 12.
4. LOCATION OF WILDLIFE CROSSINGS ALONG THE ROAD ALIGNMENT ARE NOT SHOWN. WILDLIFE CROSSING LOCATIONS TO BE FINALIZED DURING FUTURE STAGES OF DESIGN BASED ON EXISTING CARIBOU TRAIL MAPPING AND DISCUSSIONS DURING COMMUNITY ENGAGEMENT.

REFERENCES

1. CONTOUR AND BATHYMETRIC DATA PROVIDED BY AURORA GEOSCIENCES LTD., FILE: Final 1m Contours - Priority Area.dxf, DATE RECEIVED: OCTOBER 29, 2013
2. WATER OBTAINED FROM CANVEC NATURAL RESOURCES CANADA, 2012.
3. JAY PIT MODEL: GOLDER ASSOCIATES LTD., 2014. DOMINION DIAMOND JAY PIT - PRE-FEASIBILITY MINE DESIGN STUDY. SUBMITTED TO DOMINION DIAMOND EKATI CORPORATION, DATED OCTOBER 7, 2014. REFERENCE NO: 1313280041-E14065-R-Rev0-2020. (FILE NAME: pit_v6_OL.dxf).
4. LAC DE GRAS BATHYMETRIC DATA FROM FILE : Diavik_Bathymetry_April2006.shp

NOT FOR CONSTRUCTION

0 1,000 2,000 3,000
SCALE METRES

REV	DATE	REVISION DESCRIPTION	DES	CADD	CHK	RVW
	2014-12-18	ISSUED FOR FINAL	JFC	JD	JFC	JCC

PROJECT

DOMINION DIAMOND

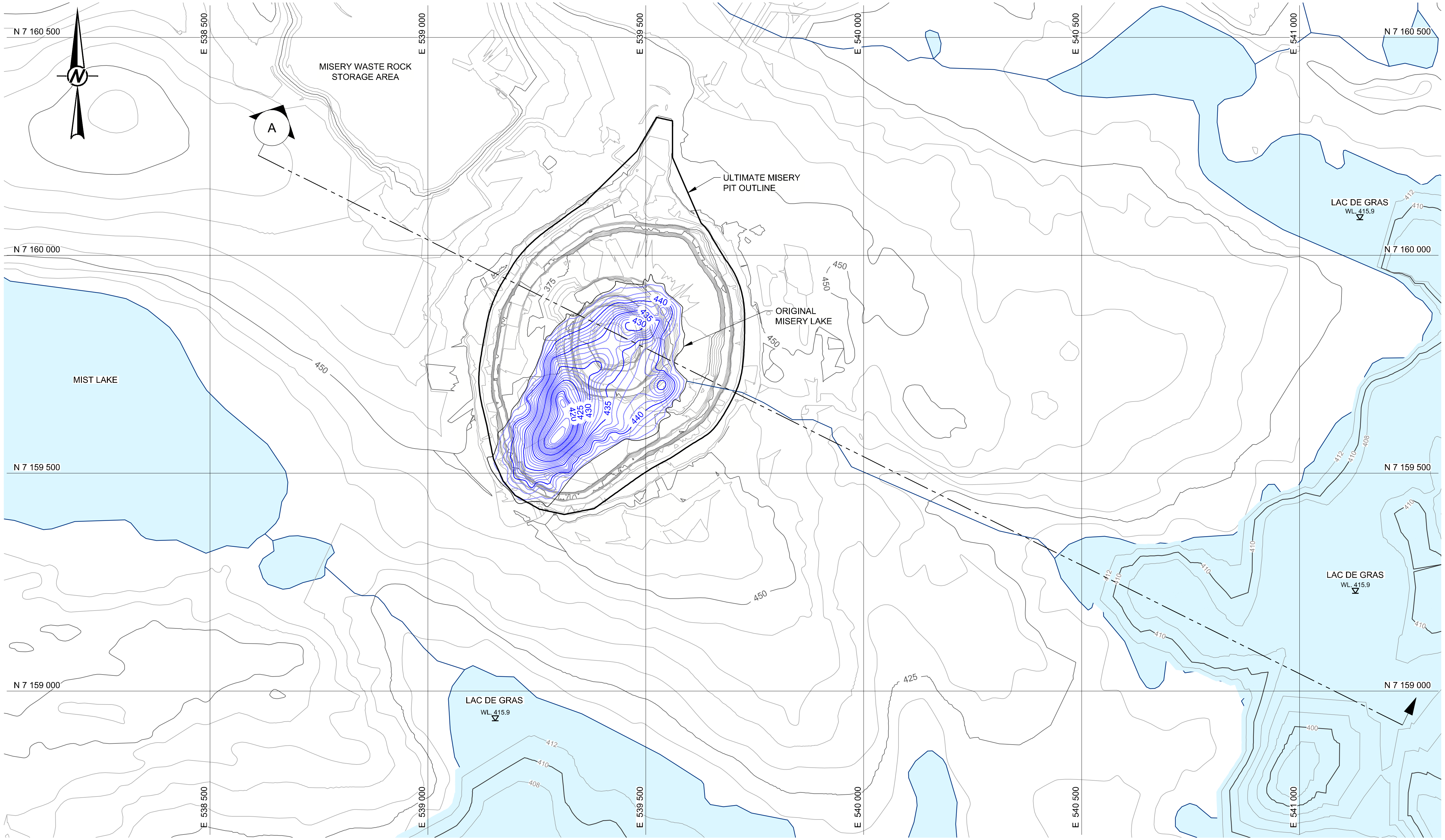
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

PROJECT DEVELOPMENT FOOTPRINT DURING OPERATIONS

Golder Associates

PROJECT No.	13-1328-0041.2020.30		FILE No. 1313280041_2020_30_1-3
DESIGN	JFC	2014-10-21	SCALE AS SHOWN
CADD	JD	2014-10-21	FIGURE
CHECK	JFC	2014-12-17	
REVIEW	JCC	2014-12-17	1-3



PLAN
SCALE AS SHOWN

LEGEND

- WATERBODY
- WATERCOURSE
- WL — WATER LEVEL ELEVATION

NOTES

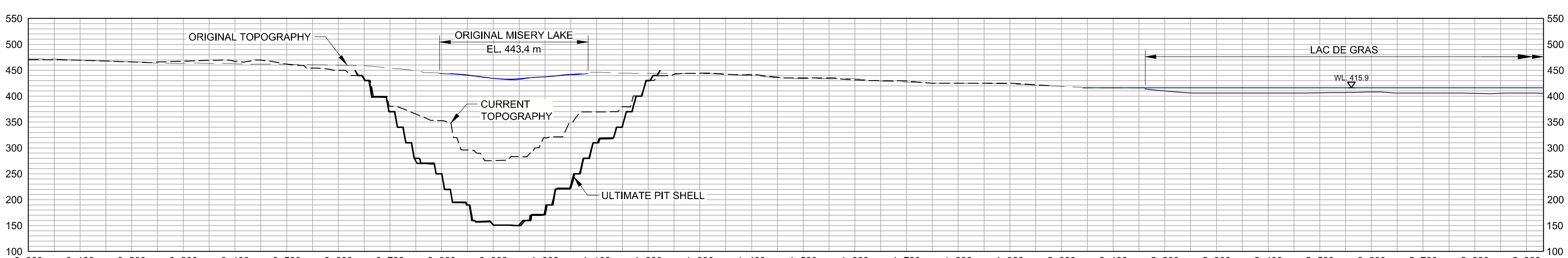
1. ALL UNITS ARE IN METRES UNLESS OTHERWISE NOTED.
2. ELEVATIONS ARE IN METRES ABOVE SEA LEVEL.
3. COORDINATES ARE SHOWN IN DATUM: NAD 83, PROJECTION: UTM ZONE 12.
4. CURRENT TOPOGRAPHY CONTOURS ARE SHOWN AT 5 m INTERVALS.
5. ORIGINAL MISERY LAKE BATHYMETRY CONTOURS ARE SHOWN AT 1 m INTERVALS.

REFERENCES

1. ORIGINAL TOPOGRAPHY OBTAINED FROM FILE: misery original.dxf.
2. CURRENT TOPOGRAPHY OBTAINED FROM FILE: misery current-20140609.dxf.
3. ULTIMATE MISERY PIT SHELL DESIGN OBTAINED FROM FILE: Misery_v7e.dxf.
4. WATER OBTAINED FROM CANVEC NATURAL RESOURCES CANADA, 2012.
5. LAC DE GRAS BATHYMETRIC DATA FROM FILE : Diavik_Bathymetry_April2006.shp

NOT FOR CONSTRUCTION

0 200 400 600
SCALE METRES



SCALE AS SHOWN (A) SECTION A

REV	DATE	REVISION DESCRIPTION	DES	CADD	CHK	RVW
0	2014-12-18	ISSUED FOR FINAL	JFC	JD	JFC	JCC

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

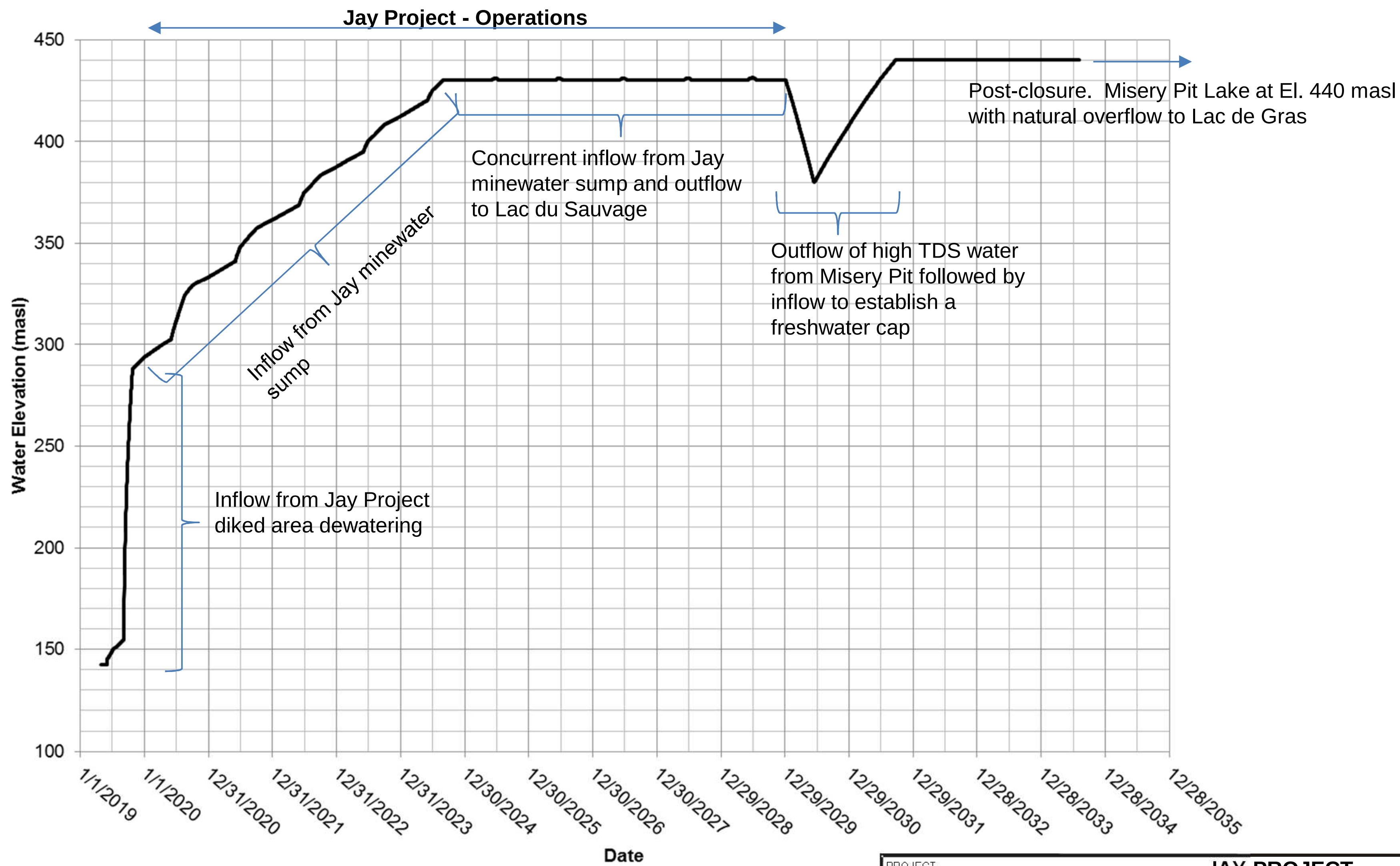
TITLE

MISERY PIT FILLING THERMAL ASSESSMENT MODEL SECTION

Golder Associates

PROJECT No.	13-1328-0041.2020.30		FILE No.	1313280041_2020_30_2-1
DESIGN	JFC	2014-09-23	SCALE	AS SHOWN
CADD	JD	2014-09-24	FIGURE	
CHECK	JFC	2014-12-17		2-1
REVIEW	JCC	2014-12-17		

FILE: O:\Active_2013\1328\13-1328-0041 2000 DD Eng\2020 Pre-Feasibility\30 Thermal & Hydrogeology LDS\Misery Pit Filling Thermal\memo



Note: based on Jay Project Mine Water Management Plan by Golder (2014)

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES
CANADA

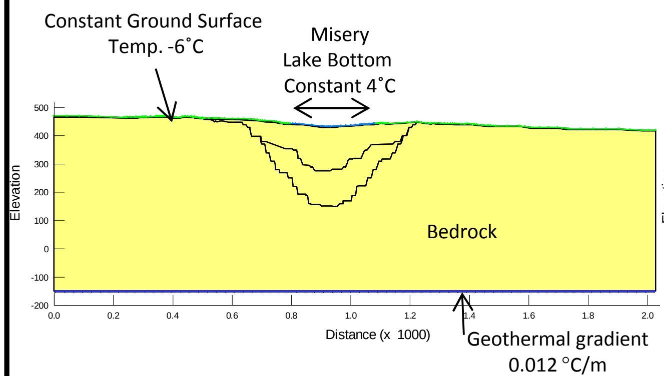
TITLE

MISERY PIT
BACK-FLOODING SCHEDULE

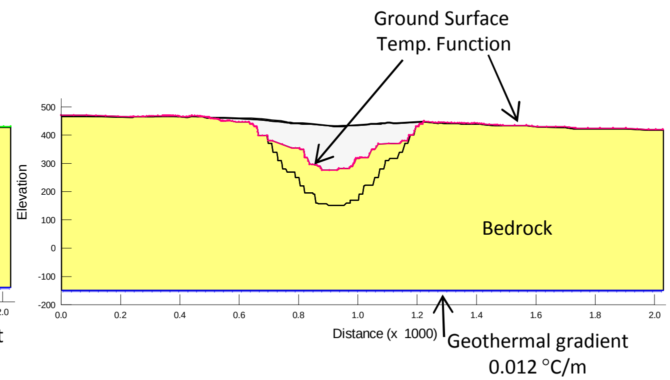
Golder Associates

PROJECT No. 13-1328-0041			PHASE No. 2020	
DESIGN	JFC	24SEP14	SCALE NTS	REV. B
CADD	JFC	24SEP14	**FIGURE 2-2**	
CHECK	JFC	18DEC14		
REVIEW	JCC	18DEC14		

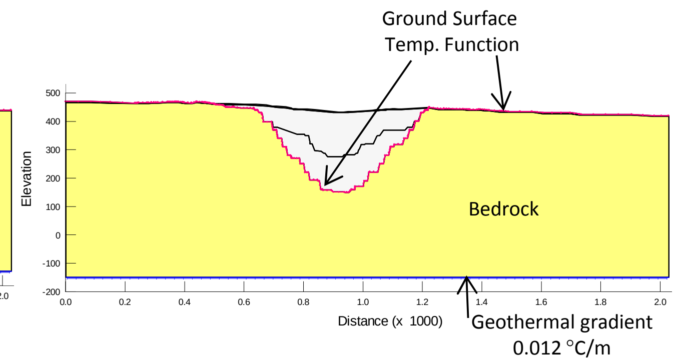
FILE: O:\Active_2013\1328\13-1328-0041 2000 DD Eng\2020 Pre-Feasibility\30 Thermal & Hydrogeology LDS\Misery Pit Filling Thermal\memo



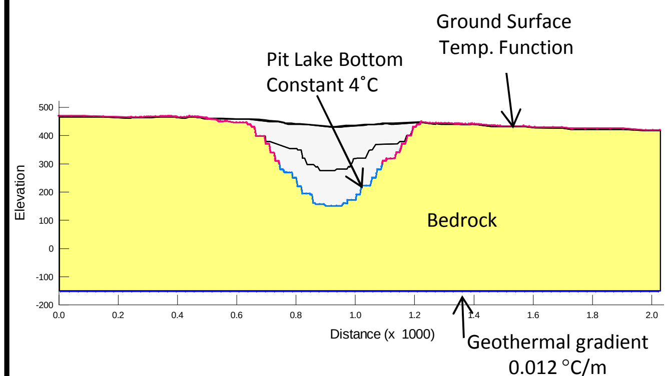
Step 1. Initial conditions with original Misery Lake.



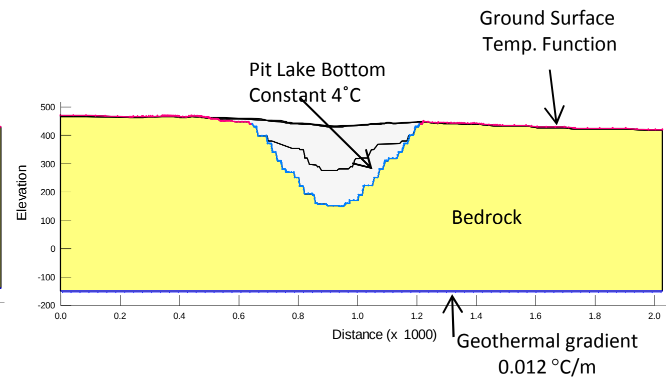
Step 2. 2014 pit topography – 10 years after initial conditions.



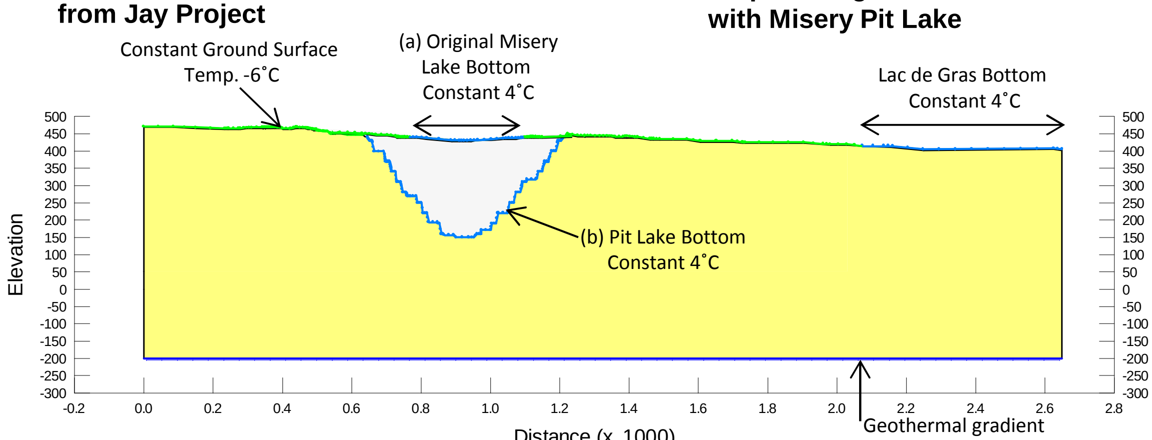
Step 3. Ultimate pit topography – 13 years after initial conditions.



Step 4. Back-flooding with minewater from Jay Project



Step 5. Long-term thermal conditions with Misery Pit Lake



Model with both Misery Lake and Lac de Gras

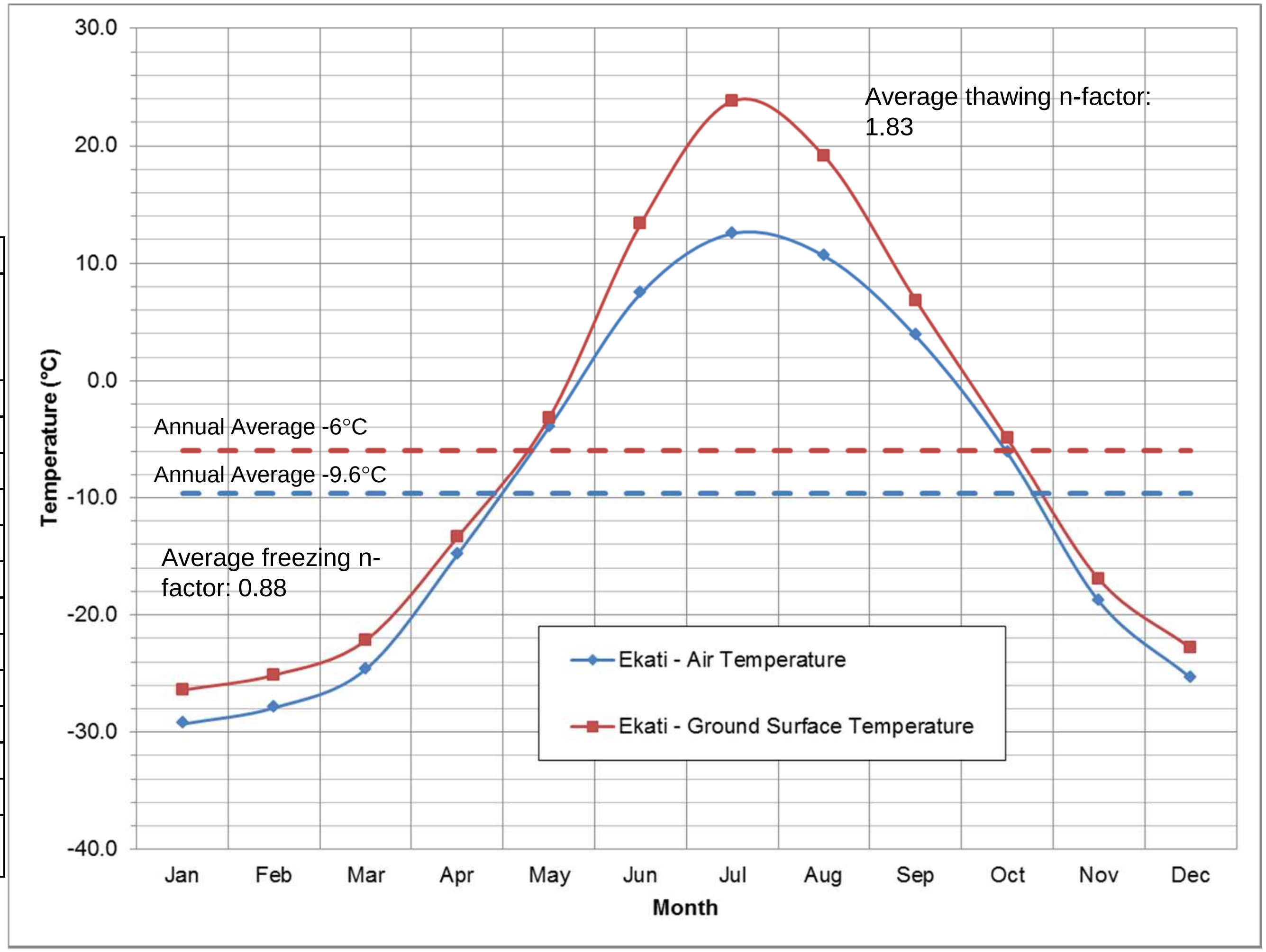
Note: Refer to Table 2 for detailed scenario descriptions

PROJECT	DOMINION DIAMOND **JAY PROJECT NORTHWEST TERRITORIES CANADA**
TITLE	**THERMAL MODEL STEPS WITH BOUNDARY CONDITIONS**

Golder Associates

PROJECT No.	13-1328-0041		PHASE No. 2020	
DESIGN	JFC	24SEP14	SCALE NTS	REV. B
CADD	JFC	24SEP14	**FIGURE 3-1**	
CHECK	JFC	18DEC14		
REVIEW	JCC	18DEC14		

Ekati Site		
Month	**Mean Monthly Air Temperature (°C)**	**Mean Monthly Ground Surface Temperature (°C)**
Jan	-29.3	-26.4
Feb	-27.9	-25.1
Mar	-24.6	-22.2
Apr	-14.9	-13.4
May	-4.0	-3.2
Jun	7.4	13.4
Jul	12.5	23.8
Aug	10.6	19.1
Sep	3.8	6.9
Oct	-6.2	-4.9
Nov	-18.8	-17.0
Dec	-25.4	-22.8
Annual Average	-9.6	-6.0



Note: Air temperatures from Dominion Diamond (2014), Annex X.

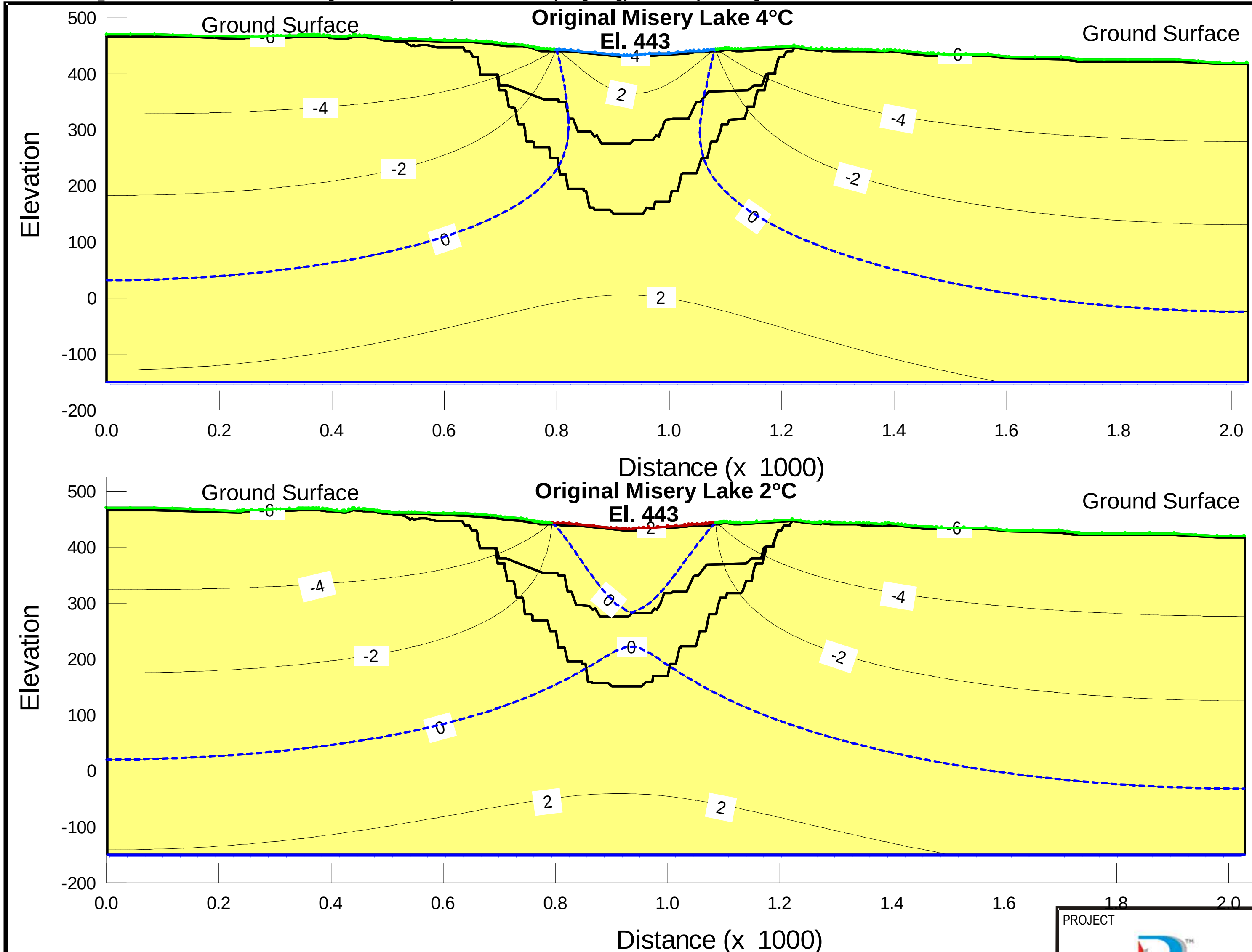
PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES
CANADA

TITLE
EKATI SITE
AIR AND GROUND TEMPERATURES

Golder Associates

PROJECT No.	13-1328-0041		PHASE No. 2020	
DESIGN	JFC	24SEP14	SCALE NTS	REV. B
CADD	JFC	24SEP14	**FIGURE 3-2**	
CHECK	JFC	18DEC14		
REVIEW	JCC	18DEC14		

FILE: O:\Active_2013\1328\13-1328-0041 2000 DD Eng\2020 Pre-Feasibility\30 Thermal & Hydrogeology LDS\Misery Pit Filling Thermal\memo



Step 1
Initial condition with original Misery Lake.

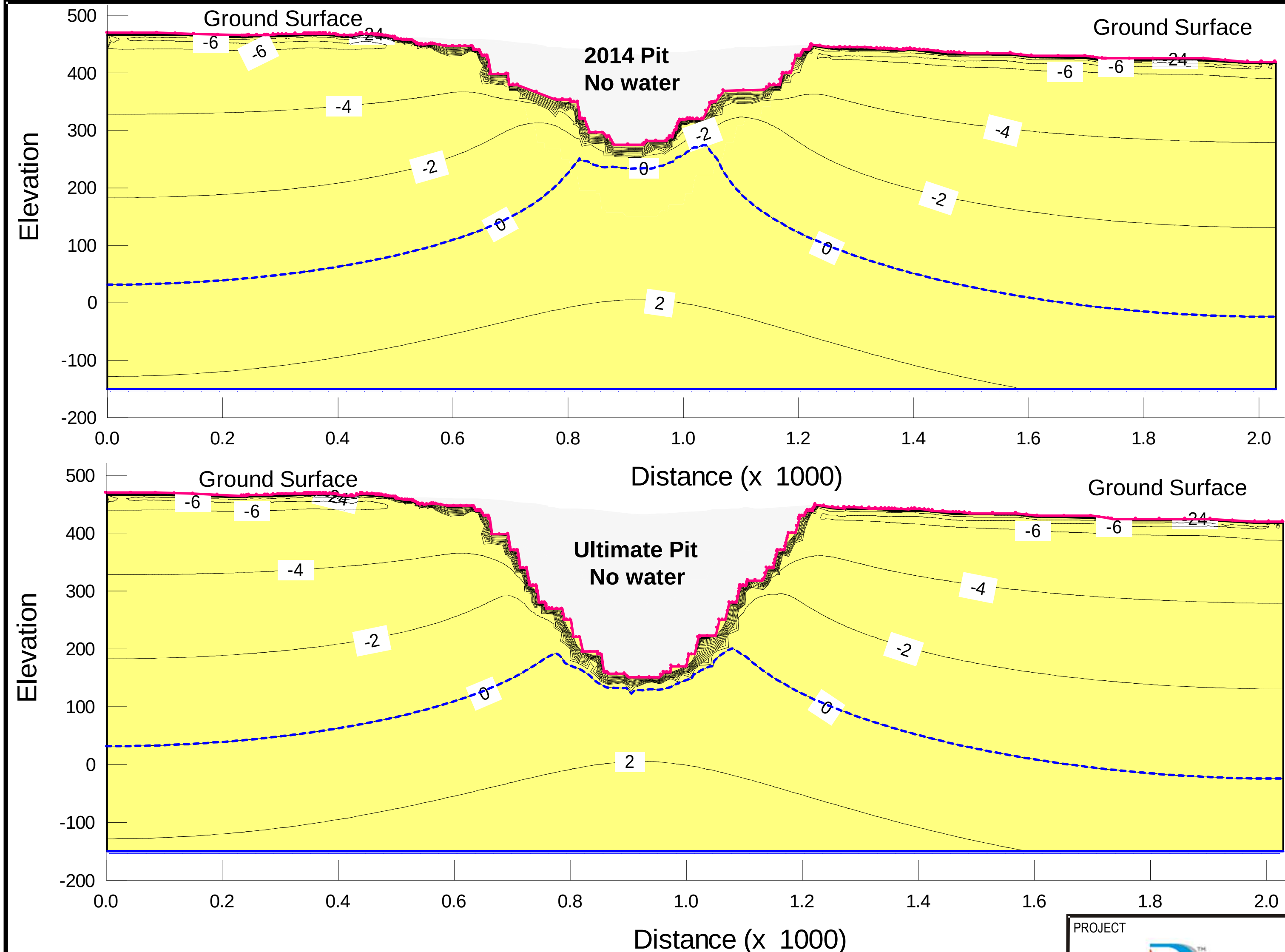
Note: Elevations are in metres above sea level (masl), distances in metres (m), and temperatures in degree Celsius (°C), unless otherwise noted; temperature contour interval 2°C; representing winter thermal condition on December 31.

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES
CANADA

TITLE
THERMAL CONDITIONS IN 2D SECTION WITH ORIGINAL MISERY LAKE

Golder Associates

PROJECT No.	13-1328-0041	PHASE No. 2020	
DESIGN	JFC	24SEP14	SCALE NTS — REV. B
CADD	JFC	24SEP14	
CHECK	JFC	18DEC14	**FIGURE 4-1**
REVIEW	JCC	18DEC14	



Step 2
2014 pit topography – 10 years after initial conditions.

Step 3
Ultimate pit topography – 13 years after initial conditions.

Note: Elevations are in metres above sea level (masl), distances in metres (m), and temperatures in degree Celsius (°C), unless otherwise noted; temperature contour interval 2°C; representing winter thermal condition on December 31.

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES
CANADA

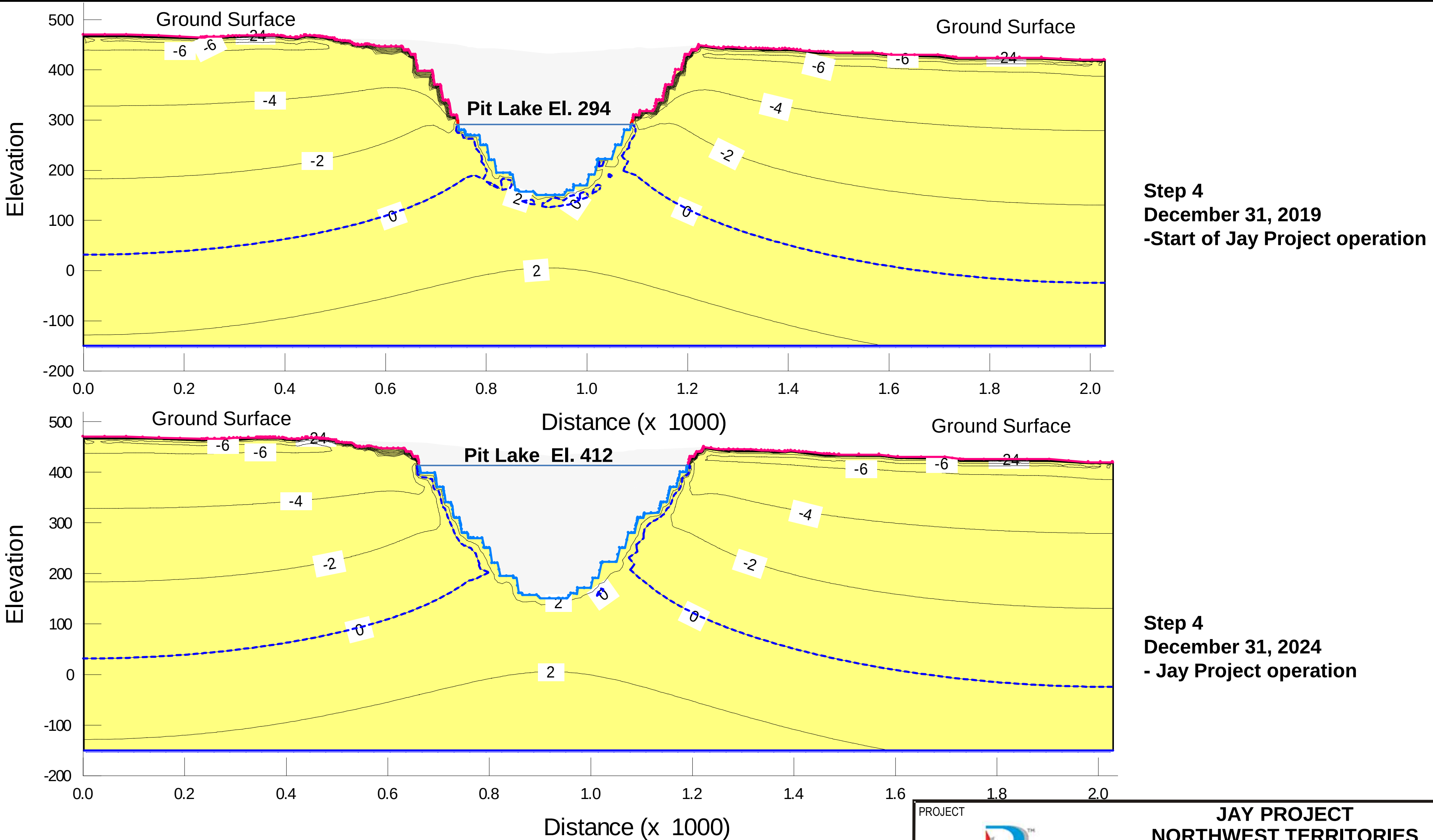
TITLE

THERMAL CONDITIONS IN 2D SECTION BEFORE PIT BACK-FLOODING

Golder Associates

PROJECT No.	13-1328-0041		PHASE No.	2020
DESIGN	JFC	24SEP14	SCALE NTS	REV. B
CADD	JFC	24SEP14	**FIGURE 4-2**	
CHECK	JFC	18DEC14		
REVIEW	JCC	18DEC14		

FILE: O:\Active_2013\1328\13-1328-0041 2000 DD Eng\2020 Pre-Feasibility\30 Thermal & Hydrogeology LDS\Misery Pit Filling Thermal\memo



Note: Elevations are in metres above sea level (masl), distances in metres (m), and temperatures in degree Celsius (°C), unless otherwise noted; temperature contour interval 2°C; representing winter thermal condition on December 31.

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES
CANADA

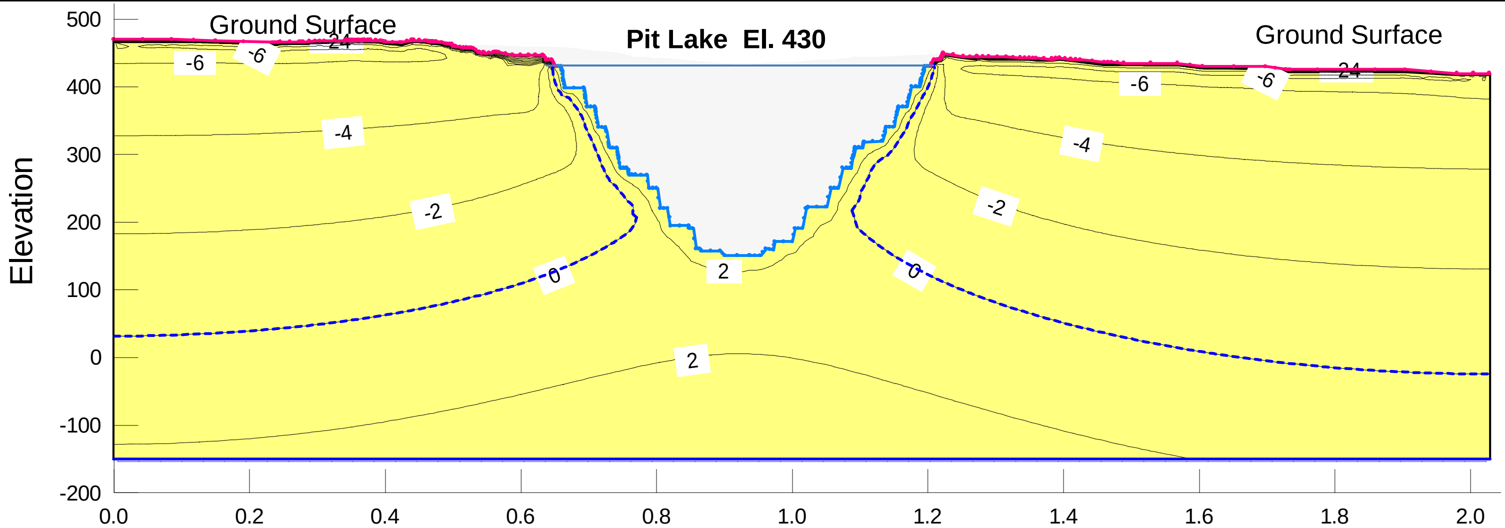
TITLE

THERMAL CONDITIONS IN 2D SECTION DURING BACK-FLOODING MISERY PIT

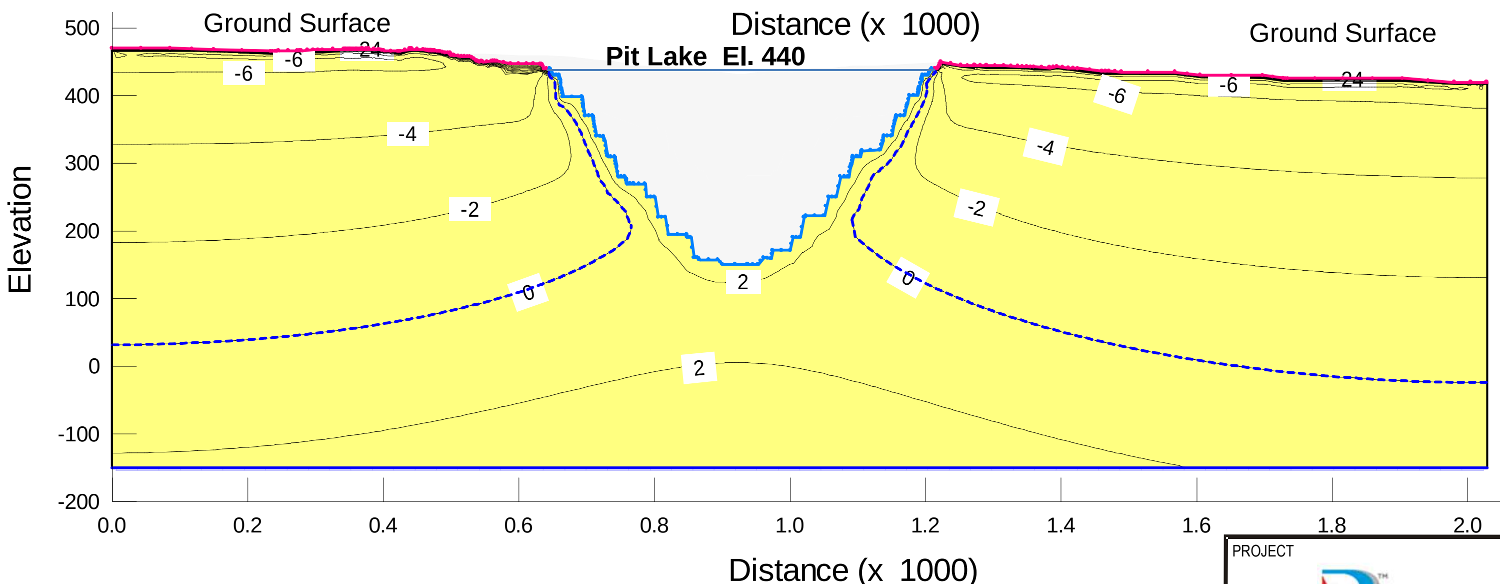
Golder Associates

PROJECT No.	13-1328-0041		PHASE No. 2020	
DESIGN	JFC	24SEP14	SCALE NTS	REV. B
CADD	JFC	24SEP14	**FIGURE 4-3**	
CHECK	JFC	18DEC14		
REVIEW	JCC	18DEC14		

FILE: O:\Active_2013\1328\13-1328-0041 2000 DD Eng\2020 Pre-Feasibility\30 Thermal & Hydrogeology LDS\Misery Pit Filling Thermal\memo



Step 4
December 31, 2029
- end of Jay Project operation



Step 4
December 31, 2031
- Jay Project Closure

Note: Elevations are in metres above sea level (masl), distances in metres (m), and temperatures in degree Celsius (°C), unless otherwise noted; temperature contour interval 2°C; representing winter thermal condition on December 31.

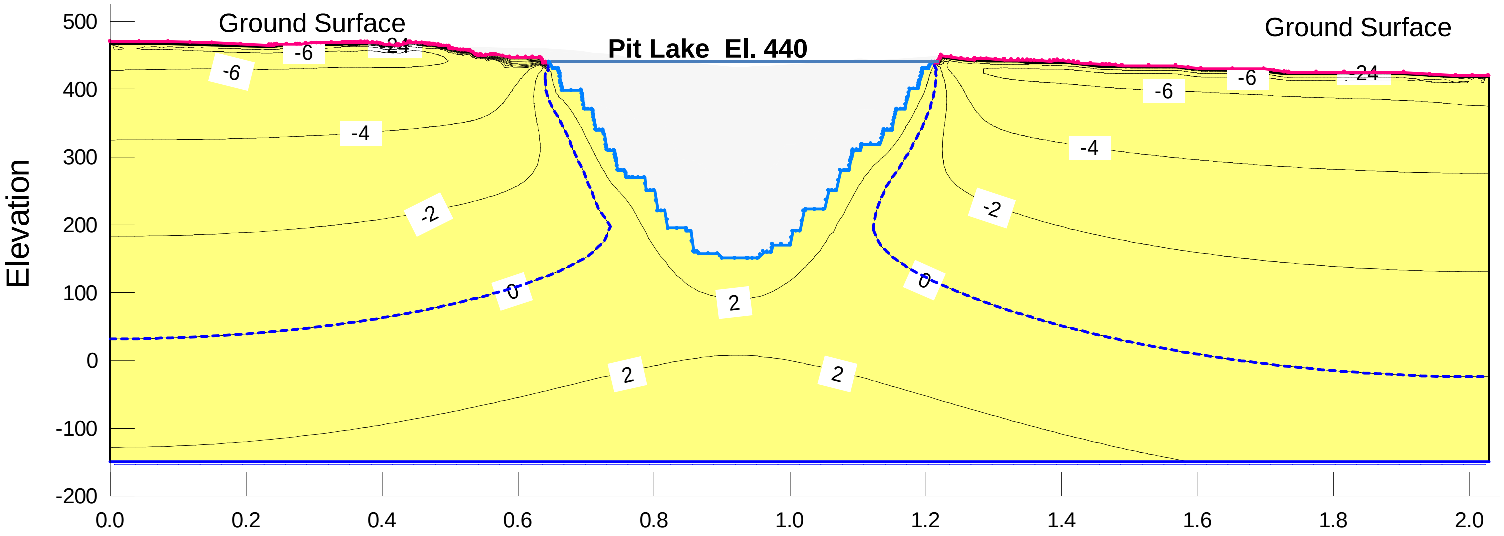
PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES
CANADA

TITLE
THERMAL CONDITIONS IN 2D SECTION DURING BACK-FLOODING MISERY PIT

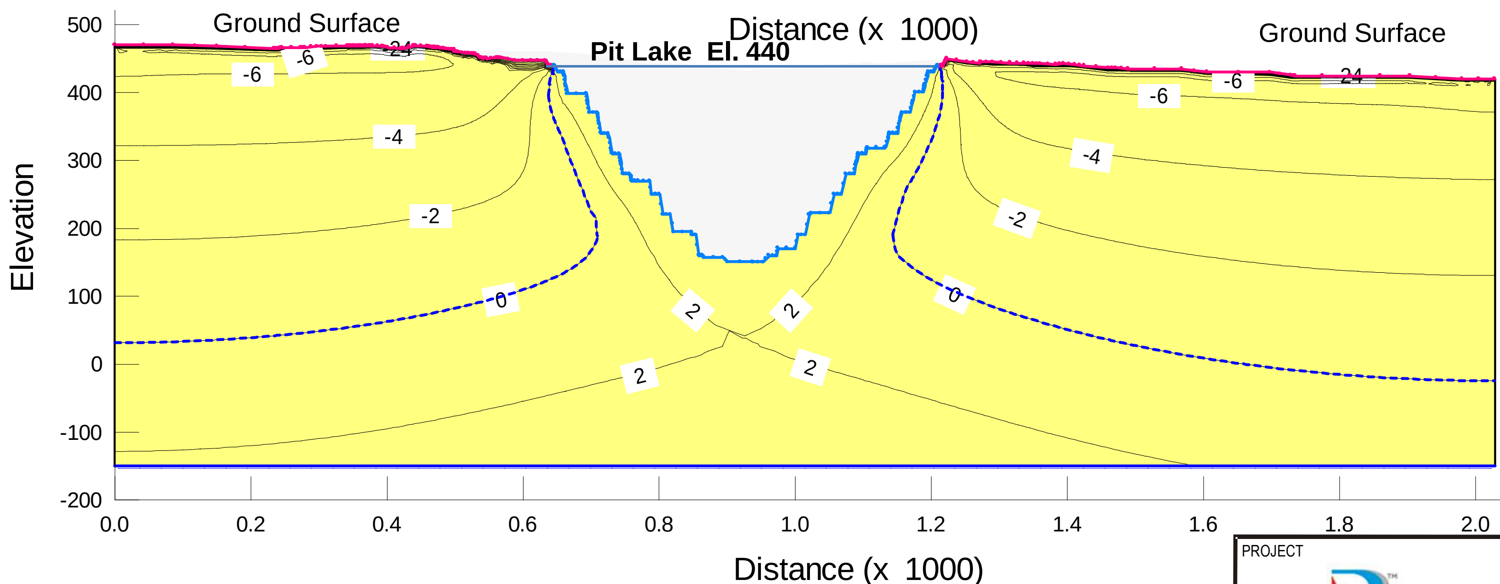
Golder Associates

PROJECT No.	13-1328-0041		PHASE No. 2020	
DESIGN	JFC	24SEP14	SCALE NTS	REV. B
CADD	JFC	24SEP14	**FIGURE 4-4**	
CHECK	JFC	18DEC14		
REVIEW	JCC	18DEC14		

FILE: O:\Active_2013\1328\13-1328-0041 2000 DD Eng\2020 Pre-Feasibility\30 Thermal & Hydrogeology LDS\Misery Pit Filling Thermal\memo



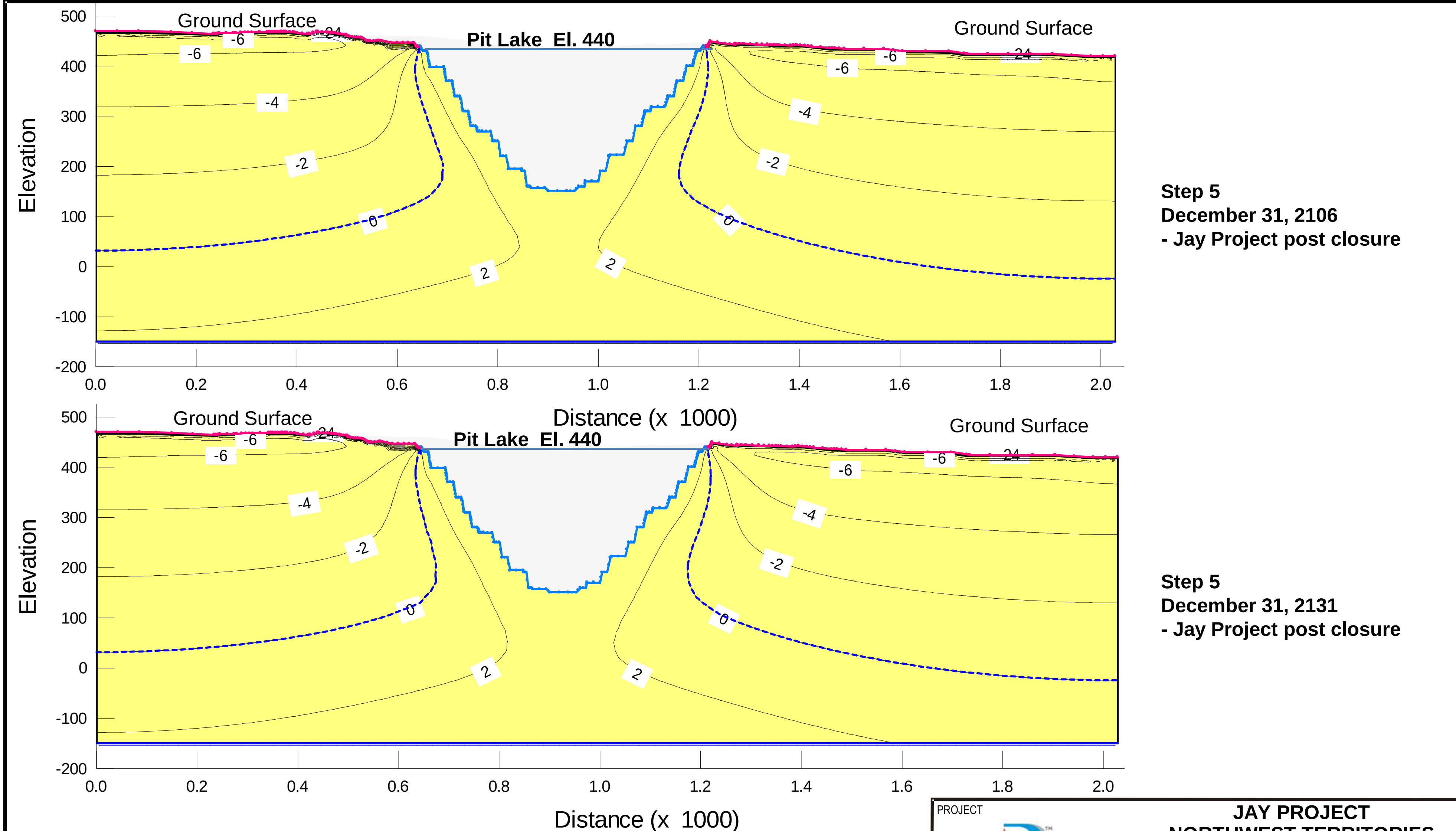
Step 5
December 31, 2056
- Jay Project post closure



Step 5
December 31, 2081
- Jay Project post closure

Note: Elevations are in metres above sea level (masl), distances in metres (m), and temperatures in degree Celsius (°C), unless otherwise noted; temperature contour interval 2°C; representing winter thermal condition on December 31.

PROJECT	JAY PROJECT NORTHWEST TERRITORIES CANADA			
DOMINION DIAMOND				
TITLE	THERMAL CONDITIONS IN 2D SECTION AFTER PIT BACK-FLOODING			
Golder Associates	PROJECT No.	13-1328-0041	PHASE No. 2020	
	DESIGN	JFC	24SEP14	SCALE NTS	REV. B
	CADD	JFC	24SEP14	FIGURE 4-5
	CHECK	JFC	18DEC14	
	REVIEW	JCC	18DEC14	



Note: Elevations are in metres above sea level (masl), distances in metres (m), and temperatures in degree Celsius (°C), unless otherwise noted; temperature contour interval 2°C; representing winter thermal condition on December 31.

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES
CANADA

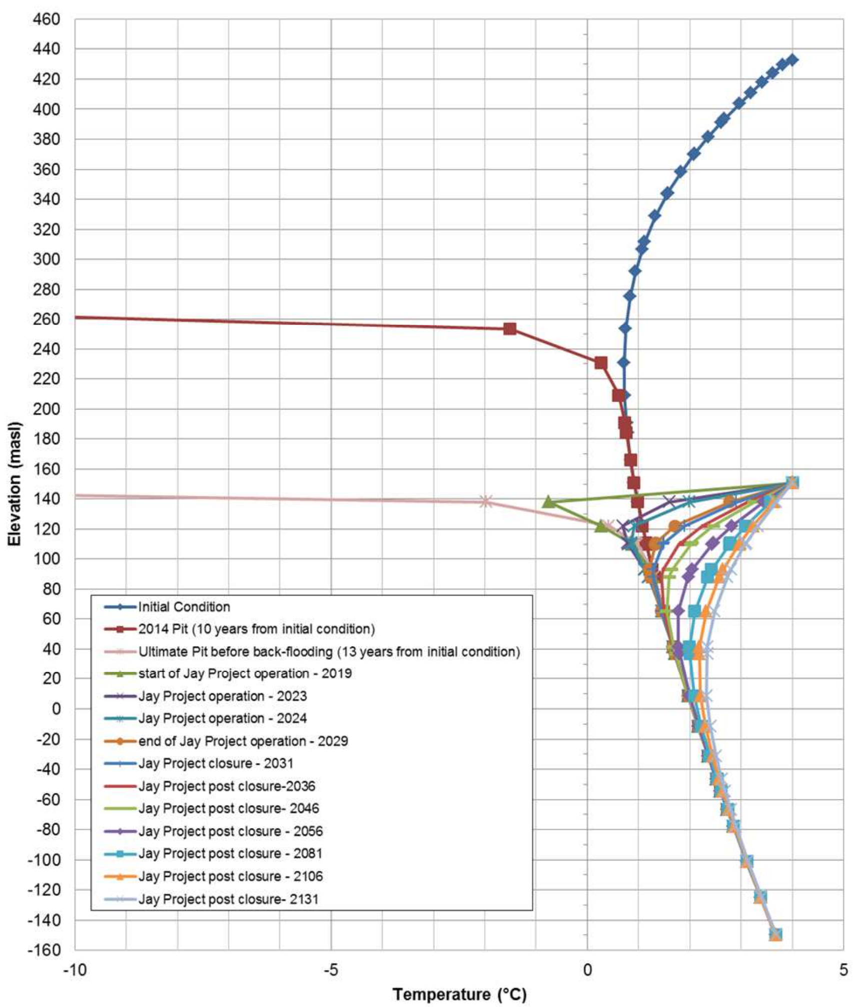
TITLE

THERMAL CONDITIONS IN 2D SECTION AFTER PIT BACK-FLOODING

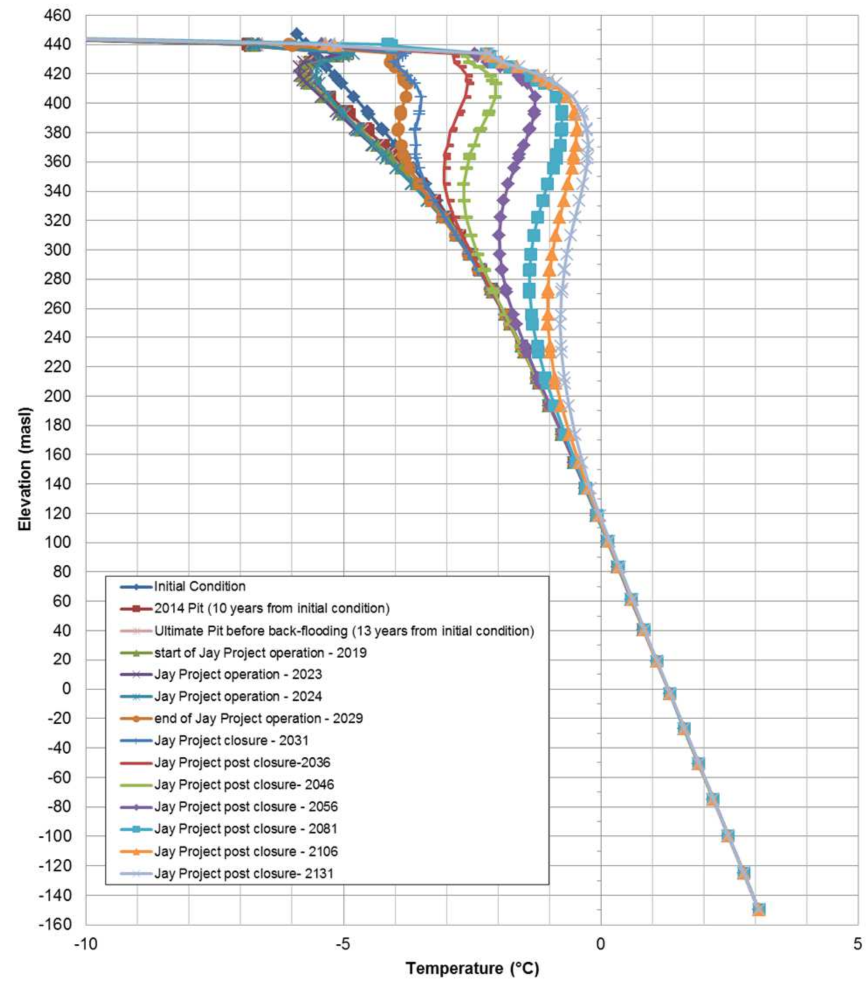
Golder Associates

PROJECT No.	13-1328-0041	PHASE No.	2020
DESIGN	JFC	24SEP14	SCALE NTS / REV. B
CADD	JFC	24SEP14	
CHECK	JFC	18DEC14	**FIGURE 4-6**
REVIEW	JCC	18DEC14	

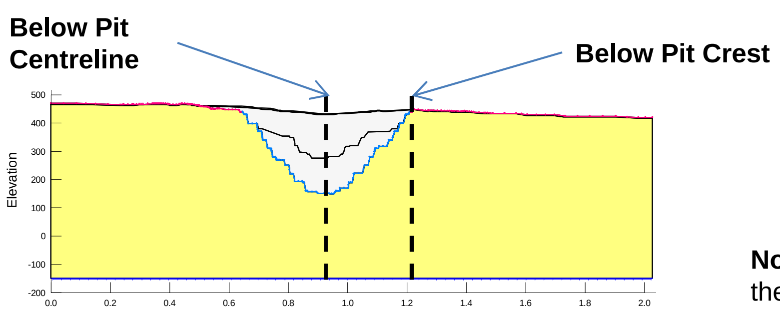
FILE: O:\Active_2013\1328\13-1328-0041 2000 DD Eng\2020 Pre-Feasibility\30 Thermal & Hydrogeology LDS\Misery Pit Filling Thermal\memo



Below Pit Centreline



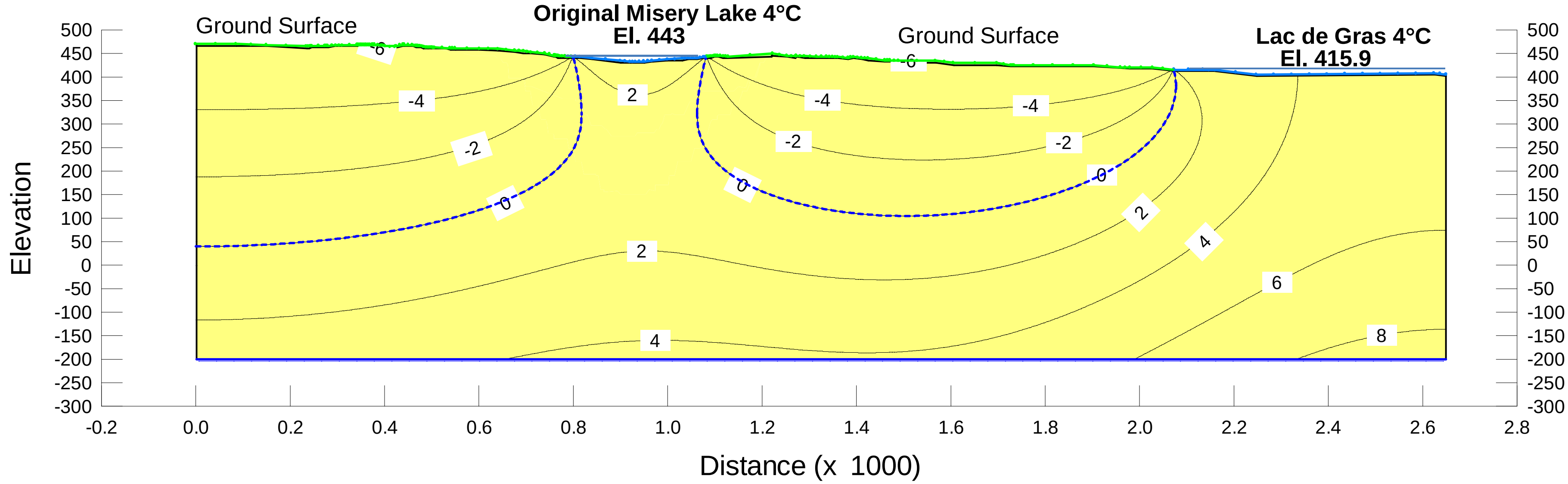
Below Pit Crest

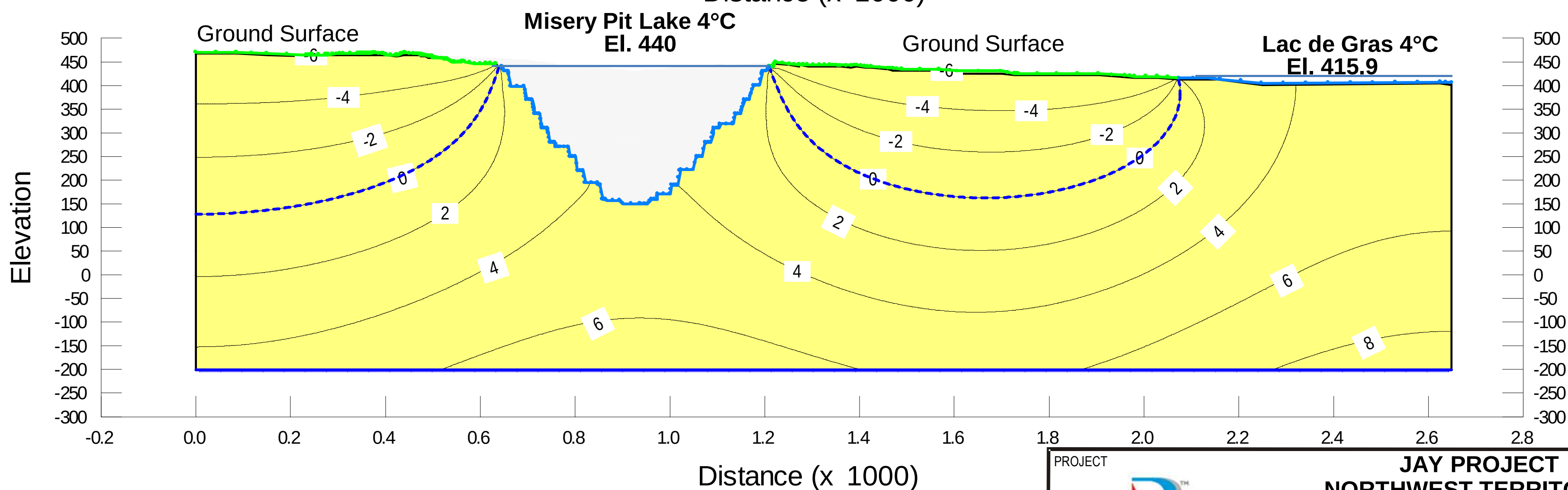


Note: all profiles representing winter thermal condition on December 31.

PROJECT	JAY PROJECT NORTHWEST TERRITORIES CANADA			
TITLE	VERTICAL TEMPERATURE PROFILES BELOW PIT CENTRELINE AND CREST			
PROJECT No.	13-1328-0041		PHASE No. 2020	
DESIGN	JFC	24SEP14	SCALE NTS	REV. B
CADD	JFC	24SEP14	FIGURE 4-7	
CHECK	JFC	18DEC14		
REVIEW	JCC	18DEC14		

FILE: O:\Active_2013\1328\13-1328-0041 2000 DD Eng\2020 Pre-Feasibility\30 Thermal & Hydrogeology LDS\Misery Pit Filling Thermal\memo





Note: Elevations are in metres above sea level (masl), distances in metres (m), and temperatures in degree Celsius (°C), unless otherwise noted; temperature contour interval 2°C; representing winter thermal condition on December 31.

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES
CANADA

TITLE

STEADY STATE
THERMAL CONDITIONS IN 2D SECTION
MODELLED WITH LAC DE GRAS

Golder Associates

PROJECT No.	13-1328-0041		PHASE No. 2020	
DESIGN	JFC	24SEP14	SCALE NTS	REV. B
CADD	JFC	24SEP14	**FIGURE 4-8**	
CHECK	JFC	18DEC14		
REVIEW	JCC	18DEC14		