APPENDIX B

Kami Mine Hydrogeological and Water Balance Study - Rose Pit Water Management Infrastructure Design

Kami Mine Hydrogeological and Water Balance Study – Rose Pit Water Management Infrastructure Design

Technical Report

Champion Iron Ore

Mining & Metallurgy

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SNC-LAVALIN INC.
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Montréal, April 22, 2024

Mr. Michel Groleau
CHAMPION IRON ORE
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Montréal, QC
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Subject: Kami Mine Hydrogeological and Water Balance Study – Rose Pit Water Management Infrastructure Design
Our file: 692696-8000-40ER-0001-02

Dear sir Groleau,

We are pleased to submit the revised report mentioned in the above subject.

Do not hesitate to communicate with the undersigned should you have further questions regarding the content of this report.

Truly yours,

SNC LAVALIN INC.

Marie-Hélène Paquette, Eng., M. Env.
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List of Revisions

Revision					Revised pages	Remarks
#	Prep.	Rev.	App.	Date		
PA	P. Pasquis S. Nachet R. Perez P. Pagé E. Millet M-H. Paquette	S. Nachet F-A. Desrochers M-H. Paquette C. Contreras		2023-09-08		Draft version issued for client review
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Executive Summary

The Kami project is an open pit iron ore mine planned in western Labrador, located between the towns of Fermont (QC) and Wabush (NFL). This document presents the design of the water management infrastructures related to the Rose Pit, the Rose North Overburden Stockpile and the Rose South Waste Rock Stockpile.

The Kami mine project has already been the object of an Environmental Impact Statement released by the government of Newfoundland and Labrador in January 2014. Alderon was the owner at that time. Now that Champion Iron is the owner of this asset, an update of the project is ongoing. Conditions associated with the project release in 2014 are integrated in the update of this project. In particular, the hydrogeological environment knowledge is refined with data review, new field investigation and modelling.

The mining project remains similar, and improvements were made in order to plan infrastructures that will reduce risks related to water management while keeping open the possibilities of adapting the flow routing as the project develops. The hydrogeological modelling update carried out as part of this project defines the dewatering rate to be managed and this data is key for improvements made to the water management plan.

To be prepared for the large amount of infiltration to manage, the Rose Pit Collection Pond planned capacity have been increased. Another improvement aimed at securing the operation is the planning of the Pike Dike, which aims to move Pike Lake away from the pit rim. And finally, runoff on overburden stockpile and waste rock stockpile have been defined as contact water and will be diverted to the Rose Pit Collection Pond and treated.

The infrastructures designed as part of this study include pumping systems and pipelines to pump water out of the Rose Pit, a collection pond, a treatment plant, a dam and pumping system to restrain Mid Lake from flowing into the pit, a dike to divide the south portion of Pike Lake South in order to move the lake away from the pit, collection ditches and a pond at the Rose North Overburden Stockpile and collection ditches and ponds at the Rose South Waste Rock Stockpile.

There are a lot of possibilities regarding the flow routing of the entire site. The current water management plan has been developed to be conservative. For instance, the size of the Rose Pit Collection Pond is planned to stock water from pit dewatering while no water treatment is considered in the coldest months of the year. Heat and tracing of the pipeline leading to and leaving the treatment plant is however already planned, allowing for the possibility of a yearly water treatment with no further investments. Considering the runoff water on the Rose North Overburden Stockpile to be contact water is also a conservative assumption.

Following an extensive data review and conceptual hydrogeological modelling, an infiltration rate in the pit of 40,000 m³/d have been set as a base for the design. Potential faults and bad quality bedrock account for this high infiltration rate. Combined with runoff and design criteria set up to manage a 1:100 environmental design flood, this high infiltration rate leads to the planning of a 4 Mm³ capacity collection pond. This pond will allow for the accumulation of water in the coldest winter months, where no treatment and effluent release to the environment is planned.

The collection pond will be created south of the Rose Pit by constructing dikes to close Elfie and End Lakes outlet. The required dams' main shoulders will be built with NPAG rockfill and will reach 19 and 12 m

respectively. The upstream slope of the dams will be sealed with geosynthetics. Foundation, which is probably constituted of silty sand (no geotechnical information is currently available in the alignment of the dams) will be sealed with jet grouting.

Mid Lake Dam, which will reach 5.5 m in height, will have the same design as Elfie and End Lake Dam. Pike Dike will be built entirely in the Pike Lake South with NPAG rockfill. It will be sealed with a slurry trench and grouting in overburden and rock.

The ponds designed to catch the runoff on the overburden and waste rock stockpiles will be built at low points of the topography so that collection ditches can bring water by gravity. The upstream of the dikes closing the low points and bottom of the ponds will be entirely sealed with geosynthetics. The dikes height required to build these ponds ranges from 4.5 to 10 m.

Stability and seepage analyses have been conducted on the main dams planned i.e., Elfie Lake Dam, Mid Lake Dam, and Pike Dike. No specific issues have been identified at this stage, except for the fact that geotechnical information in the alignment of the dams will be necessary to proceed to the next step of engineering.

At the end of mine life, eleven (11) pumping stations will be necessary to manage the water and their capacity will range from 495 m³/h for the smallest pump associated to the Pike Dike to 9000 m³/h for pumps associated with the water treatment plant. Around 35 km of HDPE pipes and 7 km of steel pipes will also be necessary.

The treatment plant planned downstream of the Rose Pit Collection Pond will treat water for total suspended solid (TSS hereafter). It should be noted that the treatment of nitrogen species is assumed not to be required at this time, and this will be confirmed by the geochemical modelling (carried out by others).

All the infrastructures presented in the lines above will need to be confirmed once new data will have been obtained in the next phases of engineering. The main data to collect are hydrogeological data that will be obtained through drilling campaign and pumping test in critical area of the future pit, and this will allow to confirm the expected pit dewatering rate with more certainty. The other data to collect is geotechnical information in the alignment of the planned infrastructures. Assumptions from the available information in boreholes at various distances of the infrastructures have been used to design the dikes at this point.

The uncertainties about infiltration rate in the pit and effects of pit dewatering on the surrounding lakes, in particular Pike Lake, represent the main area of concern regarding the water management plan. This will be addressed with future data acquisition (presented in previous paragraphs) and with the setting of mitigation measures. A way to mitigate risks of affecting Pike Lake water level would be to plan a water transfer from Long Lake, which is part of a greater watershed where pumping activities have little effect. Year-long treatment could also be a mitigation concerning the uncertainties about dewatering and the impacts on Pike Lake water level.

1.0 INTRODUCTION

This document presents the design of the water management infrastructures related to the Rose Pit, the Rose North Overburden Stockpile, and the Rose South Waste Rock Stockpile at the future Kami Mine.

1.1 Context

The Kami Iron Ore Project consists of developing an open-pit iron ore mine in western Labrador and to build associated infrastructure at the Port of Sept-Îles, Québec. The project is expected to produce up to 8,3 million metric tonnes of iron ore concentrate per year that will be transported by existing railway to the Port of Sept-Îles, Québec.

The Kami Mine project includes construction, operation, and closure/decommissioning of the following primary components:

- The open pit mine (the Rose Pit).
- The Rose North Overburden Stockpile and Rose South Waste Rock Stockpile.
- The processing infrastructures including crushing, grinding, spiral concentration, magnetic separation, and tailings thickening areas.
- The tailings storage facility (TSF).
- The ancillary infrastructure to support the mine and process plant.
- A rail transportation component including spur line construction to connect the mine site to the Québec North Shore & Labrador (QNSL) Railway.

The project was previously developed by Alderon in 2010 – 2012 and an Environmental Impact Statement was submitted to the government of Newfoundland & Labrador (N.L.) in October 2012. It was approved by the latter in January 2014.

In 2018, the Feasibility Study of the project was updated by Alderon.

Champion Iron (Champion), owner of Minerai de Fer Québec, is the new owner of the Kami asset and wishes to update the study and resubmit the project for approval by the Government of N.L.

The update of the project is now at the stage of Pre-Feasibility and is led by BBA.

1.2 Mandate

As part of the Pre-Feasibility Study update, Champion Iron Ore (Champion) has mandated SNC-Lavalin (SNCL) to design the water management infrastructures related to the planned Rose Pit and the two major stockpiles of the project (overburden stockpile and waste rock stockpile). This engineering report presents the design of these infrastructures.

The determination of the expected dewatering rate of the Rose Pit is a key component of the water management plan and infrastructure planning, and part of SNCL mandate is to conduct a hydrogeological study. The hydrogeological study is an input to the infrastructure design, and includes data revision (completed Q2 2023), conceptual modelling (Q3 2023) and field work necessary to fulfill part of the data gaps (completed Q4 2023). Reporting of the hydrogeological conceptual modelling is presented in separate deliverables. The result of the conceptual modelling currently completed is used for the infrastructure design presented in this report.

To manage infiltration and runoff in the Rose Pit, and runoff in the overburden stockpile and waste rock stockpile area, several water management infrastructures are designed as part of this study:

- Perimeter diversion channel around Rose Pit.
- Diversion dam and pumping facilities upstream of Rose Pit (Mid Lake Dam).
- Dewatering pumping facilities to dewater groundwater seepage and surface runoff from Rose Pit.
- Rose Pit Collection Pond to collect groundwater seepage and surface runoff from Rose Pit and the overburden and waste rock stockpiles. The pond is created by the construction of two dams at the outlet of Elfie and End Lake, and the lakes are used as ponds.
- Perimeter diversion channel around Rose Pit Collection Pond.
- A TSS treatment plant to treat water from the collection pond before discharging it to the environment.
- A dike to seclude Pike Lake water further from Rose Pit (Pike Dike).
- Dewatering facilities to empty Pike Lake upstream of Pike Dike.
- Perimeter collection ditches around Rose North Stockpile (overburden stockpile).
- Pond to collect runoff from Rose North Stockpile (overburden stockpile).
- Perimeter collection ditches around Rose South Stockpile (waste rock stockpile).
- Ponds to collect runoff from Rose South Stockpile (waste rock stockpile).

Champion also mandated SNCL to conduct a review on the stability of the Rose North Overburden Stockpile and Rose South Waste Rock Stockpile. The proposed geometry, capacity and operation planning of the stockpiles is not designed by SNCL.

2.0 Basis Data

2.1 Geographic Data

The Kami Iron Ore Mine is located in Labrador, south of the towns of Wabush and Labrador City (Labrador) and east of Fermont (Québec).

General data about topography, hydrography and bathymetry was provided by several sources. The site layout was provided by BBA, and includes information prepared by all consultants involved in the project.

Table 2-1: Geographic and Layout Data Source

	Data Type[1]	Data Name	Source	Date Received	Isocontours / Precision
1	Topography	3813101-ACAD-XREF_TOPO COURBES 1-5m + ROUTES EXISTANTES.dwg	BBA	September 2022	Contour interval 1-5 m.
2	Topography[2]	CanVec Series, Topographic Data of Canada	Government of Canada	2022	Contour interval 10 m.
3	Site infrastructure #1	3813101-000000-45-D20-0001_NAVIS.dwg	BBA	September 2022	
4	Site infrastructure #2	3813101-000000-45-D20-0001_2023-05-26.dwg	BBA	June 2023	
5	Waste Rock Stockpile	3813101-021180-4M-D52-0002-RAC.dxf	BBA	October 2023	
6	Bathymetry[3]	Bathymetry survey point	WSP	June 2023	
7	Hydrography	3813101-000000-45-D20-0001_NAVIS.dwg	BBA	September 2022	
8	Rose Pit 3D model Phase I & II	3813101-ACAD-C3D_MINIER.dwg	BBA	September 2022	
9	Rose Pit 3D model Phase III	3813101-GDR (SDH9FB4.tmp.cJcJwBSB)-2022-11-14.dxf	BBA	February 2023	

[1] Coordinate system: NAD 1983 (CSRS) UTM Zone 19N.
[2] Year of publication: 2017.
[3] Bathymetry for the following lakes: Mid Lake, Pike Lake South, Elfie Lake, End Lake.

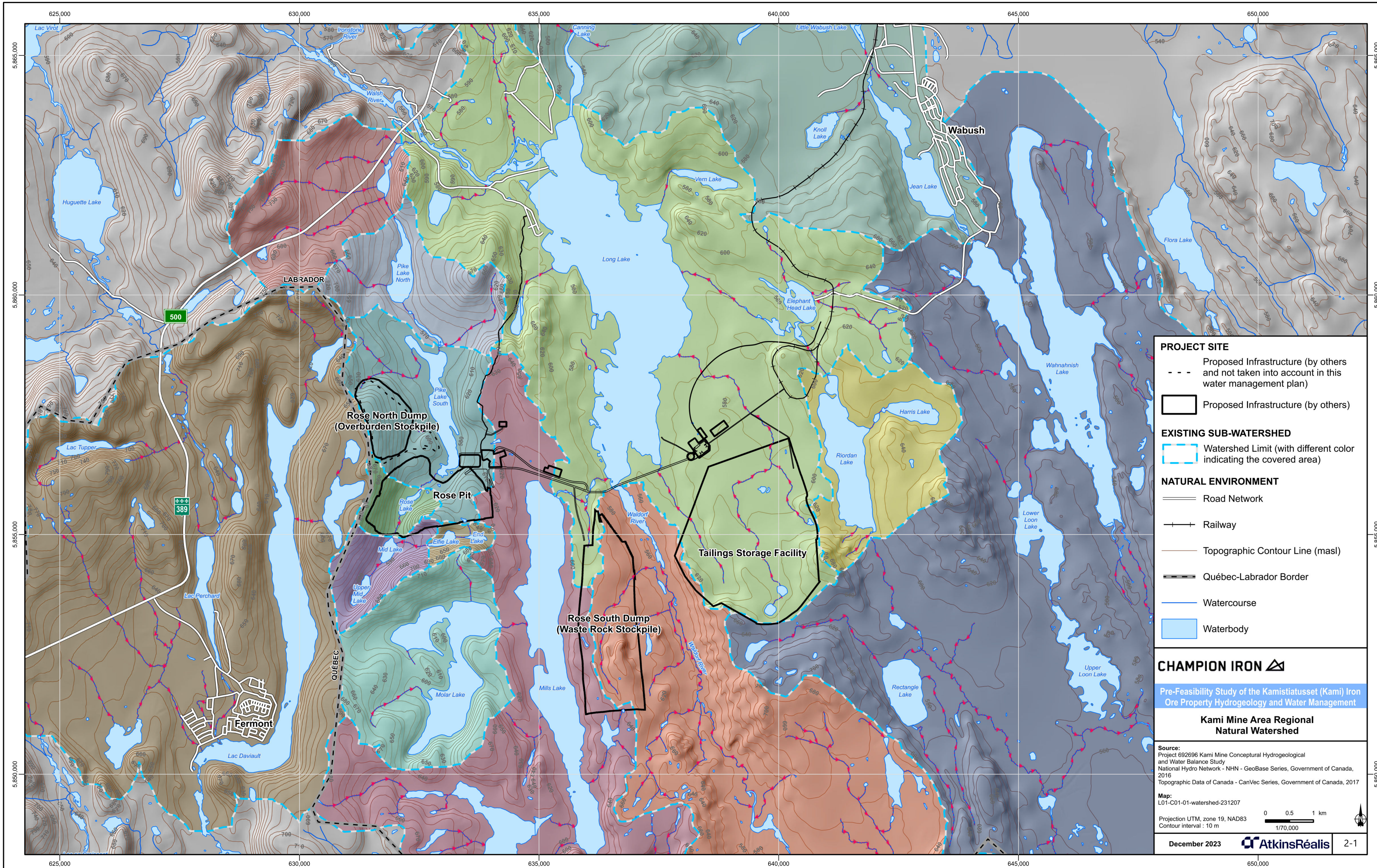
The bathymetry (ref. 6 of previous Table) was provided in terms of depth, and to link the information to the elevation above sea level, it was assumed that the 0 of the bathymetric survey was equivalent to the lake elevation above sea level available on the topography provided by BBA (ref. 1, **Table 2-1**). The following Table shows the lake elevation assumed.

Table 2-2: Assumed Lake Elevation

Lake	Assumed Elevation (m)
Mid Lake	580
End Lake	612
Elfie Lake	609
Pike Lake South	568

Based on the information provided in **Table 2-1**, the regional watershed in the site area have been defined.

The planned Rose Pit and Overburden Stockpile are in the west section of the site in Pike Lake South, Rose Lake, and Mills Lake watersheds. The Rose South Waste Rock Stockpile is in the east portion of the site in Waldorf River, Mills Lake, and Long Lake watersheds. Ultimately, Pike Lake South drains in Long Lake.



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2.2 Hydrological Data

As there is no weather station at the Kami project site, weather data sets from nearby Environment Canada weather stations were analyzed. Monthly precipitation was analyzed from stations Wabush Lake A-ID 8504175 (1961-2012), Wabush A-ID 8504176 (2013-2014), and Wabush A-ID 8504177 (2014-2022). **Figure 2-2** shows that the trend is different for the three stations; however, the Wabush Lake A-ID 8504175 station data are older, and the trend is stable over time and higher than for the others, therefore this station was selected.

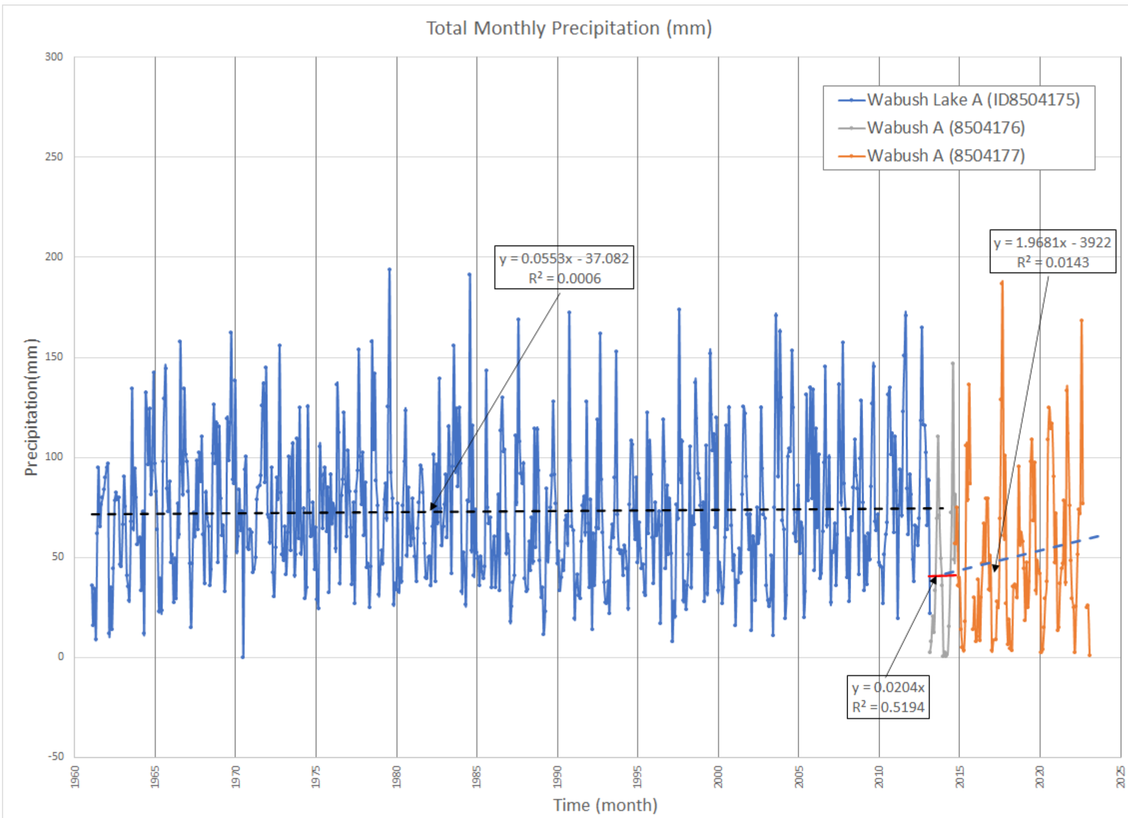


Figure 2-2: Monthly Precipitations for Kami Stations

The historical data analyzed consist of daily measurements recorded at the weather station Wabush Lake A. The main characteristics of the selected station are presented in **Table 2-3**. **Figure 2-3** shows its location and distance in kilometers from the site.

Table 2-3: Characteristics of the Weather Station

Station		Latitude North[1]	Longitude West[1]	Elevation[1] [m]	Distance[2] [km]	Available Period[3]
Number[1]	Name[1]					
8504175	WABUSH LAKE A	52.56°	66.52°	551	14.94	1961 – 2012

[1] Data from the report CCEE (2015).
[2] Distance estimated from QGIS.
[3] The available period for IDF curves (1974-2012) from CRA (2015). For hydrologic parameters (1961-2012) from Environment Canada (2023).

The analyzed parameters from the meteorological station, as part of the study carried out for the Kami project, were temperature (T), precipitation (P), rain (Pl) and snow on the ground (NS). If a year did not have sufficient data at the considered station, the year was excluded from the analysis.

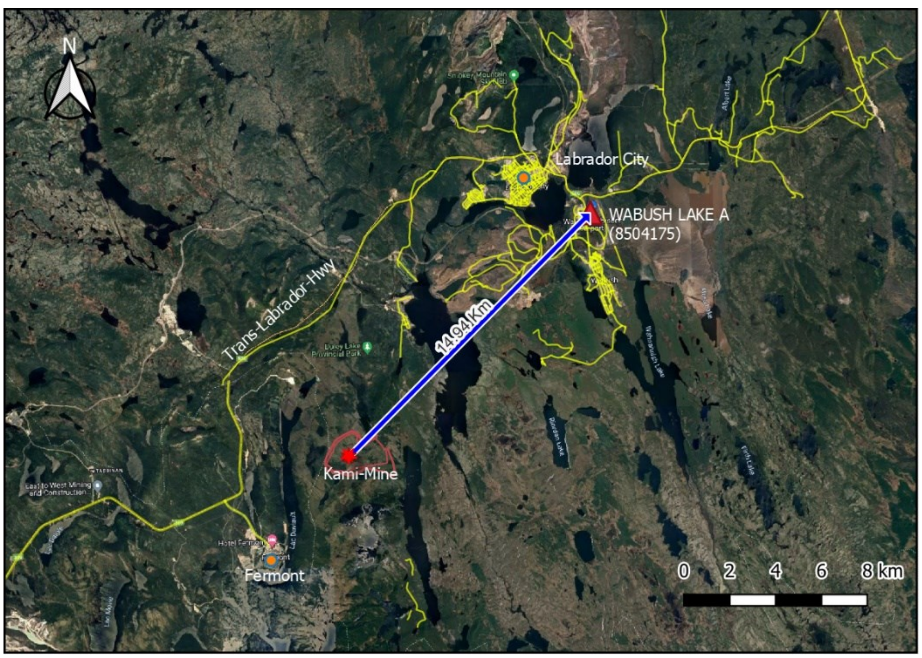


Figure 2-3: Location of the Weather Station (Google Earth, 2023)

The hydrological data that will be used to design the water management infrastructures are provided in Table 2-4 to Table 2-14.

2.2.1 Precipitation

Precipitation, rain, and snowfall averages were estimated based on data obtained from the Wabush Lake A station for the period 1961-2012 (Environnement Canada, 2023). **Table 2-4** presents the monthly average of precipitation, rain, and snow fall.

Table 2-4: Rainfall, Snowfall and Precipitation for the Kami Mine Site

Month	Rainfall (mm)[1]	Snowfall (cm)	Precipitation (mm)[1]
January	0.8	53.2	54.0
February	1.3	40.1	41.4
March	3.2	51.8	55.0
April	11.4	42.9	54.3
May	42.1	16.7	58.7
June	83.5	1.9	85.4
July	111.9	0.0	111.9
August	102.9	0.0	102.9
September	89.1	4.8	93.9
October	41.1	37.7	78.8
November	15.5	61.6	77.2
December	3.5	61.1	64.6
Annual	**506.3**	**371.8**	**878.1**

[1] **Calculated from Wabush Lake A station data (1961-2012).**

The 100-year wet and dry year precipitation have been evaluated using Gumbel distribution (Chow, Maidment, & Mays, 1988).

Table 2-5: 100-Year Wet and Dry Precipitations[1]

Month	100-Year Dry (mm)	100-Year Wet (mm)
January	33.3	83.0
February	24.8	64.0
March	30.8	86.4
April	15.1	94.9
May	34.4	91.4
June	77.6	115.6
July	109.9	146.4
August	96.3	137.6
September	92.2	122.9
October	67.3	109.4
November	54.3	114.4
December	39.8	99.3
Annual	**675.8**	**1265.3**

[1] Calculated from Wabush Lake A station data (1961-2012).

2.2.2 Temperature and Wind Speed

Temperature averages were estimated based on data obtained from the Wabush Lake A station for the period 1961-2012 (Environnement Canada, 2023). Wind speed averages were taken from the Environment Canada site for the Wabush Lake A station for the period between 1981 and 2010 (Environnement Canada, 2023). **Table 2-6** presents the monthly average temperature and wind speed.

Table 2-6: Mean Monthly Air Temperature and Wind Speed

Month	Temperature (°C)	Wind speed (Km/h)
January	-22.0	13.8
February	-20.5	13.8
March	-13.7	14.9
April	-4.8	14.9
May	3.5	13.8
June	10.2	14.3
July	13.8	12.7
August	12.5	12.8
September	7.1	14.4
October	0.4	15.2
November	-7.9	14.7
December	-17.3	13.2
Annual	**-3.2**	**14.0**

2.2.3 Short Duration Rainfall

IDF curves were extracted from the report "Intensity-Duration-Frequency Curve Update for Newfoundland and Labrador" (CRA, 2015). The methodology used to estimate the IDF curves was based on the Gumbel distribution with a two-parameter extreme value distribution, and the values of this distribution were obtained using the method of moments. The moment parameters used in the analysis were the mean and the standard deviation (Chow, Maidment, & Mays, 1988).

The future climate IDF curves were estimated employing a statistical modelling approach. This approach considers the parameters of the historical IDF probability distribution combined with the projected Global Circulation Model (GCM) precipitation distribution functions to evaluate the future climate IDF curves (CRA, 2015).

Table 2-7 presents the short duration rainfall Intensity-Duration-Frequency data (IDF curves) for the actual period and **Table 2-8** presents the IDF's curves for a 2041–2070 time horizon. Values of **Table 2-8** were selected for this study.

Table 2-7: IDF Curves – Wabush Lake A (2015)

Duration	Return Interval (years)					
	2	5	10	25	50	100
	Rainfall Amount (mm)					
5-min	4.2	6.2	7.5	9.2	10.4	11.7
10-min	5.9	8.7	10.5	12.8	14.6	16.3
15-min	7.0	10.4	12.6	15.4	17.5	19.6
30-min	9.7	14.1	17.0	20.7	23.5	26.2
1-hr	11.8	17.2	20.8	25.3	28.7	32.0
2-hr	14.8	20.4	24.1	28.7	32.2	35.6
6-hr	21.1	26.8	30.6	35.4	38.9	42.4
12-hr	28.2	35.6	40.4	46.6	51.1	55.6
24-hr	35.2	44.1	50.1	57.6	63.2	68.7

Table 2-8: IDF Curves for 2041 – 2070 Time Horizon – Wabush Lake A (2015)

Duration	Return Interval (years)					
	2	5	10	25	50	100
	Projected Precipitation Amount (mm)					
5-min	5.8	7.9	9.4	11.2	12.5	13.8
10-min	8.1	11.1	13.2	15.7	17.5	19.3
15-min	9.7	13.3	15.8	18.8	21.0	23.2
30-min	13.2	17.9	21.3	25.2	28.1	30.9
1-hr	16.1	21.9	26.0	30.8	34.4	37.9
2-hr	19.2	25.2	29.4	34.4	38.0	41.7
6-hr	24.9	31.0	35.1	40.2	44.0	47.7
12-hr	33.2	41.3	46.8	53.7	58.7	63.7
24-hr	41.3	51.0	57.6	65.7	71.7	77.6

2.2.4 Long Duration Precipitation

Table 2-9 presents the long-term rain-on-snow events for durations between 1 and 30 days for return periods between 2 and 100 years. These data were extracted from the WSP (2023) report where it is indicated that they were obtained from Environment and Climate Change Canada based on the model 3 (Western Canadian Mountain Basin) at the Wabush A Station for the recording period of 1961-2012. Values presented in this Table are for upper confidence levels.

Table 2-9: Long-Term Rain-on-Snow Events for Various Durations

Duration (days)	Rain-on-Snow Depth (mm)					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
1	50.59	66.87	77.65	91.27	101.37	111.40
2	83.97	110.42	127.94	150.07	166.49	182.79
3	108.20	139.43	160.11	186.23	205.61	224.85
4	128.64	163.10	185.92	214.75	236.13	257.36
5	147.52	185.75	211.07	243.05	266.78	290.33
6	165.55	208.24	236.51	272.22	298.72	325.02
7	183.03	231.54	263.66	304.24	334.35	364.23
8	199.87	251.07	284.96	327.79	359.56	391.09
9	215.00	268.37	303.70	348.35	381.47	414.35
10	228.92	284.36	321.06	367.44	401.84	435.99
15	285.17	345.91	386.13	436.94	474.64	512.06
20	330.36	395.92	439.33	494.17	534.86	575.24
25	358.86	429.11	475.62	534.39	577.99	621.27
30	388.15	460.23	507.95	568.24	612.97	657.37

2.2.5 Snow Cover

The snow cover for different return periods was estimated based on the Gumbel distribution. The snow on the ground data used to perform the calculations were obtained from the Wabush Lake A station in the period between 1961 and 2012 (Environnement Canada, 2023). The water equivalent depth of snow was estimated using a density of 3 mm eq-water/cm.

Table 2-10 presents the maximum snow cover and the water equivalent for return periods between 2 and 10,000 years.

Table 2-10: Maximum Snow Cover and Water Equivalent – Wabush Lake A – 1961-2012

Return Period	Snow Cover (cm)	Water Equivalent (mm)
2	102	307
5	139	416
10	163	488
25	193	578
100	237	712
1000	311	933
2000	333	999
10,000	384	1153

2.2.6 Evaporation and Evapotranspiration

Lake evaporation represents the amount of water that can pass from the liquid phase to the gas phase on the surface of a body of water during a given period. The rate of evaporation is a function of a multitude of factors including precipitation, temperature, sunshine, solar radiation, etc. Evapotranspiration represents the amount of water that can be transpired by vegetation and evaporate on the surface of the soil during a given period. The rate of evapotranspiration is a function of the same parameters as those for lake evaporation with the addition of the rate of vegetation development and the availability of water in the soil. The methodology used to calculate these parameters is based on the Thornthwaite equation. **Table 2-11** presents the lake evaporation and the evapotranspiration values calculated for the project. These parameters were calculated using data such as precipitation and temperature from Wabush Lake A station (1961-2012).

Table 2-11: Evaporation and Evapotranspiration – Wabush Lake A – 1961-2012

Month	Lake Evaporation (mm)	Evapotranspiration (mm)
January	0.0	0.0
February	0.0	0.0
March	0.0	0.0
April	0.0	0.0
May	42.9	37.2
June	95.3	95.3
July	117.5	117.5
August	97.3	97.3
September	54.0	39.6
October	2.6	0.3
November	0.0	0.0
December	0.0	0.0
Annual	**409.8**	**387.3**

2.2.7 Probable Maximum Precipitation

Table 2-12 presents the spring and summer-autumn maximum probable precipitation (PMP) water depths for the Kami project site. Data for durations between six (6) hours and three (3) days were calculated based on the methodology proposed by SNC-Lavalin (2004). The results obtained for durations of less than six (6) hours were calculated considering a recurrence of 1:10,000 years (SNCL, 2004).

The PMPs (Probable Maximum Precipitation), evaluated according to the SNC-Lavalin (2004) report, are presented in the following table:

Table 2-12: Probable Maximum Precipitations

Month	Spring	Summer-fall
5-min	17.0	23.5
10-min	23.8	32.8
15-min	28.6	39.4
30-min	37.7	52.1
1-hr	46.3	63.9
2-hr	49.4	68.3
6-hr	182.2	142.5
12-hr	247.5	222.3
24-hr	272.0	285.0
48-hr	293.8	336.3
72-hr	296.5	356.3

PMP alone (no spring freshet considered) will be used for IDF evaluation assuming summer-fall PMP will produce the most critical conditions for spillway design.

2.2.8 Hydrograph and Flood Events

When computing a flood routing with a rain event, a typical hydrograph based on the IDF curves will be used. **Figure 2-4** and **Figure 2-5** show the hydrographs used as input for simulations sequences with the hydrologic models.

The flood events considered for the project are the following:

- A long-term rain-on-snow event of 100 years with a duration of 30 days was the spring event selected to estimate pumping rates and verify storage capacity. The inflow to carry out the model was based on a precipitation of 657.37 mm divided into 30 days.
- Different summer Inflow Design Flood (IDF) were selected to estimate the dimensions of the spillways. The IDF was based on PMP (72 hours), 100 years (24 hours) and 1000 years (24 hours) events, according to the dike classification (**Table 6-2**).

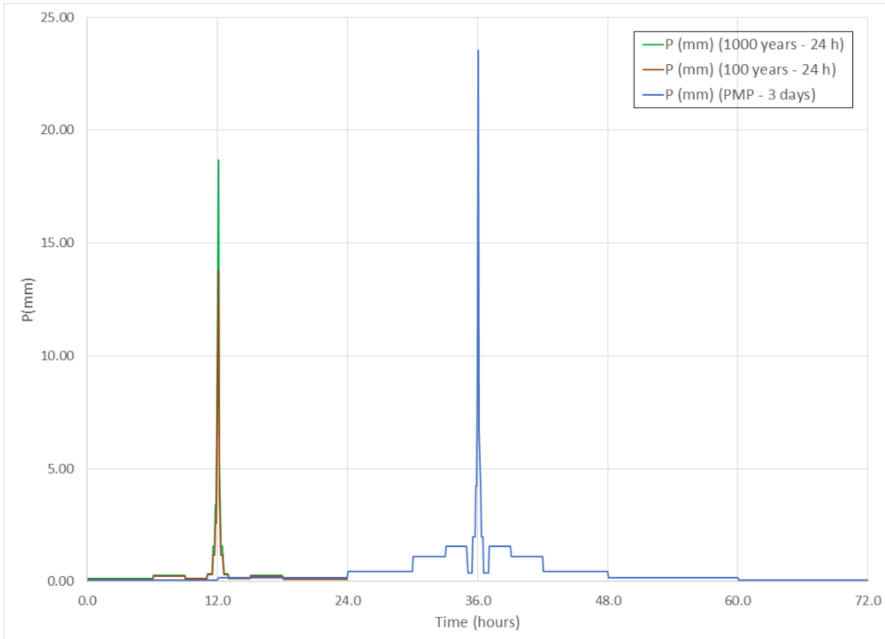


Figure 2-4: Hydrograph for PMP (72 h), 1000 Years Return (24 h) and 100 Years Return (24 h)

- The hydrograph of 100 years summer event for 24 hours was used to estimate ditches and culverts.

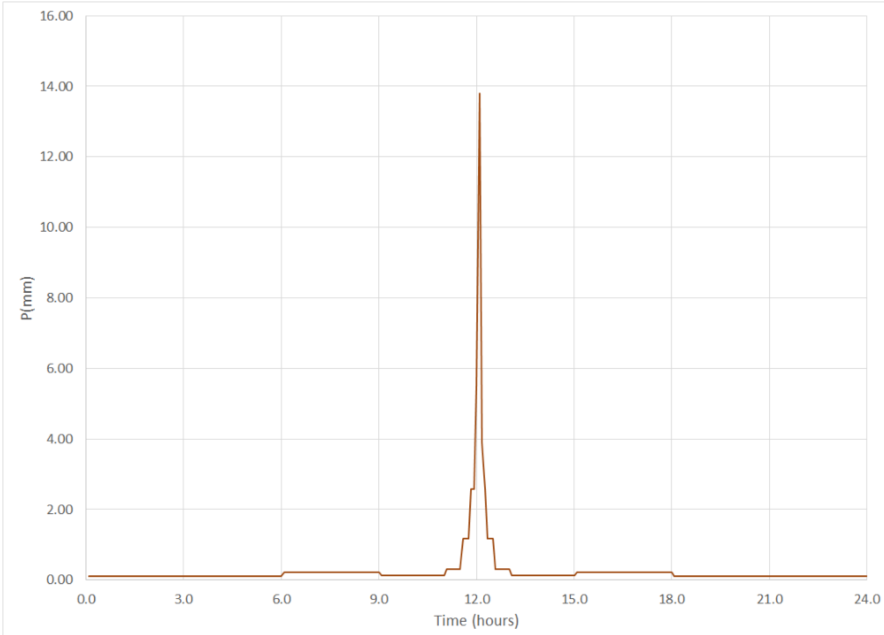


Figure 2-5: Hydrograph for 100 Years Return and 24 Hours

2.2.9 Runoff Coefficient

Runoff coefficients were used for the design of infrastructures using flood events and for the annual water balance. Two sets of runoff coefficients were used for those two types of calculation. For the flood events, the runoff coefficients were evaluated through numerical modeling with PCSWMM software where runoff was evaluated based on the Manning Coefficient and the Infiltration Coefficient. With this methodology, the runoff coefficient varied depending on the modeled meteorological event.

The proposed runoff coefficients presented in **Table 2-13** for the flood event were calculated with the PCSWMM models considering specific sets of infiltration parameters for the spring event and for the summer-fall event. Those coefficients were generated when simulating the 1:100-year spring event (30 days melting of the rain-on-snow depth) and the summer-fall 24 h 1:100-year event.

For the annual water balance, the runoff coefficients were based on the information provided by the literature, according to the type of terrain and the assumed humidity conditions during spring and summer-fall.

The following table shows the runoff coefficients to be used as part of the project. Regarding the runoff coefficient of the Rose Pit, it has been determined based on the proportion of horizontal surfaces of compacted rock versus the surfaces of bare rock pit walls.

Table 2-13: Proposed Runoff Coefficients

	Flood Event Proposed Runoff Coefficient			Annual Water Balance Proposed Runoff Coefficient		
Surface Type	**Spring**	**Summer / Fall**	**Reference**	**Winter**	**Summer / Fall**	**Reference**
Natural Ground – Forest	0.87	0.27	PCSWMM model 2023	1.00	0.19	Mailhot. A. et al (2021)
Roads and Pads	0.94	0.78	PCSWMM model 2023	1.00	0.50	Mailhot. A. et al (2021)
Rose Pit	0.95	0.70	PCSWMM model 2023	1.00	0.59[1]	
Overburden Stockpile	0.86	0.38	PCSWMM model 2023	1.00	0.30	Mailhot. A. et al (2021)
Waste Rock Stockpile	0.84	0.30	PCSWMM model 2023	1.00	0.25	Mailhot. A. et al (2021)

[1] Weighted coefficient according to the different soil surfaces in the Rose Pit (Forest, Roads, and pit walls).

2.3 Water Quality Data

The raw water that must be managed and treated at the Kami Mine site will be a mix of the raw water pumped from the Rose Pit and the runoff stemming from the overburden and waste rock stockpiles. At this stage of the project, and since the operations in Rose Pit have not started yet, the only way to assess the expected quality of the raw water is to use the data from other mining sites that are in the vicinity of Kami Mine and that are also mining iron ore.

Bloom Lake is an open-pit iron ore mine operated by Champion and located a few kilometers away from the Kami Mine site. According to Champion, the operations at Kami Mine will be similar to those at Bloom Lake. Therefore, it would be safe to assume that the raw water at Kami Mine would be of comparable quality to that of Bloom Lake.

Based on the experience at Bloom Lake the Rose Pit is not expected to generate any adverse environmental effects associated with Acid Rock Drainage (ARD) and Metal Leaching (ML). The same conclusion was reached by Stantec According to the Feasibility Level Rehabilitation & Closure Study Report (Stantec, 2012d). Therefore, water quality treatment for ARD and ML is not required. The contaminants of potential concern at Kami Mine will be nitrogen species (ammonia and nitrates) and total suspended solids (TSS hereafter). The TSS are the result of the runoff water transporting small particles whereas nitrogen species are normally present in waters associated with mining because of blasting activities using explosives containing ammonium nitrate or other explosives that can yield ammonia or nitrates. This section will only present the general raw water quality parameters such as: alkalinity, pH, hardness, metals, etc. A thorough assessment of nitrogen species and TSS will be presented in **Section 6.4**.

As for the general parameters, raw water quality design criteria have been built based on the results of the sampling of the water quality carried out at Bloom Lake between October 2020 and May 2023. The samples at Bloom Lake were taken from:

- The two (2) pits: Fosse Pignac (FP) and Fosse Bloom West (FBW).
- The stockpiles: Principale, Dyno and Triangle.

The following table summarizes the raw water design criteria:

Table 2-14: Water Quality Design Criteria (General Parameters)

	Average	Median	Maximum
Alkalinity (mg CaCo3)	39.5	41.2	54.7
Aluminum (mg/l)	1.6	0.3	2.78
Antimony (mg/l)	0.0007	0.0005	0.0005
Silver (mg/l)	0.0001	0.00005	0.00005
Arsenic (mg/l)	0.0004	0.0003	0.0007
Barium (mg/l)	0.1	0.06	0.12
Boron (mg/l)	0.02	0.02	0.02
Cadmium (mg/l)	0.0001	0.0001	0.00005
Calcium (mg/l)	90.2	56.6	213
Chloride (mg/l)	3.5	2.7	7.4
Chromium (mg/l)	0.004	0.001	0.009
Cobalt (mg/l)	0.009	0.007	0.0196
Conductivity (mg/l)	815	643	1630
Copper (mg/l)	0.004	0.002	0.007
BOD5 (mg/l)	1.2	1	1
COD (mg/l)	9.1	8	15
Hardness (mg/l)	355	238	777
Iron (mg/l)	2.3	0.7	4.4
Fluoride (mg/l)	0.05	0.05	0.05
C10-C50 (mg/l)	0.14	0.05	0.1
Magnesium (mg/l)	32.4	21.7	69.7
Manganese (mg/l)	0.5	0.4	0.899
Mercury (mg/l)	0.0001	0.0001	0.00005
Molybdenum (mg/l)	0.001	0.001	0.003
Nickel (mg/l)	0.08	0.04	0.258
Total phenols (mg/l)	0.005	0.003	0.0084
Phosphorus (mg/l)	0.5	0.03	0.218
Lead (mg/l)	0.0004	0.0003	0.0006
Potassium (mg/l)	15.5	13	27.1
Radium 226 (mg/l)	0.016	0.005	0.0357

	Average	Median	Maximum
Selenium (mg/l)	0.004	0.003	0.009
Sodium (mg/l)	6.9	5.3	12.9
Total dissolved solids (mg/l)	701	506	1380
Total solids (mg/l)	874	557	1401
Sulfate (mg/l)	357	230	832
Thallium (mg/l)	0.0002	0.0002	0.0002
Turbidity (UTN)	45	10	94.62
Uranium (mg/l)	0.0047	0.003	0.01251
Zinc (mg/l)	5.4	0.01	0.026
Temperature (°C)	8.3	7.9	17.2
Dissolved O2 (%)	91.4	91	109.6
Dissolved O2 (mg/l)	13.8	11.4	14.11
Specific conductivity (µs/cm)	813	605	1581.6
pH	6.99	7	7.63
ORP (V)	119	122	157.13

2.4 Hydrogeological Data

To estimate dewatering flows from the future Rose Pit, a conceptual 3D hydrogeological model was built. Regional geological information and hydraulic conductivity measurements led to the definition of four hydrostratigraphic units in the model, whose hydraulic conductivity values are presented in **Table 2-15**:

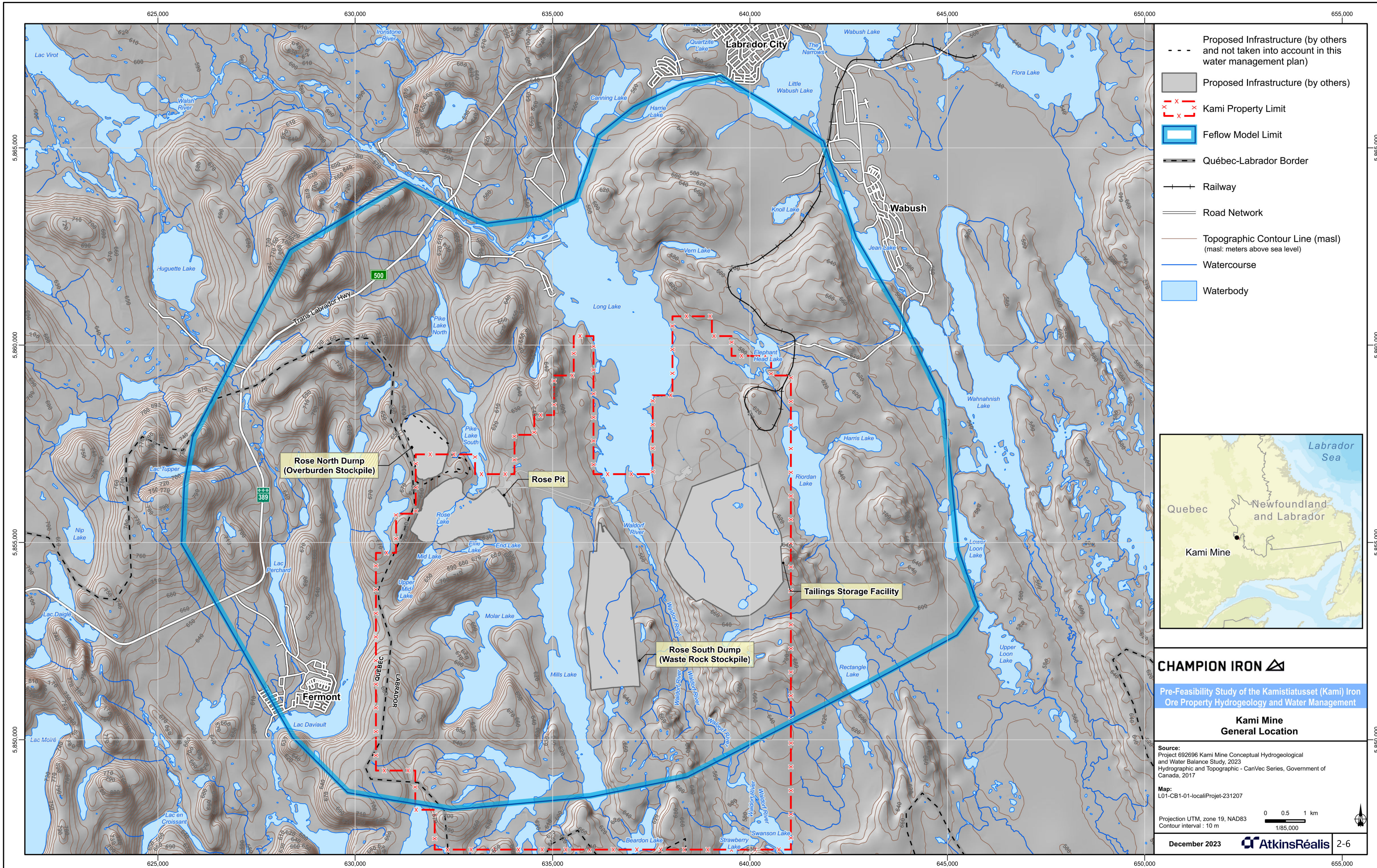
- **Overburden** (between 0-60 m thick): Overburden materials consist of veneers of organic soils overlying sequences of glacial till, and occasional glacio-fluvial and fluvial deposits (Stantec, 2012c) overlying bedrock whose conductivity was measured by slug tests at 4 boreholes.
- **Bedrock** (0-450 m): Although a 3D Leapfrog geological model is available, the limited data available and the absence of significant variations in the hydraulic conductivity of the bedrock at depth conditioned the choice to represent the bedrock by a hydrostratigraphic unit of average hydraulic conductivity encompassing all the geological formations at the level of the pit (from the surface to the maximum pit depth). The hydraulic conductivity of the bedrock was measured in 2 packer tests carried out in 2012 by Stantec 2012c (RBR-12-01 and RBR-12-02) and in 2 shallow slug tests. The maximum vertical depths of drillholes RBR-12-01 and RBR-12-02 are around 180 m and 250 m respectively, which is less than the pit's maximum operating depth (around 450 m).

- **Deep bedrock** (approx. 200 m thick): Corresponds to the bedrock beneath Rose Pit. In the model, the deep bedrock has a hydraulic conductivity of $1x10^{-8}$ m/s to represent the assumed decrease in hydraulic conductivity of rock at depth (Stober and Bucher, 2007).
- **Faults or fractured rock zones** (thickness between 50 and 30 m): Based on previous reports (Stantec, 2012c) and on the analysis of televiewer data, two faults crossing the pit have been identified. The orientation of the faults generally follows the orientation of the various rock units, trending north-east-southwest and dipping towards the southeast (150°). The hydraulic conductivity of these faults has not been determined but is known to be locally greater than $1x10^{-5}$ m/s, which corresponds to the maximum hydraulic conductivity that the packer system was able to measure.
  - In the western part of the pit, the **Katsao-Wishart Fault**, which represents the contact between Katsao and Wishart formations, has been identified as a trust fault that has resulted in poor quality rock mass, mainly in the Wishart formation. In the hydrogeological model, the width of the fault corresponds to the average thickness of the Wishart unit, i.e., around 50 m.
  - **Central Fault**: in the central part of the pit, interpretation of televiewers data has identified a fault zone in the Sokoman formation (iron formation), whose fractures appear to belong to the same family. Based on the fracture widths observed at the televiewers, the width of the central fault is around 30 m in the model.

Table 2-15: Measured and Calibrated Hydraulic Conductivity

Hydrostratigraphic Units	Hydraulic Conductivity K (m/s)	
	Mean selected value estimated through slug tests and packer tests	Calibrated values
Overburden	1.2E-06	1.0E-06
Bedrock	1.0E-07	5.0E-08
Deep Bedrock	1.0E-08	1.0E-08
Faults	>1.0E-05	1.0E-05

The model domain is based on physical boundaries that extend from the topographic highs west of Daviault Lake (Québec province) to Wahnahnish Lake in the east (Labrador province). To the north, the model boundary follows a hydrographic limit to a topographic low near Labrador City. To the south, the model boundary follows a succession of topographic highs (no flow line) which correspond to the catchment basin limits, and then joins Lac Wahnahnish. The elevation of the major lakes (Daviault, Molar, Pike, Mills, Long and Riordan) was determined from topographic data.



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The hydrogeological model was calibrated in steady-state against water levels from 29 piezometers, measured between November 2011 and June 2012. The piezometers are located on the topographic highs at the periphery of the pit and in the topographic low in the center of the pit. The piezometers screened intervals intercept till, till/bedrock and bedrock. The model calibration is satisfactory, with an NRMSE error (normalized root mean square error) of 9.5% (Roberson et al, 2012).

To estimate dewatering rates, a steady-state simulation was then carried out using the pit's maximum operating depth (450 m). Several sensitivity analyses were also carried out by varying the hydraulic conductivity of the units, as well as the faults' connection to the surrounding lakes. In a conservative approach, a baseline scenario was selected (selected case), assuming the faults were connected to the lakes and that their hydraulic conductivity was 5 times higher than the injection limit reached during packer tests ($5x10^{-5}$ m/s). It was also assumed that lake levels would remain constant during dewatering operations. Based on the above assumptions, the simulated dewatering flow rate for the selected case is 41,000 m^3/day, with 30,000 m^3/day coming directly from Pike Lake, which is located north of the pit. Contributions of lakes Daviault, Mills and Molar during dewatering are also presented for the selected case in **Table 2-16**.

Table 2-16: Pit Dewatering Rate and Lakes Contribution for the Selected Case

Dewatering Scenario	Pit Outflow Rate (m^3/day)	Inflow Rate (m^3/day)			
		Pike Lake	Mills Lake	Daviault Lake	Molar Lake
End of Year 26	40,849	29,460	525	7,017	110

An evaluation has also been done to estimate the infiltration rate in the first years of operation (end of Year 5), considering the pit is partly excavated based on the operation planning. The following Table shows the results of this analysis.

Table 2-17: Pit Dewatering Rate and Lakes Contribution for the Selected Case

Dewatering Scenario	Pit Outflow Rate (m^3/day)	Inflow Rate (m^3/day)			
		Pike Lake	Mills Lake	Daviault Lake	Molar Lake
End of Year 5	16,261	10,924	187	2,418	13

A drilling campaign was completed in Q4 2023 to better define the bedrock properties by carrying out packer tests and televiewer surveys at five (5) new boreholes within the Rose Pit bedrock. The results of hydrogeological investigations will then be integrated into a detailed 3D numerical model to refine dewatering predictions.

2.5 Geotechnical Data

2.5.1 General Information

Field investigations near the water management facility area have been conducted by Stantec between 2010 and 2012 (Stantec 2012c). This geotechnical data was provided by Champion for the purpose of this study. **Table 2-18** summarizes available borehole reports.

Table 2-18: Summary of All Available Data in the Area of the Water Management Infrastructures

Year	Source	Borehole #	Description
2010	Stantec 2012c	K-10-25 to K-10-93	Location: boreholes in the pit area. No available log. Information on ground elevation and bedrock elevation.
2011	Stantec 2012c	K-11-99 to K-11-172	Location: boreholes in the pit area. No available log. Information on ground elevation and bedrock elevation.
		ROB-11-01 to ROB-11-16	Location: boreholes on the perimeter of the pit. Sampling: overburden and bedrock. Lab testing: on soils and bedrock.
		ROB-11-17 to ROB-11-20	Location: boreholes in the center of the pit. Sampling: overburden and bedrock. Lab testing: on soils and bedrock.
2012	Stantec 2012c	K-12-173 to K-12-213	Location: boreholes in the pit area. No available log. Information on ground elevation and bedrock elevation.
		RBR-12-01 and RBR-12-02	Location: boreholes in the pit area. Sampling: bedrock only. Lab testing: on bedrock.

No specific investigation has been conducted for the water management infrastructures. The nearest data is from the Stantec campaigns. Additionally, only the 2011 campaign provides information on the overburden.

Based on information from these campaigns, soils generally consist of the following:

- Organic soils;
- Loose to compact sandy SILT to silty SAND with gravel;
- Dense to very dense sandy SILT to silty SAND with gravel (Till). Occasionally, a loose to compact layer was noted more in depth. Cobbles and boulders were encountered in this layer.

Overburden thickness ranges approximately from less than 1 m to 60 m. Thicker overburden areas are generally associated with topographic depressions whereas a surface bedrock is found on topographic heights.

The following table summarizes the available data near each infrastructure.

Table 2-19: Summary of Available Data Near Infrastructures

Infrastructure	Borehole Number	Depth of Borehole (m)	Overburden Thickness (m)	Overburden Description
Elfie Lake West Dam	ROB-11-10	7.6	3.6	Loose to very dense silty sand to sandy silt, trace of gravel, cobbles and boulders (Till)
	K-10-68	234 (inclined 45 degrees)	7.4	N/A
	K-10-59	569 (inclined 50 degrees)	6.8	N/A
	K-10-60	131 (inclined 55 degrees)	19.7	N/A
End Lake East Dam	N/A	N/A	N/A	N/A
Pike Lake Dike	ROB-11-01	50.9	47.0	Very loose to very dense silty sand, trace of gravel, cobbles and boulders (Till)
	ROB-11-02	25.9	21.4	Very loose to very dense silty sand, trace of gravel, cobbles and boulders (Till)
	ROB-11-03	23.7	20.1	Compact to very dense silty sand with gravel, cobbles and boulders (Till)

Infrastructure	Borehole Number	Depth of Borehole (m)	Overburden Thickness (m)	Overburden Description
	ROB-11-15	9.0	4.3	Loose to very dense silty sand, trace of gravel, cobbles and boulders (Till)
	ROB-11-16	16.5	12.2	Compact silty sand with gravel to silty sand, cobbles and boulders (Till)
Mid Lake Dam	ROB-11-07	60.1	52.9	Compact to very dense silty sand with gravel, cobbles and boulders (Till)
	ROB-11-08A/B	29.0	22.9	Compact to very dense silty sand with gravel, cobbles and boulders (Till)
	ROB-11-09	30.5	25.9	Loose to compact sand, dense to very dense sand with gravel (Till)
Rose North Overburden Stockpile Basin	N/A	N/A	N/A	N/A
Rose South Waste Rock Stockpile Basin	BH-RSD-05	23.3	18.2	Very dense silty sand with gravel, cobbles and boulders (Till)
	BH-RSD-12	9.9	4.7	Compact to very dense silty sand with gravel, cobbles and boulders (Till)
	BH-RSD-13	7.5	2.4	Compact to dense silty sand with cobbles and boulders (Till)
	BH-RSD-16	19.8	>19.8	Dense to very dense silty sand with gravel, cobbles and boulders (Till)

A more detailed description of each layer is provided in the following sections.

2.5.2 Organic Soils

A layer of loose organic soils is present at the surface of all boreholes. The thickness of this layer varies from 0.1 m to 2.1 m, with an average thickness of 0.5 m.

2.5.3 Loose to Compact Sandy SILT to Silty SAND With Gravel

A loose to compact layer of sandy SILT/silty SAND with gravel is generally found directly under the organic soils. Thickness of this layer varies from approximately 1.0 m to 29.0 m.

Close attention should be paid to areas where loose soils have been encountered in depth, notably:

- At ROB-11-01, between 26.0 m and 28.0 m of depth.
- At ROB-11-16, between 11.1 m and 11.7 m of depth.
- At ROB-11-17, between 29.0 m and 29.6 m of depth.

Some cobbles and boulders can be found in this layer.

2.5.4 Dense to Very Dense Sandy SILT to Silty SAND With Gravel

Under the previous layer, a dense to very dense sandy SILT to silty SAND with gravel (Till) is noted. Cobbles and boulders are present in this layer.

The thickness of this layer varies from approximately 2.0 m to 51.0 m and SPT “N” (Standard Penetration Test) values range from 30 to over 50 blows per 0.3 m.

3.0 Design Criteria

The geotechnical, hydrological and water treatment design criteria have been discussed and confirmed by Champion and are summarized in the document "*Rose Pit Water Management Infrastructures Design Criteria - Kami Mine*" available in Appendix A. The following lines present a summary of the design criteria.

The design basis of the water management infrastructures is mainly based on CDA (Canadian Dam Association) Guidelines and on applicable regulation for water quality in Canada and NL.

The following Table shows the level of consequence assumed for all the infrastructures required for the water management based on CDA methodology, and associated design earthquake and Inflow Design Flood (IDF). Note that it is assumed that water management infrastructures will be dismantled at closure. Therefore, the Construction, Operation and Transition criteria (CDA, 2014) are selected.

Table 3-1: Level of Consequence of Water Management Infrastructures

No.	Infrastructure	Class	Design Earthquake	IDF[1]
1	Mid Lake dam	Very high	1/2 between 1/2 475 and 1/10 000 or MCE	2/3 Between 1/1000 and PMF
2	End Lake East dam	Very High	1/2 between 1/2 475 and 1/10 000 or MCE	2/3 Between 1/1000 and PMF
3	Elfie Lake West dam	Very high	1/2 between 1/2 475 and 1/10 000 or MCE	2/3 Between 1/1000 and PMF
4	Pike Lake dike	Low	1/100 AEP	1/100
5	Rose North Overburden Stockpile Pond Dike	Low	1/100 AEP	1/100
6	Rose South Waste rock stockpile Pond Dikes (NB, WB and SWB)[2]	Low	1/100 AEP	1/100
7	Rose South Stockpile Pond Dikes (EB)[3]	Significant	Between 1/100 and 1/1 000	Between 1/100 and 1/1 000

Notes:
[1] IDF: Inflow Design Flood. To be managed by the emergency spillway.
[2] North Basin, West Basin and South-West Basin.
[3] East Basin.

The seismic parameters for Kami site were extracted from the 2020 National Building Code of Canada Seismic Hazard Tool. According to available information, the first 30 m of soil is generally assumed to be of site Class C (very dense soil and soft rock) with some sectors being of site Class D (stiff soils) or Site Class E (soft soils).

Table 3-2: Seismic Parameters for Kami Site Class C, D and E

Return Period	Peak Horizontal Ground Acceleration (PGA)		
	Class C	Class D	Class E
1:475	0.0185	0.0289	0.0316
1:1000	0.0296	0.0467	0.0511
1:2475	0.0518	0.0820	0.0898
1/2 between 1:2475 and 1:10000	0.0884	0.1410	0.1549
1:10000	0.1250	0.2000	0.2200

The PGA for a 10 000-year return period was extrapolated based on the 2020 National Building Code of Canada Seismic Hazard Tool.

The loading cases and safety factors criteria for the stability of the dikes and dams are the following:

Table 3-3: Geotechnical Factors of Safety - Dams

Loading condition	Minimum FoS Recommended (CDA, 2014)
Static – End of construction	> 1.3
Static – Long Term	1.5
Pseudo-static	1.0
Post-seismic	1.2

Water management infrastructures will be built with the available material on site. Information on the characteristics of available material on site is based on former field investigations realized by Stantec (2012c), WorleyParsons (2015) and Golder (2018). Material properties for stability and seepage analyses are based on information available in previous site wide geotechnical studies.

It is assumed that the majority of the good quality till will be used for the construction of the tailings storage facility, geomembrane in combination with cut-off key trench is prioritized as the sealing method for the dams related to the Rose Pit water management.

Geometrical criteria for the width of the roads and dams is established based on the Newfoundland Occupational Health and Safety Regulation considering width of trucks which will circulate in the different area. When needed, room for pipelines is planned along the roads and crest of the dams.

The following criteria was retained:

Table 3-4: Geometrical Criteria for Roads and Dams Width

	Circulating Width	Berm Height	Berm Width
Rose Pit Ring Road	21.0	1.8	5.4
Mid Lake Dam	21.0	1.8	5.4
Pike Lake Dike	21.0	1.8	5.4
Other dikes and access roads	10.5	1.0	3.0

The design of the Rose pit pumps and pipes and the design of the Rose Pit collection pond and treatment plant considers the inflow from pit dewatering in addition to runoff. This inflow is set to 40 000 m³/d based on the hydrogeological data review and conceptual hydrogeological modelling conducted as part of this project.

The following Table summarizes the criteria associated with water management for all the infrastructures.

Table 3-5: Water Management Design Criteria

<table>
<tr><th></th><th>Rose Pit Sumps</th><th>Rose Pit Collection Pond</th><th>Rose North Overburden Stockpile Basin,
Rose South Waste Rock Stockpile Basins</th><th>Mid Lake Dam</th><th>Pike Dike</th></tr>
<tr><td>Water Type</td><td>Contact Water</td><td>Contact Water</td><td>Contact Water</td><td>Non-Contact Water</td><td>Non-Contact Water</td></tr>
<tr><td>Environmental Design Flood (EDF to be contained)</td><td>Most critical of:
30 days 100-yr rainfall plus snowmelt events or
24 hours 100-yr rainfall events[1]</td><td colspan="4">Most critical of:
30 days 100-yr rainfall plus snowmelt events or
24 hours 100-yr rainfall events</td></tr>
<tr><td>Inflow Design Flood (IDF) (to be evacuated by Emergency Spillway)</td><td>N/A</td><td colspan="4">See</td></tr>
<tr><td>Pump Intake</td><td>0</td><td colspan="4">Min 1 m above bottom of basin</td></tr>
<tr><td>Freeboard (Crest – IDF)</td><td>0</td><td colspan="4">Minimum 1 m</td></tr>
<tr><td>Pumping Period</td><td>12 month / year</td><td>No pumping from January to Mid-March inclusively</td><td>No pumping from November to Mid-March inclusively</td><td>No pumping from November to Mid-March inclusively</td><td>No pumping from November to Mid-March inclusively</td></tr>
<tr><td>Pumping Capacity</td><td>Pumping to accommodate EDF
Consider 1 month to reach the NOWL[2] after the EDF[1]</td><td colspan="4">Pumping to accommodate EDF
Consider 1 month to reach the NOWL[2] after the end of EDF.</td></tr>
<tr><td>Piping</td><td>Above Ground, Heat Traced</td><td>Above Ground, Heat Traced</td><td>Above ground</td><td>Above ground</td><td>Above ground</td></tr>
<tr><td>Diversion and Collection Ditches</td><td colspan="5">Minimum slope 0,5%
Transversal slope min. 2H:1V
Design flow: 100 years – duration for the concentration time
Freeboard: 0.3 m</td></tr>
<tr><td colspan="6">Notes:
[1] It was checked whether accepting flooding of the pit floor for recurrence events between 10 and 100 years would optimize pumping, and the required pumping capacity was not significantly lower. The 100-year criterion for the sumps was therefore retained.
[2] NOWL = Normal Operational Water Level.</td></tr>
</table>

The effluent discharged from the treatment plant to the environment shall comply with the following regulations:

- Newfoundland and Labrador Environmental Control Water and Sewage Regulations (NL Reg. 65/03).
- Metal and Diamond Mining Effluent regulations (MDMER) (SOR/2002-222).
- Wastewater Systems Effluent Regulations (SOR/2012-139).

Section 6.4 details the assumptions regarding raw water quality. In terms of quantity, the water treatment plant shall have the capacity to treat the maximum flowrate pumped from the Rose Pit collection pond during the life of the mine (LOM). This flowrate corresponds to the Environmental Design Flood (EDF) which is 7100 m3/h.

4.0 General Water Management Philosophy

All the proposed infrastructures for water management are defined considering the End of Mine development when the Rose Pit, Rose North Stockpile and Rose South Waste Rock Stockpile will be at their maximum footprint.

The following figures present the proposed water management infrastructures and the water management plan schematic plan.

Note that basins 1, 2, 3 and 4 shown on **Figure 4-2** are retention basins that are not part of the infrastructure designed in the present report and fall within the scope of BBA. The water coming from the retention basins 1 and 2 will be pumped to the Waste Rock Stockpile North Basin and the water coming from the retention basins 3 and 4 will be pumped to the Rose Pit collection pond. Initially, these two (2) effluents were not taken into consideration in the sizing of water management infrastructure presented in this report as this information was sent by BBA only after the design was finished. However, after a verification was carried out, it was concluded that the additional two (2) effluents can be managed by the designed infrastructure without any changes or upgrades.

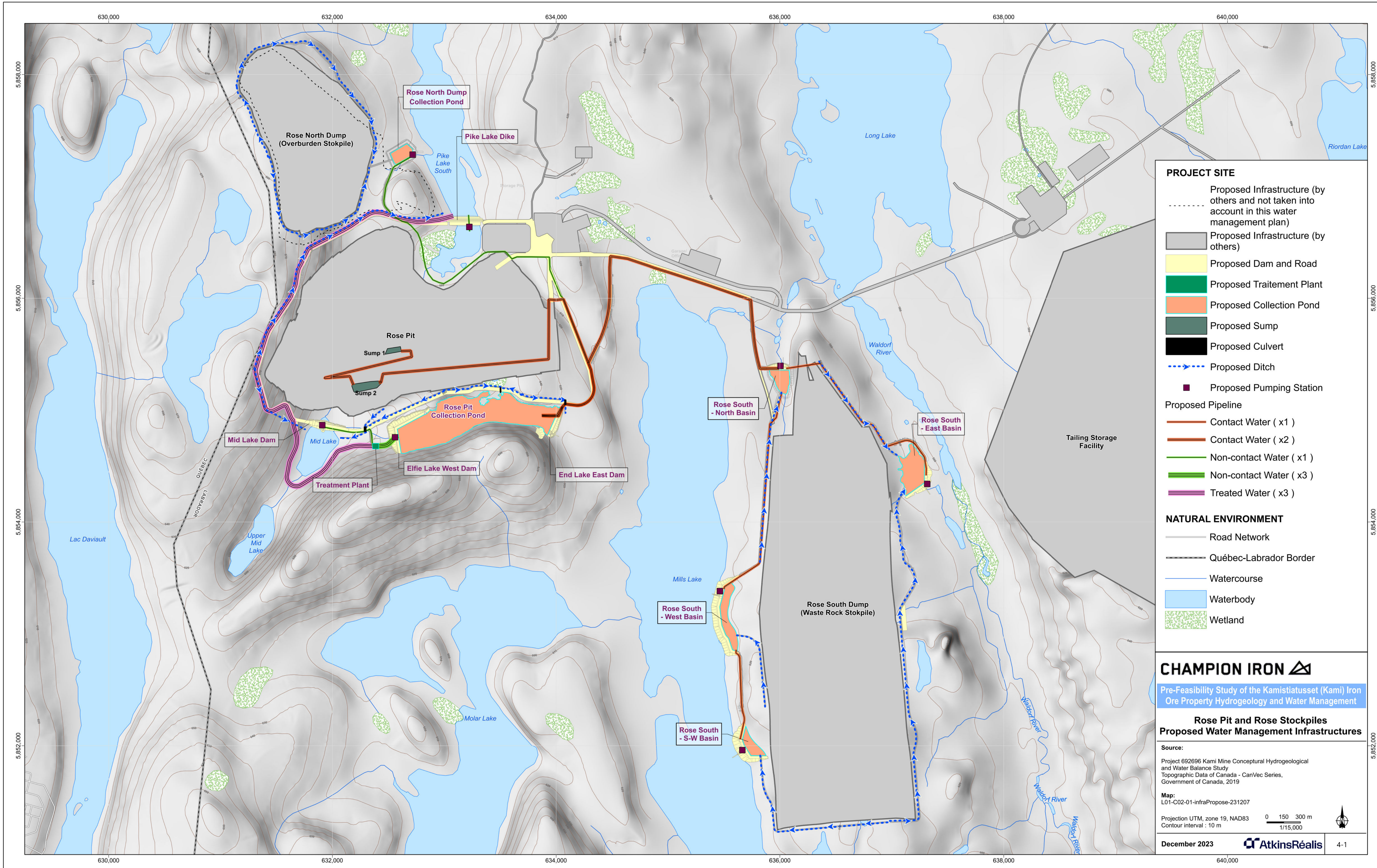

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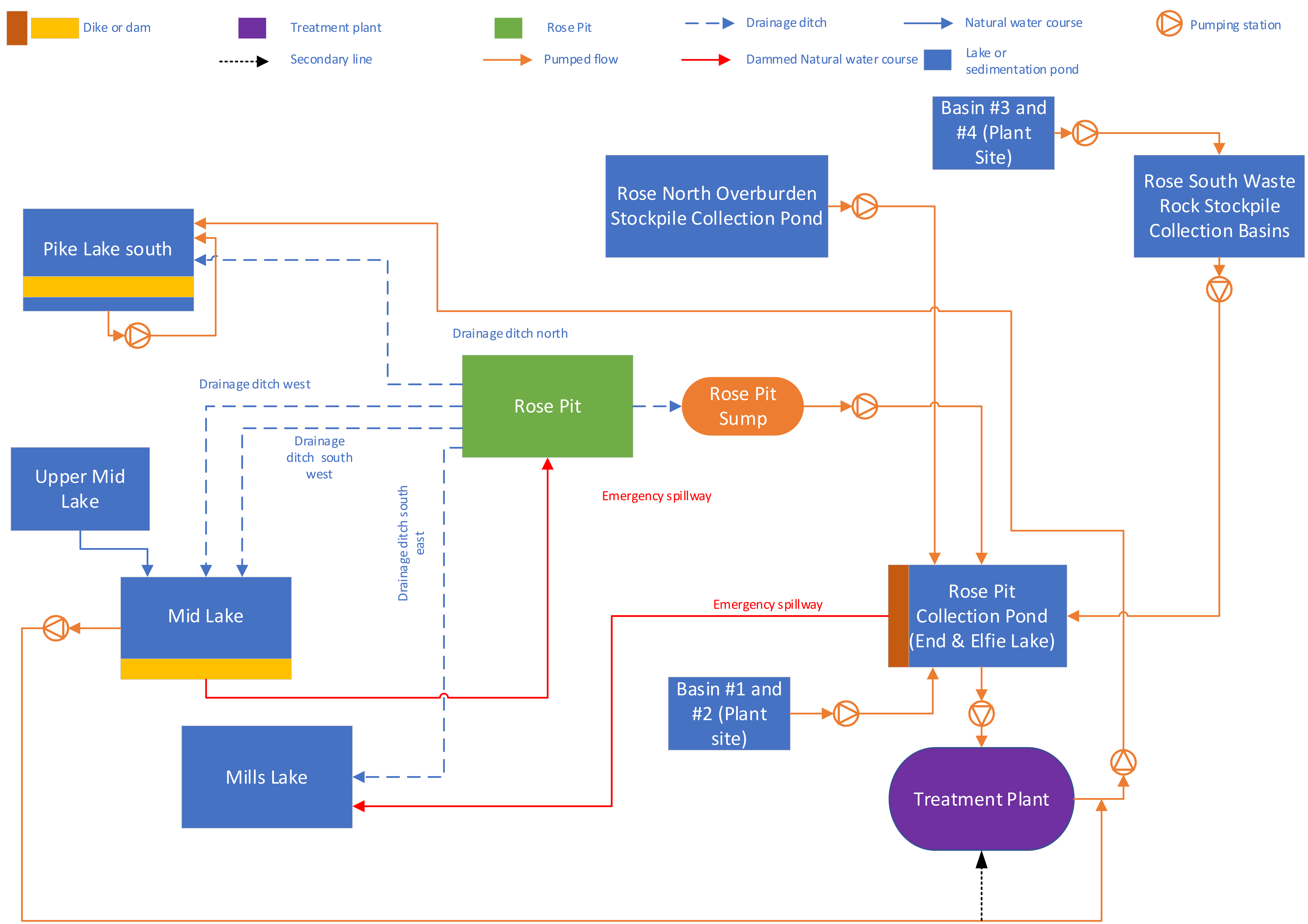
Figure 4-2 : Water Management Plan Schematic Plan



4.1 Improvements and Changes Since 2012 Project

Compared to the water management philosophy presented by Alderon in 2012, improvements were made in order to comply with the conditions asked by N.L. government as part of the 2014 project release. Refining the hydrogeological knowledge of the project is the main 2014 condition affecting the water management plan.

The main uncertainty related to water management in the Kami project is the amount of infiltration associated with the exploitation of Rose Pit. Due to the geology of the area and the poor quality of the bedrock, a large amount of infiltration is expected in the pit.

The review of project data, new site investigations and the creation of a conceptual hydrogeological model incorporating a better understanding of the site are all actions taken as part of the current project update, with the aim of reducing the risks associated with pit infiltrations while complying with 2014 project conditions. The completion of these tasks has allowed to refine the hydrogeological knowledge of the site and plan for large volumes of infiltration to be expected.

In order to be prepared to manage a large amount of infiltration, the Rose Pit Collection Pond planned capacity have been raised from 50,000 m^3 in the 2012 Alderon project to 4 Mm^3. This large capacity also allows to store water during the coldest months of winter when the operation of a treatment plant and effluent discharge has been proven to present more operational difficulties. The collection pond will be created by the building of dikes at the outlet of Elfie Lake and east of End Lake.

Another improvement aimed at reducing the project risk is the planning of the Pike Dike, which aims to move Pike Lake away from the pit rim. This infrastructure could allow a reduction of infiltration to the pit and will also reduce the risks of flooding the pit in case of extreme events. This will also secure mining operation by reducing the risk of flooding of the pit by Pike Lake in case local pit slope failure.

The quality of runoff water on the Rose North Overburden Stockpile and Rose South Waste Rock Stockpile is still to be determined with the ongoing realization of geochemical tests and modelling (by others). Although in the Alderon 2012 project it was planned to divert runoff water directly to the nearby lakes after a stay in a collection pond, to be ready for any eventuality regarding water quality, all the stockpile runoff water will be pumped to the Rose Pit Collection Pond, which has a large capacity. Local collection ponds are still planned in the periphery of the stockpiles. Current design includes the lining of all ponds with a geomembrane to protect groundwater, assuming the natural soil might be pervious until confirmation by a geotechnical campaign in this area. The routing of the Rose South Waste Rock Stockpile to the tailing storage facility, which would be closest, was discarded for the moment due to uncertainties regarding the TSF capacity to manage this amount of water.

The treatment plant, which will be located downstream of the Rose Pit Collection Pond, has now the capacity of treating all the inflows coming from Rose Pit, Rose North Overburden Stockpile and Rose South Waste Rock Stockpile. The treated volume will be around 18 Mm^3/y on an average year with a capacity to treat 7100 m^3/h, compared to a 1000 m^3/h capacity for the Alderon project. The treated water will be diverted to the Pike Lake South.

The management of the water coming from the south watershed of Rose Pit and towards Mid Lake is the same as in the 2012 Alderon project, with the building of the Mid Lake Dam and pumping of the water to Pike Lake South. However, the routing of the pipeline now allows for the water to be treated in the treatment plant if needed.

The following Table summarizes the main changes in the current update compared to previous versions of the project water management.

Table 4-1: Main Water Management Changes

	Current Project Update	Alderon	Alderon Reference
Expected Dewatering Rate	40,000 m³/d	3838 m³/d used WM for design.	Stantec (2012a).
		10,659 m³/d (average estimated).	Stantec (2012c).
Rose Pit Collection Pond Capacity	4 Mm³	5.8 ha, 5 m depth: approx. 240,000 m³.	Stantec (2012a).
		55,000 m³.	WorleyParsons (2014).
Treatment Plant Capacity	7100 m³/h	1000 m³/h.	Stantec (2012a).
		3600 m³/h: based on graph interpretation.	WorleyParsons (2014).
Management of Overburden and Waste Rock Stockpiles Runoff	To the treatment plant.	Directly to the lakes after sedimentation pond.	Stantec (2012a). WorleyParsons (2014).
Securing Mining Operation	Pike Dike	---	---
Design Criteria for Ponds	100-year hydrological event	100-year hydrological event.	Stantec (2012a). WorleyParsons (2014).
Management of Mid Lake Watershed Runoff	Mid-Lake Dam and pumping to Pike Lake. Possibility to treat the water if needed.	Mid-Lake Dam and pumping to Pike Lake.	Stantec (2012a).
In blue: Interpretation by AtkinsRéalis.			

4.2 Infrastructure Location Analysis

Several locations were analyzed for the construction of the Rose Pit Collection Pond. Locations on the east shore of Pike Lake South and on the south portion of Pike Lake South were considered. However, given the large amount of water expected from the pit dewatering and the large pond capacity required, Elfie Lake and End Lake were selected as the best options.

A large pond is also necessary considering that all runoff from Rose South Waste Rock Stockpile would be directed towards this pond instead of towards the east side of the site. This decision was made due to uncertainties related to the available capacity to manage water at the TSF, which would be the other option to manage water from the site.

The following Table shows the impact of the new infrastructures on the natural watershed of the site area. **Figure 4-3** and **Figure 4-4** show the original and modified watersheds of the site area.

Table 4-2: Changes in Watersheds Due to Water Management Infrastructure – Selected Layout

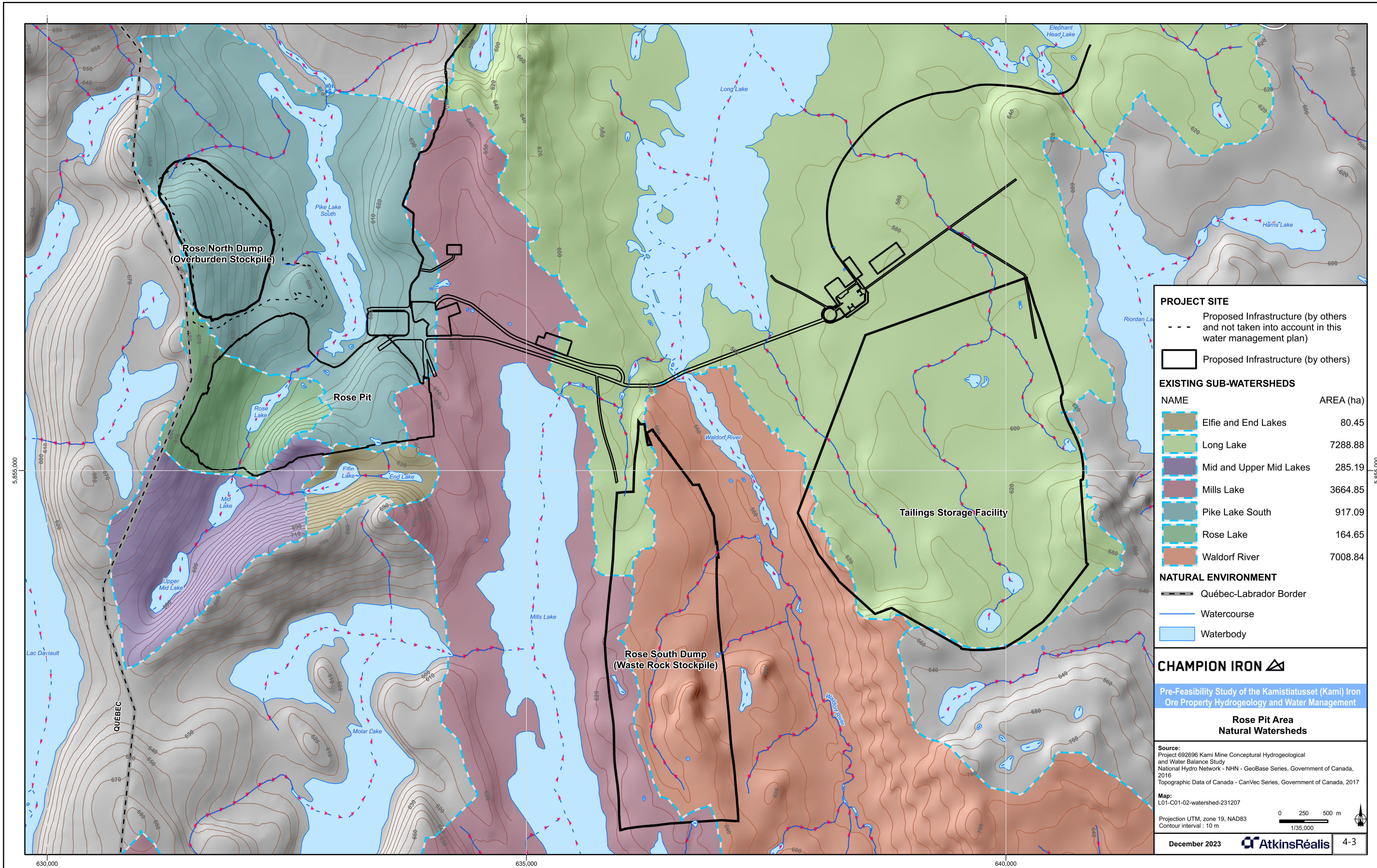
Watershed	Origin Area (ha)	Modified Area (ha)	Variation (ha)	Variation (%)
Long Lake	7289	7205	-84	-1%
Mid and Upper Mid Lakes	285	266	-19	-7%
Mills Lake	3665	3532	-133	-4%
Rose Lake	165	0	-165	-100%
Elfie and End Lakes	80	0	-80	-100%
Pike Lake South (without considering upstream watersheds)	917	571	-346	-38%
Pike Lake South (considering upstream watersheds reporting to the lake)	1447	2008	+561	+39%

Although runoff on the Rose South Waste Rock Stockpile is directed to the Pike Lake South watershed and not to Mills Lake and Long Lake, which would be the natural path, this has little impact on these two lakes, given their considerable watersheds.

This layout, however, requires a considerable amount of pumping and piping to redirect runoff from the Rose South Waste Rock Stockpile to the western part of the site.

It should be noted that it is considered that Elfie Lake and End Lake no longer exist as they are used for contact water storage and are not considered natural lakes anymore. Rose Lake, of course, is replaced by the Rose Pit.

The watershed relating to Pike Lake South is 39% higher following the construction of infrastructures. Based on the hydrogeological evaluation (see **Section 2.4**) it is expected that some water in Pike lake will be lost through infiltration towards the Rose pit, which means that the natural water level in the lake could be affected despite the raise of watershed area reporting to the lake. Mitigations for potential effects on Pike Lake water level are discussed at the end of this report.



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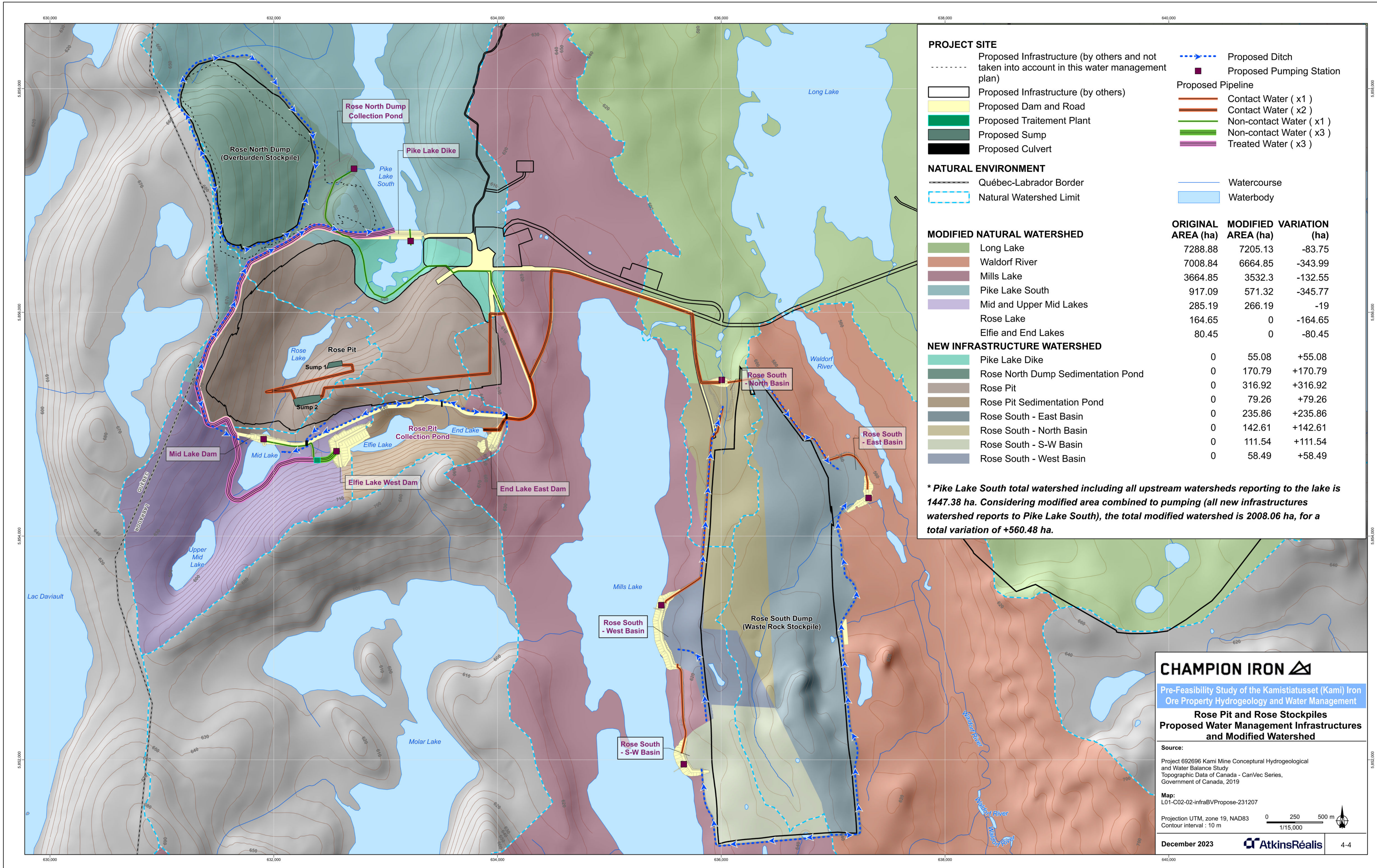

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4.3 Dams and Dikes Required for Water Management

The following Table shows the list of dams and dikes required to achieve the water management plan presented in the previous paragraphs.

Table 4-3: Summary of Dams and Dikes

WBS	Location	Crest Elevation (m)	Height (m)
21320	Mid Lake Dam	584.5	5.5
21330	Rose Pit Collection Pond / Elfie Lake West Dam	627	19
21330	Rose Pit Collection Pond / End Lake East Dam	627	12
21340	Pike Lake Dike	570.5	6
21350	Overburden Stockpile Collection Pond	572	5
21360	Waste Rock Stockpile / North Basin	574	10
21360	Waste Rock Stockpile / East Basin	555	9
21360	Waste Rock Stockpile / West Basin	599.5	4.5
21360	Waste Rock Stockpile / South-West Basin	605	5

The dikes related to the Rose South Waste Rock Stockpile are subject to more significant changes in the next iteration of the project because the topography used for the south portion of this area is the governmental topography with 10-m equidistance levels, which was the only topography available.

The following Table shows the target operation levels for all infrastructures. The evaluation and respect of these target levels are presented in **Section 5.0**.

Table 4-4: Operating Levels for all Infrastructures

Description	LOWL[1] (m)	Max. Elev.[4] EDF[2] Spillway Invert (m)	Max Elev.[4] IDF[3] (m)	Crest (m)
Elfie & End Lake (Rose Pit Collection Pond)	609.0	625.5	626.0	627.0
Mid Lake Dam	579.9	583.0	583.5	584.5
Rose North Collection Pond	568.2	570.5	571.0	572.0
Rose South – East Basin	549.0	553.5	554.0	555.0
Rose South – West Basin	596.1	598.0	598.5	599.5
Rose South – S-W Basin	601.0	603.5	604.0	605.0
Rose South – North Basin	566.0	572.5	573.0	574.0
Pike Lake Dike	566.9	569.0	569.5	570.5

[1] LOWL: Low Operating Water Level.
[2] EDF: Environmental Design Flood (to be contained).
[3] IDF: Inflow Design Flood (to be discharged by emergency spillway).
[4] Maximum elevation according to dike design and geomembrane position. The water depth in the spillways and the effective freeboard according to flood routing is presented in **Table 6-2: Spillways Dimensions and Maximum Water Depth**. A minimum freeboard of 1 meter was required for the design of all spillways.

5.0 Hydrological Model

5.1 Hydraulic Software

PCSWMM v7.4 software was used to perform the hydrological and hydraulic calculations for the study. This software, originally developed for the hydrological and hydraulic analysis of sewer pipe networks, was employed because it allows the representation of complex water flow systems including surface runoff on watersheds, free surface infrastructures (ditches, weirs, etc.), pipe networks, as well as various water transfer infrastructures (spillways, pumps, orifices, etc.). The software allows to perform hydraulic analyses using different rainfalls events as time series.

5.2 Model Geometry

Figure 5-1 shows the geometry of the PCSWMM model developed as part of this study. The site has been divided into 44 sub-watersheds. The dimensions and general characteristics of the sub-basins are presented in **Table 5-1**. The division of the sub-basins was carried out considering the topography of the current site and the areas to be used within the Kami Mine site. For the purposes of the study, the sub-basins were divided into the following areas: Rose Pit, Mid Lake, End & Elfie Lake, Mils Lake, Pike Lake South, Pike Lake

Dike, Pike Lake North, Rose North (overburden stockpile) and Rose South (waste rock stockpile). The Rose South area is divided in four sub-basins: East Basin (EB), North Basin (NB), West Basin (WB), and South-West Basin (SW).

To perform these analyses, water storage was included in the software by means of capacity curves. The capacity curves defined for the project were Rose Pit, End & Elfie Lake, Mid Lake, Pike Lake South, Pike Lake Dike, Rose North, and Rose South (four storage areas). The capacity curves for the different water storage areas are presented in **Section 5.3**. The location of the water storage is presented in **Figure 5-1**.

The water flow created by runoff on watersheds is transported to water storage areas through hydraulic structures such as ditches and culverts. The selected ditches are trapezoidal structures built with riprap cover, while the culvers are circular conduits in corrugated steel. The location of ditches and culverts are presented in **Figure 5-1** to **Figure 5-3**. The location, dimensions and section types of these hydraulic structures are presented in Appendix B.

Spillways were placed in each water storage to discharge the excess water. The spillways were conceived as trapezoidal structures with riprap cover to allow vehicle circulation. These structures and the design criteria (inflow, geometry, material, etc.) are described in **Section 6.2**. The PCSWMM model was developed including a pump system to control the water level in each storage. This system is described in detail in **Section 6.3**.

Three models were developed to obtain the hydraulic characteristics of the project. These models were performed to design the conduits and the spillways, and to carry out the flood routing of the project. The precipitation events considered to execute these models are presented in **Section 2.2.8**.

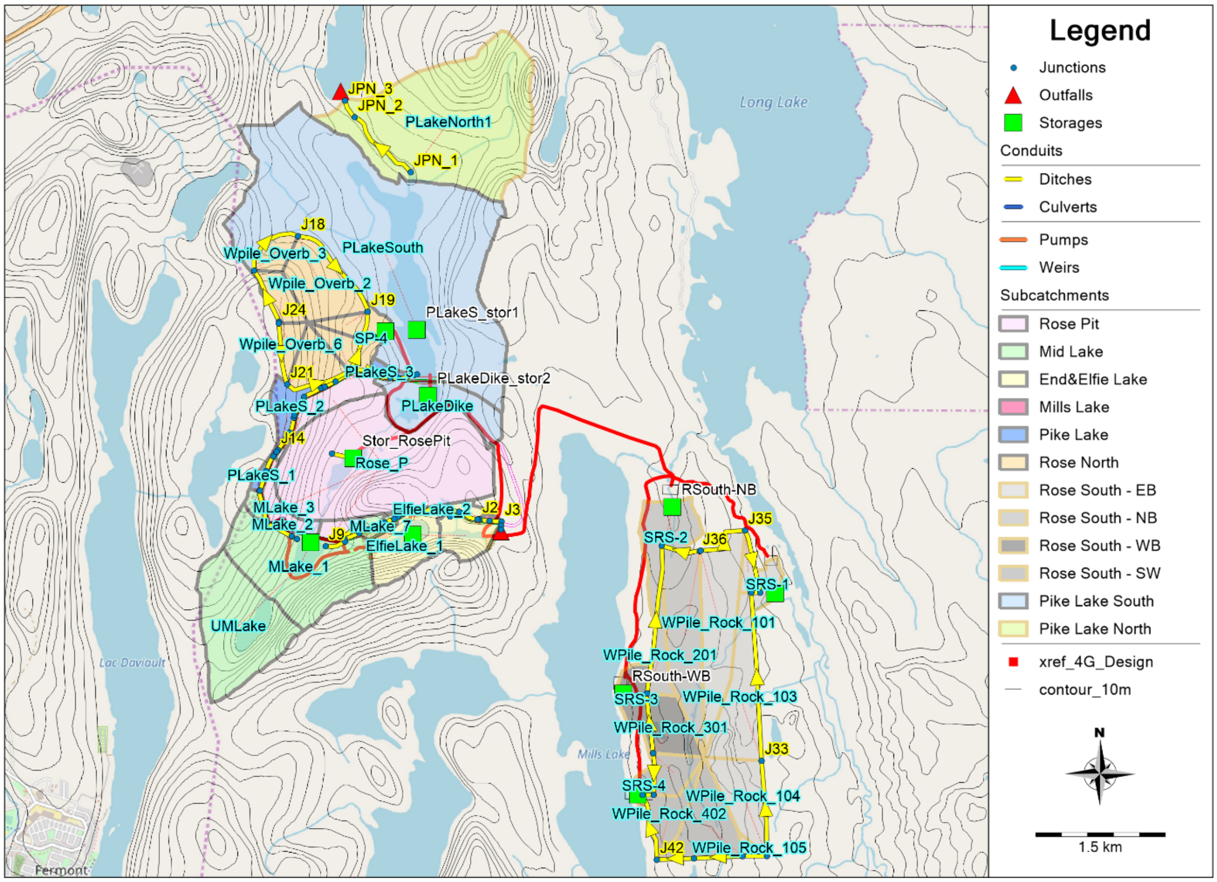


Figure 5-1: Watersheds Analyzed in the PCSWMM Model

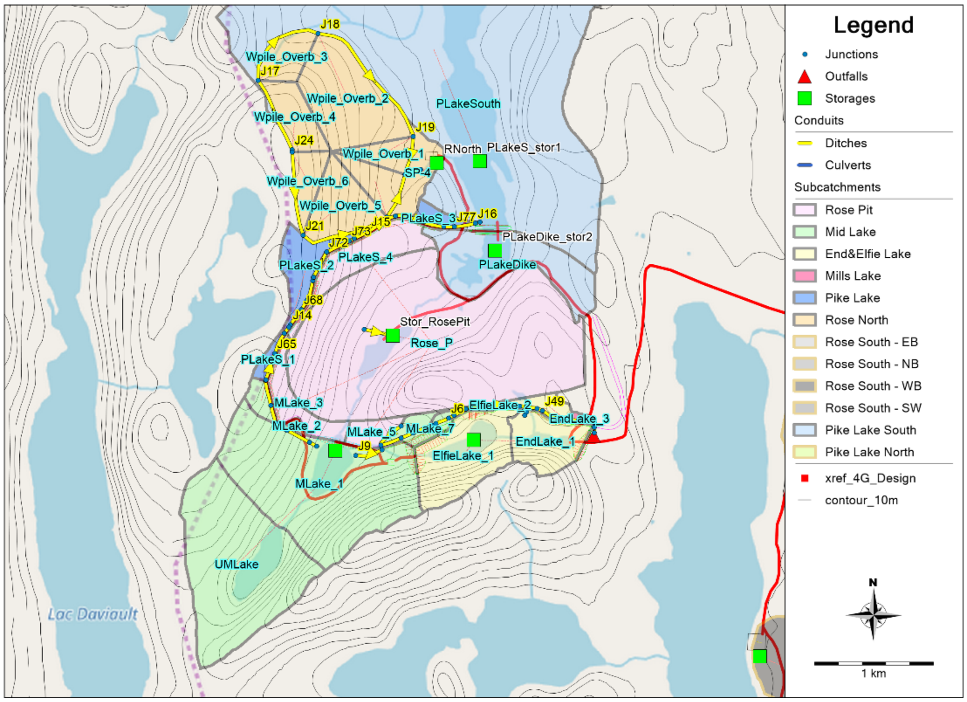


Figure 5-2: Watersheds to the North

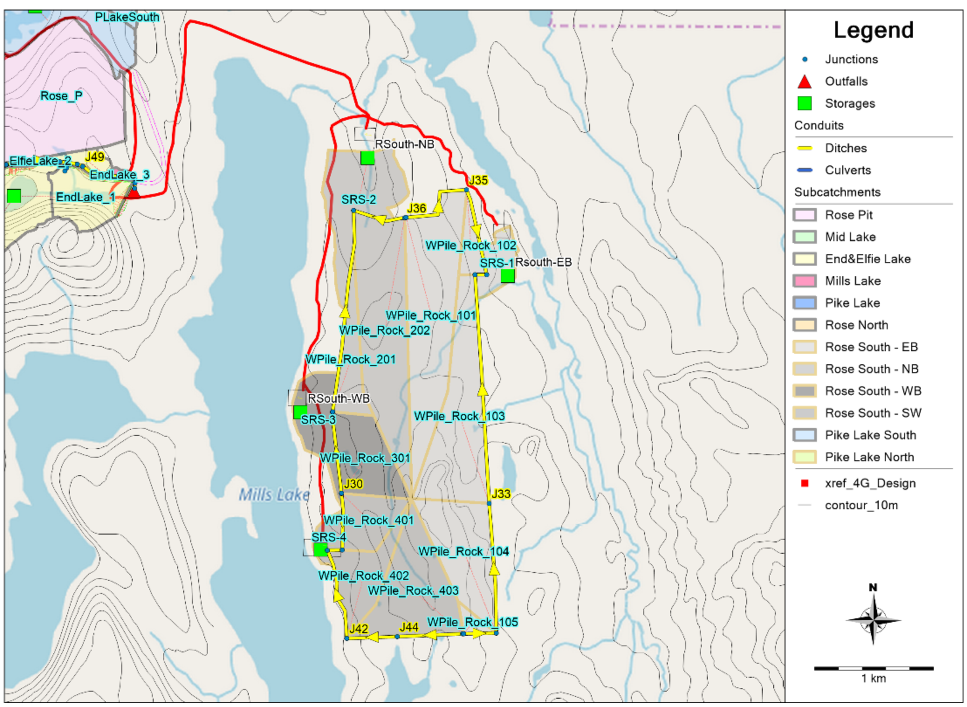


Figure 5-3: Watersheds to the South

Table 5-1: Characteristics of the Watersheds in the PCSWMM Model

Basin Name in PCSWMM	Watershed	Area	Width	Flow Length	Slope
		[ha]	[m]	[m]	[%]
ElfieLake_1	End & Elfie Lake	47.2	1107.5	426.2	21.6
ElfieLake_2	End & Elfie Lake	2.9	531.4	54.3	4.0
EndLake_1	End & Elfie Lake	26.1	693.0	376.9	16.8
EndLake_2	End & Elfie Lake	5.9	223.8	262.1	3.9
EndLake_3	Mills Lake	1.7	218.3	79.1	5.7
MLake_1	Mid Lake	131.6	1882.8	699.2	18.8
MLake_2	Mid Lake	1.2	86.0	144.5	14.7
MLake_3	Rose Pit	17.7	222.1	795.7	11.9
MLake_4	Mid Lake	6.3	183.7	345.4	10.0
MLake_5	Rose Pit	8.8	179.3	488.2	8.2
MLake_6	Mid Lake	5.0	80.9	621.4	7.0
MLake_7	Mid Lake	6.8	537.4	126.4	7.0
PLakeDike	Pike Lake Dike	55.1	724.2	760.26	6.12
PLakeNorth1	Pike Lake North	274.4	1010.2	2716.26	7.91
PLakeS_1	Pike Lake South	4.2	195.8	214.0	5.2
PLakeS_2	Pike Lake South	22.2	635.7	349.4	8.0
PLakeS_3	Pike Lake South	7.5	145.1	520.2	4.7
PLakeS_4	Pike Lake South	37.4	789.8	473.5	11.4
PLakeSouth	Pike Lake South	542.6	2895.7	1873.85	5.00
Rose_P	Rose Pit	271.0	1846.0	1467.8	4.4
SP4	Rose North	15.6	310.5	503.1	2.9
SRS1	Rose South-EB	13.1	552.6	237.7	4.9
SRS2	Rose South-NB	45.4	406.4	1116.8	2.5
SRS3	Rose South-WB	24.0	393.6	610.9	4.7
SRS4	Rose South-SW	7.5	258.4	289.8	9.1
UMLake	Mid Lake	115.7	872.1	1326.3	2.9
Wpile_Overb_1	Rose North	10.9	170.5	638.5	8.7
Wpile_Overb_2	Rose North	55.0	823.1	667.9	8.6
Wpile_Overb_3	Rose North	14.5	347.0	417.2	11.5
Wpile_Overb_4	Rose North	18.4	656.9	280.2	10.4
Wpile_Overb_5	Rose North	27.1	376.7	718.3	3.0
Wpile_Overb_6	Rose North	12.5	427.2	292.0	10.3
Wpile_Overb_7	Rose North	13.2	196.4	671.6	7.4
WPile_Rock_101	Rose South-EB	79.8	362.7	2201.5	1.7
WPile_Rock_102	Rose South-EB	8.8	724.9	121.6	9.1

Basin Name in PCSWMM	Watershed	Area	Width	Flow Length	Slope
		[ha]	[m]	[m]	[%]
WPile_Rock_103	Rose South-EB	64.3	567.0	1134.1	4.2
WPile_Rock_104	Rose South-EB	44.3	410.7	1079.2	2.2
WPile_Rock_105	Rose South-EB	3.8	116.0	326.4	3.7
WPile_Rock_201	Rose South-NB	18.9	477.7	394.7	1.3
WPile_Rock_202	Rose South-NB	78.4	357.8	2191.0	1.9
WPile_Rock_301	Rose South-WB	31.8	331.0	961.7	2.4
WPile_Rock_401	Rose South-SW	20.2	297.0	679.2	3.4
WPile_Rock_402	Rose South-SW	26.4	232.8	1133.3	2.9
WPile_Rock_403	Rose South-SW	53.0	477.6	1109.0	0.1

5.3 Capacity Curves

The capacity curves of all infrastructures have been defined based on a 3D model of the site with topographic information and a 3D shape of the planned infrastructures using MUK3D^{tm} software. The bathymetry of the natural lakes was included in the capacity curves, this is the case of Mid Lake, End Lake, Elfie Lake, Pike Lake Dike, and Pike Lake South.

As for the pumping from the Rose Pit, the water from the bottom of the pit will be pumped to a 60,000 m^3 sump located at an elevation of 265 m (Sump 1) from which it will be pumped to a 170,000 m^3 sump at an elevation of 385 m (Sump 2) and then to the collection pond. It should be noted that only the infrastructure required to pump the water from Sump 1 to Sump 2 and to the collection pond will be considered in this design.

For the infrastructures closing natural lakes (Mid lake, Elfie Lake, and End Lake), the LOWL (Low Operation Water Level) and the initial water level considered in the simulation of the spring freshet are the water levels measured on the lakes when the bathymetric surveys were taken.

For the infrastructures required to create the collection ponds at the periphery of the Rose North Overburden Stockpile and Rose South Waste Rock Stockpile, the LOWL have been defined either at 1 m from the bottom of the pond, or at the level representing 5% of the total volume of the pond for the cases where 1 m was not realistic and too low considering the topography of the area. LOWL for Pike Lake Dike was considered to be zero.

The capacity curves with key levels of the water storage defined for the project are presented in **Figure 5-4** to **Figure 5-14**. **Table 5-2** presents a summary of the levels and volumes for the different storage areas.

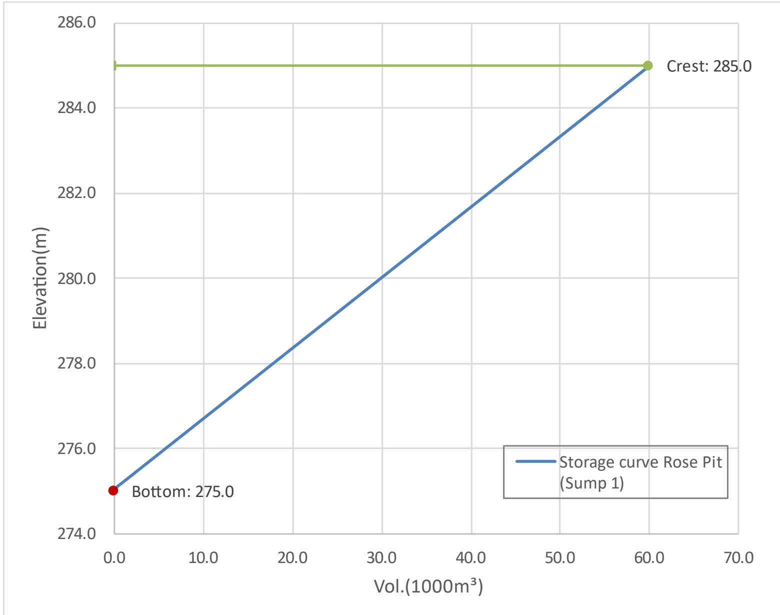


Figure 5-4: Capacity Curve for Rose Pit (Sump 1)

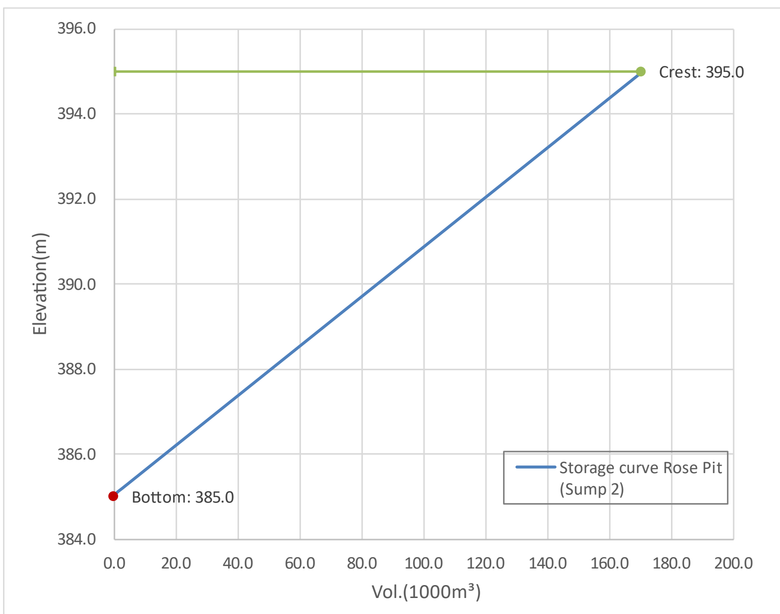


Figure 5-5: Capacity Curve for Rose Pit (Sump 2)

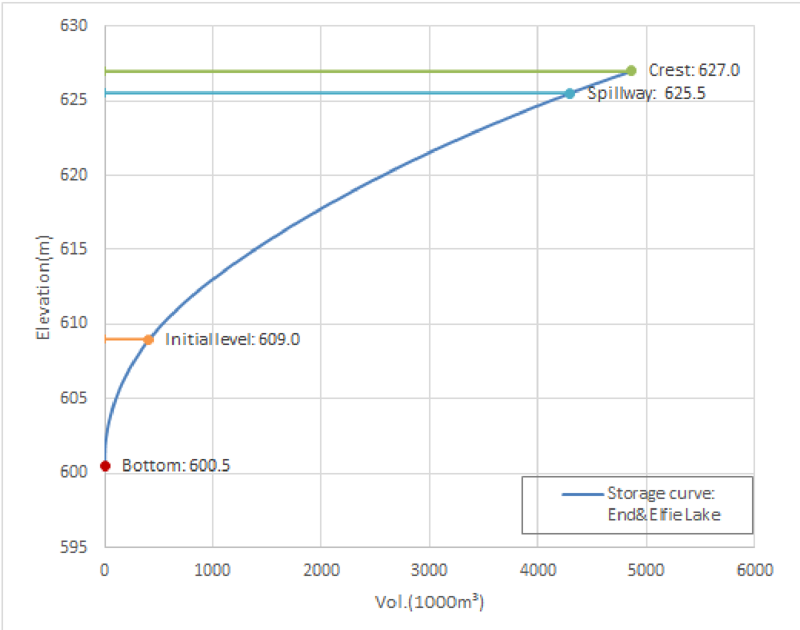


Figure 5-6: Capacity Curve for End & Elfie Lake

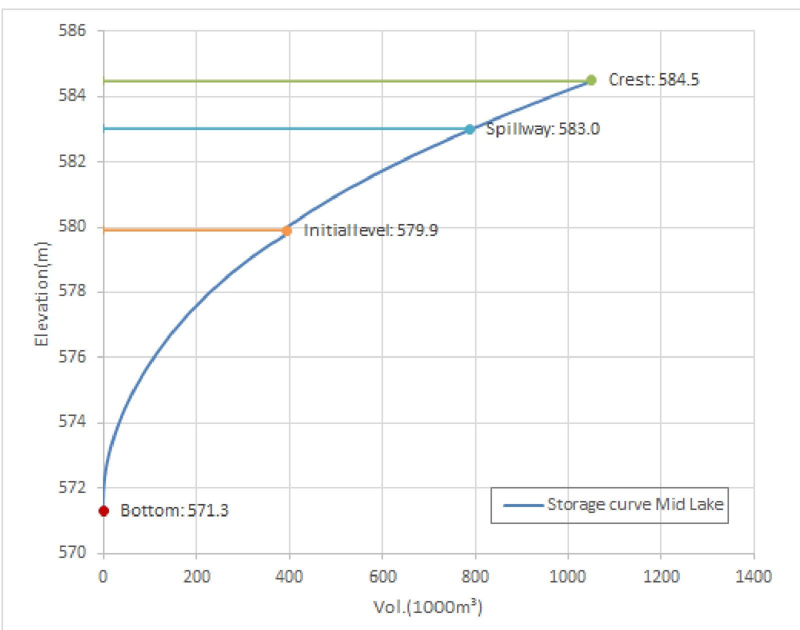


Figure 5-7: Capacity Curve for Mid Lake

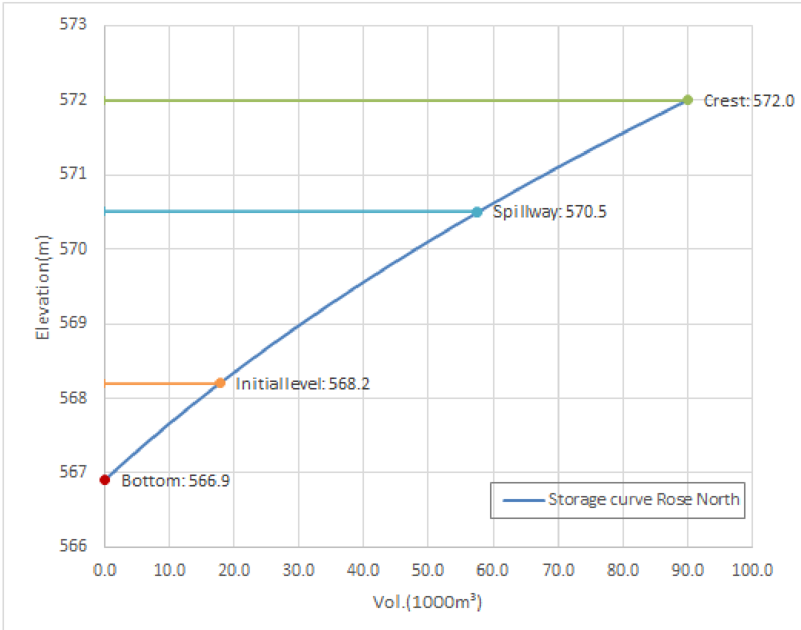


Figure 5-8: Capacity Curve for Rose North Overburden

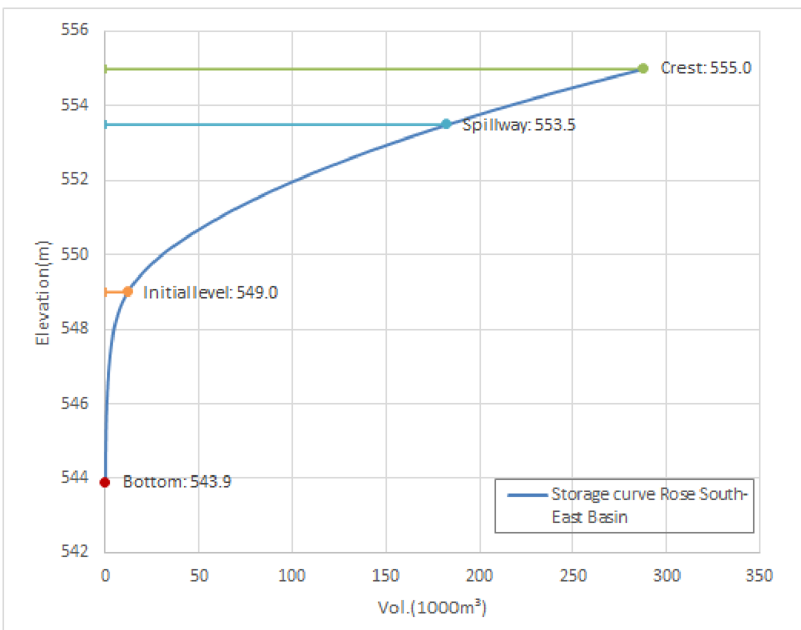


Figure 5-9: Capacity Curve for Rose South-EB

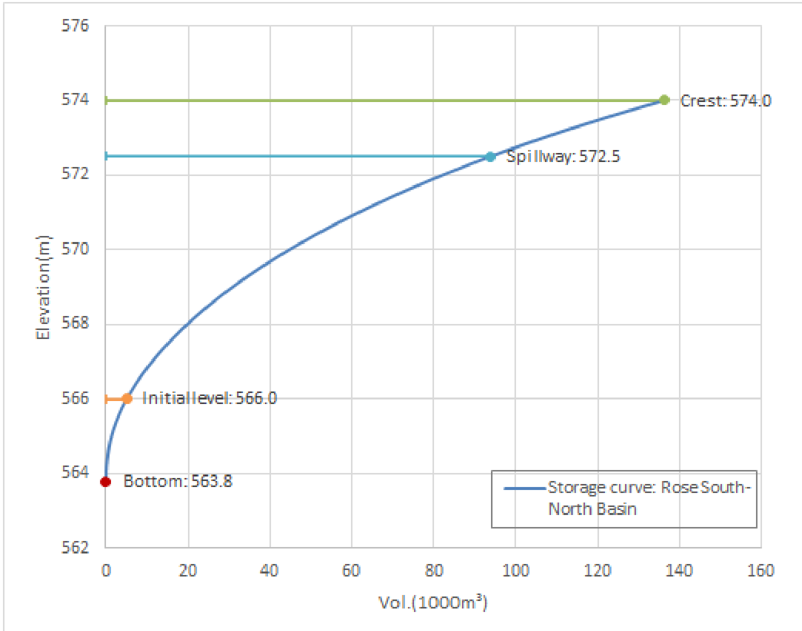


Figure 5-10: Capacity Curve for Rose South-NB

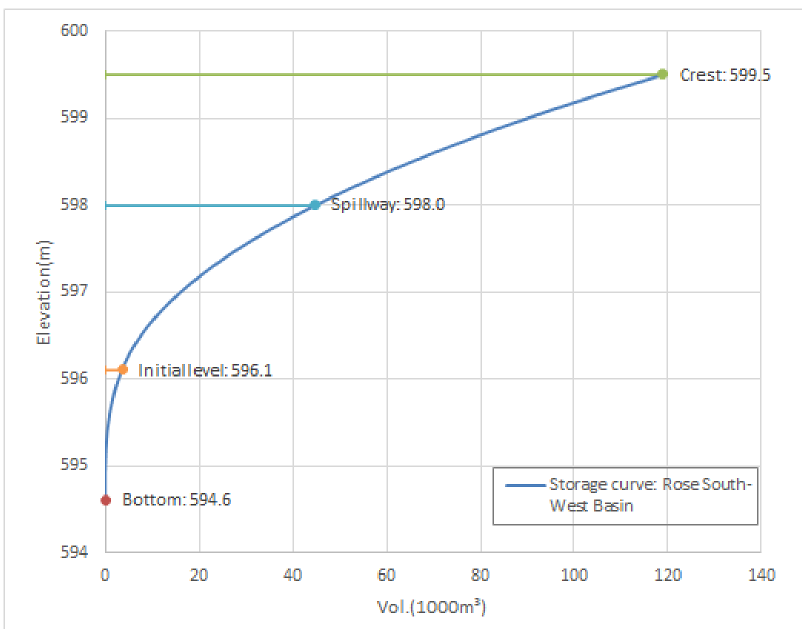


Figure 5-11: Capacity Curve for Rose South-WB

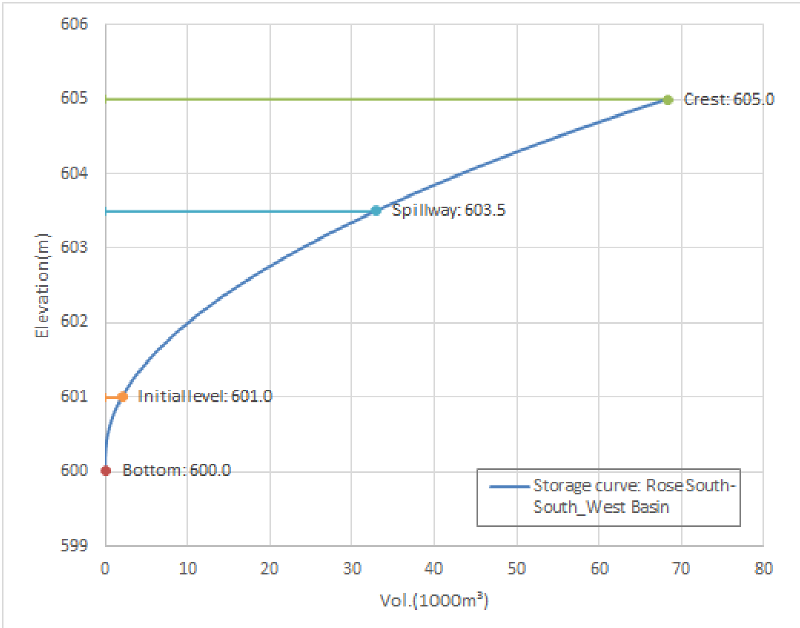


Figure 5-12: Capacity Curve for Rose South-SW

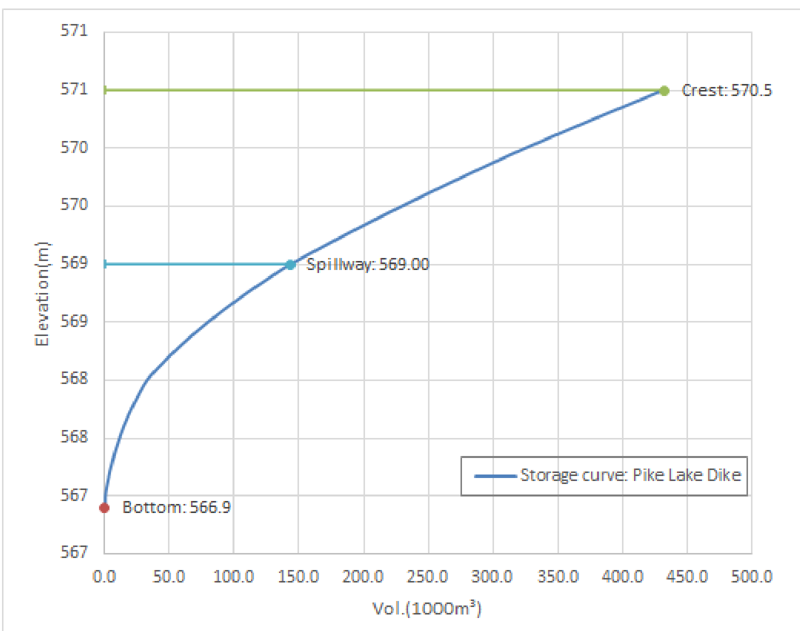


Figure 5-13: Capacity Curve for south of Pike Lake Dike

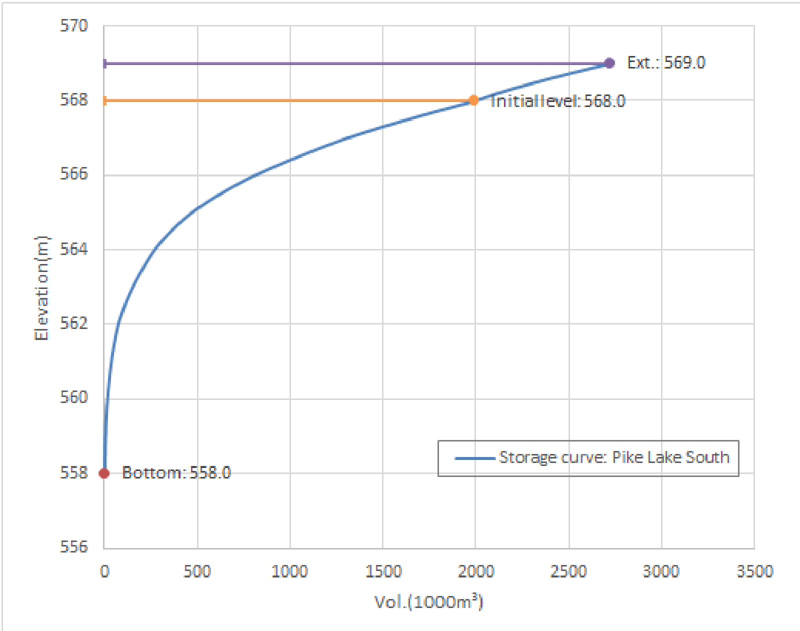


Figure 5-14: Capacity Curve for Pike Lake South to the north of the Dike

Table 5-2: Summary of Storage Levels

Storage	Bottom	Initial Level		Spillway		Crest	
	[m]	El. [m]	Vol. [m³]	El. [m]	Vol. [m³]	El. [m]	Vol.³ [m³]
Rose Pit (Sump 1)[1]	275.0	275.0	0	-	-	285.0	59,987
Rose Pit (Sump 2)[1]	385.0	385.0	0	-	-	395.0	170,153
End Lake	600.5	609.0	408,980	625.5	4,296,187	627.0	4,864,825
Mid Lake	571.3	579.9	395,122	583.0	788,622	584.5	1,051,339
Rose North	566.9	568.2	17,760	570.5	57,604	572.0	89,943
Rose South-EB	543.9	549.0	11,758	553.5	182,198	555.0	287,490
Rose South-NB	563.8	566.0	4965	572.5	93,706	574.0	136,152
Rose South-WB	594.6	596.1	3505	598.0	44,803	599.5	118,968
Rose South-SW	600.0	601.0	2054	603.5	32,910	605.0	68,281
Pike Lake Dike	566.9	566.9	0	569.0	143,648	570.5	432,283
Pike Lake South[2]	558.0	568.0	1,991,026	-	-	569.0	2,719,645

[1] The Basins in Rose Pit do not have a spillway since they are located inside the pit. The initial level of these ponds is the bottom level.
[2] The northern sector of Pike Lake South flows naturally northward.
[3] Theoretical volume up to the crest of the dike.

5.4 Flood Routing

5.4.1 End of Mine Life

The flood routing for the end of mine life for the Kami project was carried out using the PCSWMM model presented in the above sections and considering the spring 100 years and 30 days flood event (see **Section 2.2.8**) and the assumed pit dewatering rate of 40,000 m^3/d (see **Section 2.4**). The pumping capacity required during this event for every storage pond was calculated based on the PCSWMM model simulations. The water volume capacity of the storage ponds was also tested during the summer-fall 100 years and 24 hours flood event (100y-24h), considering the calculated pumping capacity.

Figure 5-15 shows the pumping flow direction from the different storage ponds. **Table 5-3** shows the key levels for the different storage ponds, the calculated pumping flow and the maximum water levels reached in the storage ponds considering the pumping system is active during the flood event. **Figure 5-16** shows the water depth and volume curves calculated for the different storage ponds considered in the PCSWMM model.

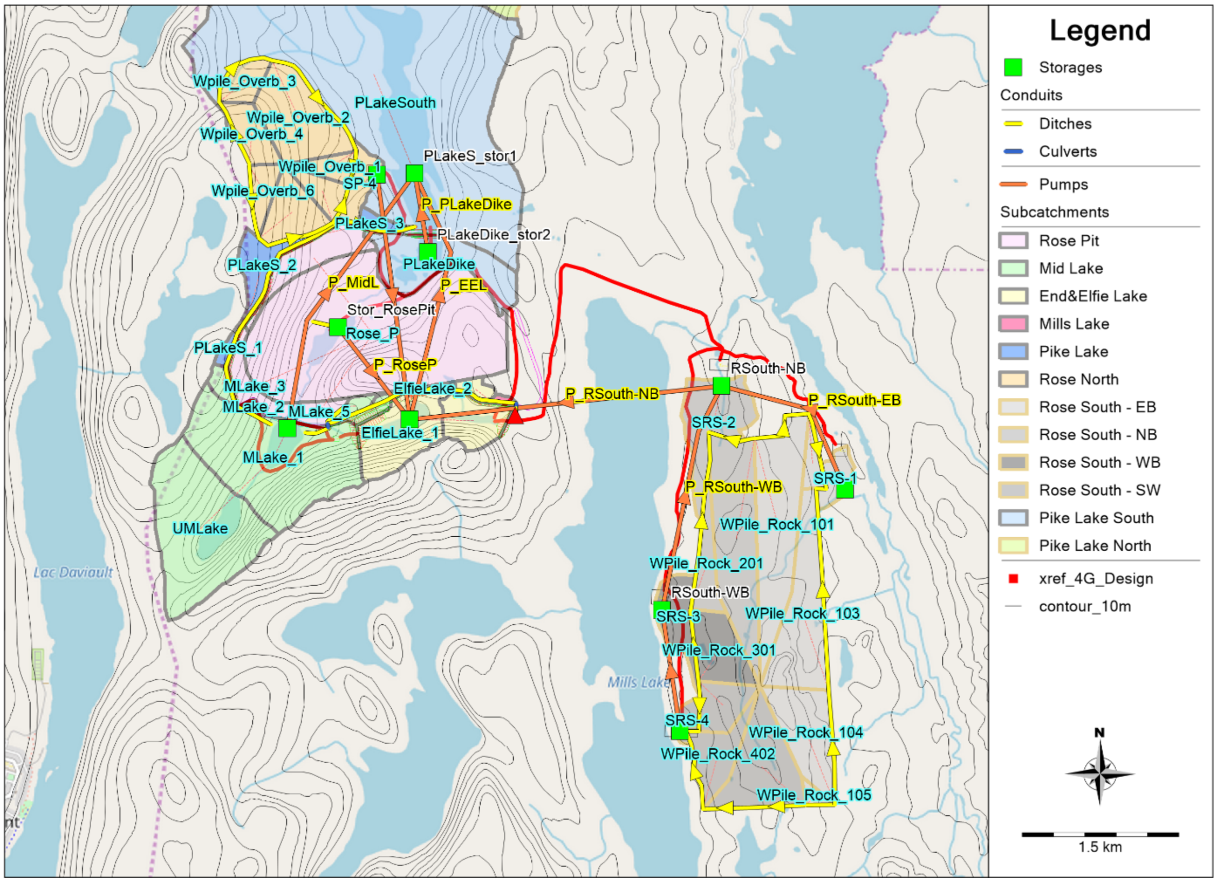
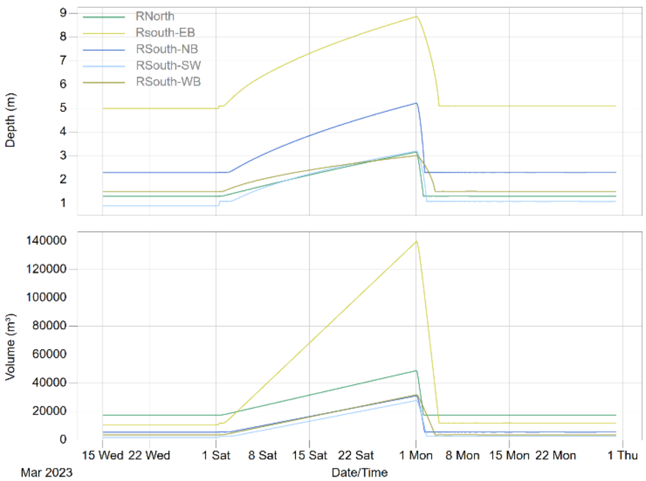


Figure 5-15: Pumping Flow Direction for PCSWMM Model

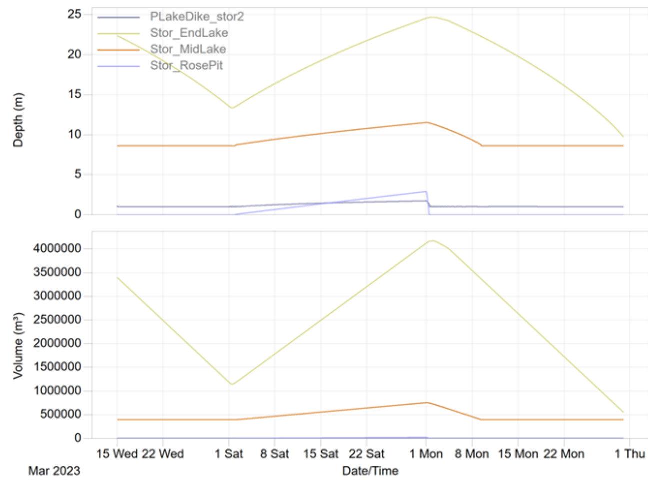
Table 5-3: Flood Routing Results for Water Storage Ponds from PCSWMM During the Spring 100 Years and 30 Days Flood Event

Water Storage	Bottom El.	Initial Water El.	Spillway Invert El.	Max. Vol. Capacity[1]	Pumping Flow	Max. Water El.[2]	Max. Vol. Stored[2]
	[m]	[m]	[m]	[m³]	[m³/h]	[m]	[m³]
Rose Pit[4]	67.0	67.0	75.0	68,670	4680	69.4[3]	19,490
End & Elfie Lake	600.5	622.9	625.5	4,296,187	7100	625.3	4,203,065
Mid Lake	571.3	579.9	583.0	788,621	1900	582.7	758,405
Rose North	566.9	568.2	570.5	57,604	1480	570.1[3]	48,750
Rose South – EB	543.9	549.0	553.5	182,198	1750	552.8[3]	139,720
Rose South – NB	563.8	566.0	572.5	93,706	4410	569.9[3]	42,840
Rose South – WB	594.6	596.1	598.0	44,803	1400	597.6[3]	31,100
Rose South – SW	600.0	601.0	603.5	32,910	936	603.2[3]	27,210
Pike Lake Dike	566.9	566.9	569.0	143,648	495	567.3[3]	4,160

[1] Maximum water storage capacity up to the spillway elevation. In the case of the Rose Pit, it represents the maximum water storage capacity of the internal basin.
[2] Considering the pumping system is active.
[3] Due to the relatively low storage capacity of the basin, a small variation in pumping flow significantly impacts water levels in the basin.
[4] To simplify the model, only one basin at the bottom of the pit was considered. The volume was similar to that of Sump 1. The proportion of runoff and infiltration managed by each sump will depend on water management at the operating mine and is not yet defined; therefore, detailed sumps analysis will be developed during the next engineering phase, when water management in the Rose Pit will be better defined.



Rose North and Rose South



End Lake, Mid Lake, Rose Pit and Pike Dike

Figure 5-16: Results of Flow Routing for Water Storage Ponds from PCSWMM During the Spring 100 Years and 30 Days Flood Event

It should be noted that since the details on pumping management in the pit are not yet defined, to simplify the model, the Rose Pit analysis in PCSWMM was carried out considering only one basin at the bottom of the pit. This basin was projected to simplify the model and to develop a pumping calculation for the models. The next design phase of the Kami project must define more precisely the Rose Pit storage system so that it can be properly represented in the model.

Table 5-4 shows the key levels for the different storage ponds, the calculated pumping flow and the maximum water levels reached in the storage ponds considering the pumping system is active during the summer-fall 100y-24h event. The results do not show overflows in the storage ponds, except at the Rose Pit where the water exceeds the level of the internal basin. However, it should be noted that the maximum volume stored after pumping in the pit is lower than the maximum capacity of the two sumps proposed for Rose Pit (60,000 m³ + 170,000 m³ = 230,000 m³). Since the model does not adequately represent the total storage capacity of the Rose Pit basin, it is considered acceptable that the internal basin could overflow if the total stored volume does not exceed the proposed storage capacity of 230,000 m³ for the pit. The next design phase of the Kami project must define more precisely the Rose Pit storage system based on the operation of the pit development so that it can be properly represented in the model.

Table 5-4: Flood Routing Results for Water Storage Ponds from PCSWMM During the Summer-Fall 100 years and 24 hours Flood Event

Water Storage	Bottom El.	Initial Water El.	Spillway Invert El.	Max. Vol. Capacity[1]	Pumping Flow	Max. Water El.[2]	Max. Vol. Stored[2]
	[m]	[m]	[m]	[m³]	[m³/h]	[m]	[m³]
Rose Pit[4]	67.0	67.0	75.0	68,670	4680	78.9[3]	154,630
End & Elfie Lake	600.5	609.0	625.5	4,296,187	7100	609.8	502,610
Mid Lake	571.3	579.9	583.0	788,621	1900	580.2	435,380
Rose North	566.9	568.2	570.5	57,604	1480	570.5	56,780
Rose South – EB	543.9	549.0	553.5	182,198	1750	550.4	41,260
Rose South – NB	563.8	566.0	572.5	93,706	4410	567.8	17,480
Rose South – WB	594.6	596.1	598.0	44,803	1400	596.8	11,580
Rose South – SW	600.0	601.0	603.5	32,910	936	602.2	12,510
Pike Lake Dike	566.9	566.9	569.0	143,648	495	567.6	12,920

[1] Maximum water storage capacity up to the spillway elevation. In the case of the Rose Pit, it represents the maximum water storage capacity of the internal basin.
[2] Considering the pumping system is active.
[3] Maximum water elevation shows overflow in the Rose Pit storage pond. This volume of excess water remains in the pit.
[4] To simplify the model, only one basin at the bottom of the pit was considered. The volume was similar to that of Sump 1. The proportion of runoff and infiltration managed by each sump will depend on water management at the operating mine and is not yet defined; therefore, detailed sumps analysis will be developed during the next engineering phase, when operation and water management in the Rose Pit will be better defined.

For all basins except the Rose Pit sump, it is possible to note that the spillway invert is not reached during this event, confirming that an operating water level between LOWL and spillway invert could be defined for the summer-fall period. Details on operation water levels will be developed in the next engineering phase.

5.4.2 First Five Years

The flood routing of the Kami mine for the first five years of operation was carried out using the PCSWMM software. The model considers the spring 100 years and 30 days flood event (see **Section 2.2.8**) and the assumed pit dewatering rate presented in **Table 2-17** (see **Section 2.4**). The pit surface area was estimated to be approximately 33% smaller. Accordingly, the surface area subtracted from the pit was added to the natural surrounding watershed that flows towards the pit. The Rose Pit pumping rate was calculated to pump the surface runoff and the dewatering rate.

The pumping rate from **Rose North,** End & Elfie Lake and Mid Lake are considered to be the same as the one presented in **Table 5-3**, for Rose South-North Basin the pumping flow was optimized. The pumping rate from the Rose South basins is set to zero for South-West and West basins, because it is considered that those basins will not have yet been built after five years of operation. The initial level at End & Elfie Lake was calculated considering 2.5 months of pumping accumulation from Rose Pit during winter.

Table 5-5 presents the key levels for the different storage ponds, the calculated pumping flow and the maximum water levels reached in the storage ponds considering the pumping system is active for Rose Pit and End & Elfie Lake. Figure 5-17 shows the water depth and volume curves calculated for the different storage ponds considered in the PCSWMM model.

It should be noted that since the details on pumping management in the pit are not yet defined, to simplify the model, the Rose Pit analysis in PCSWMM was carried out considering only one basin at the bottom of the pit. The next design phase of the Kami project must define more precisely the Rose Pit storage system so that it can be properly represented in the model.

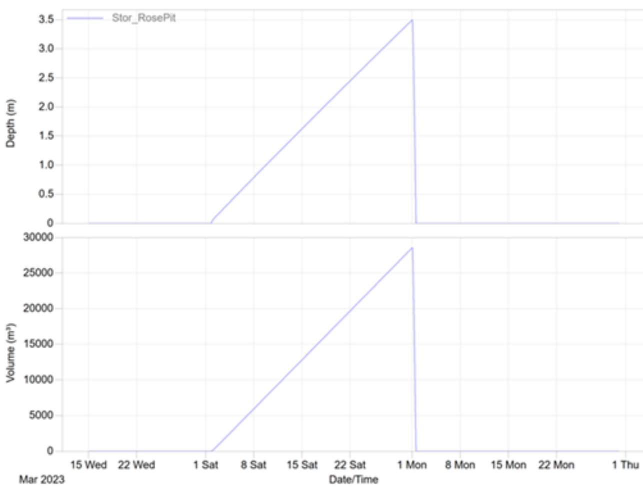
Table 5-5: Flood Routing Results for Water Storage Ponds from PCSWMM During the Spring 100 Years and 30 Days Flood Event for the First Five Years of Operation

Water Storage	Bottom El.	Initial Water El.	Spillway Invert El.	Max. Vol. Capacity[1]	Pumping Flow	Percentage of Pump Flow at Five Years[2]	Max. Water El.[2]	Max. Vol. Stored[2]
	[m]	[m]	[m]	[m³]	[m³/h]	[%]	[m]	[m³]
Rose Pit[3]					3600	77		
Rose South-NB	563.8	566.0	572.5	93,706	3000	68	570.7	55,160
End & Elfie Lake	600.5	616.8	625.5	4,296,187	7100	100	616.8	1,760,220

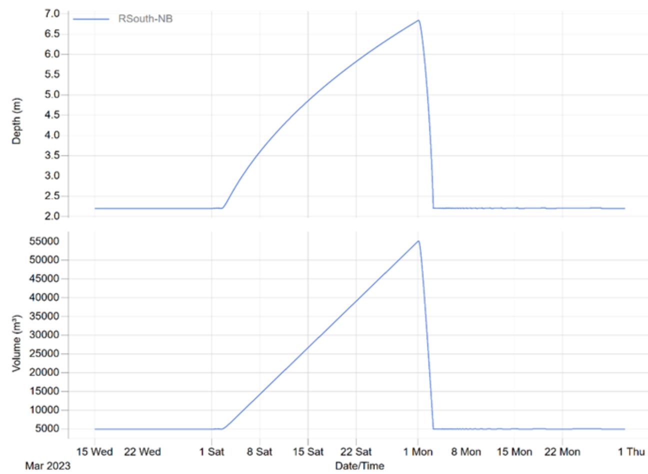
[1] Maximum water storage capacity up to the spillway elevation at the end of the life mine.
[2] Considering the pumping system is active.
[3] Only one basin at the bottom of the Rose Pit was considered. The capacity of the Rose Pit pump was calculated considering inflows from the runoff (0.88 m^3/s) and from the infiltration rate (0.21 m^3/s). The proportion of runoff and infiltration managed by each sump will depend on water management at the operating mine and is not yet defined; therefore, detailed sumps analysis will be developed during the next engineering phase, when operation and water management in the Rose Pit will be better defined.

Results for the first five years of operation showed that the estimated pumping capacity for Rose Pit is around 23% below the capacity needed at the end of the mine's life. This reduction in pumping is partially due to the reduction of the impervious surface area of the catchment area of the pit that reduces the amount of runoff water to be managed in the pit. This reduction is also due to the lower infiltration rate considered for the mine's state of development after five years.

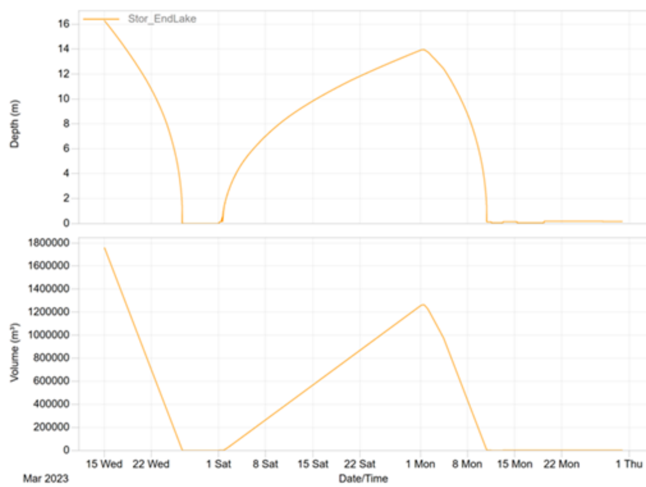
The water level reached in End & Elfie Lake after five years of operation is lower than the level reached at the end of the mine's life, if we consider the same pumping rate to the water treatment facility as the one calculated for the end of the mine life. This reduction of the water level is explained by the lower inflows coming from the Rose Pit and the Rose South Pond. This confirms that the Rose Pit Collection Pond can be built in phases.



Rose Pit



Rose South-North Basin



End & Elfie Lake

Figure 5-17: Results of Flow Routing for Water Storage Ponds from PCSWMM During the Spring 100 Years and 30 Days Flood Event for the First Five Years of Operation

5.5 Pumping Capacity to Drain Rose Lake

The pumping capacity required to drain the Rose Lake was calculated considering an approximation of the volume to be drained as well as a constant flow rate of water supply to the lake. The volume to be drained from the Rose Lake (60,964 m³) was obtained from the storage curve which includes the bathymetry. The lake being in a wetland, an additional volume was added to account for the water accumulation in the area surrounding the lake that could start flowing into it once pumping starts. This external surface area of approximately 71,914 m^2 in size, was defined by the analysis of site photographs and maps. The volume to be drained from the surrounding wetland (35,957 m³) was calculated considering an average water level of 0.50 m. **Figure 5-18** shows the Rose Lake bathymetry and the outer surface contributing to water storage.

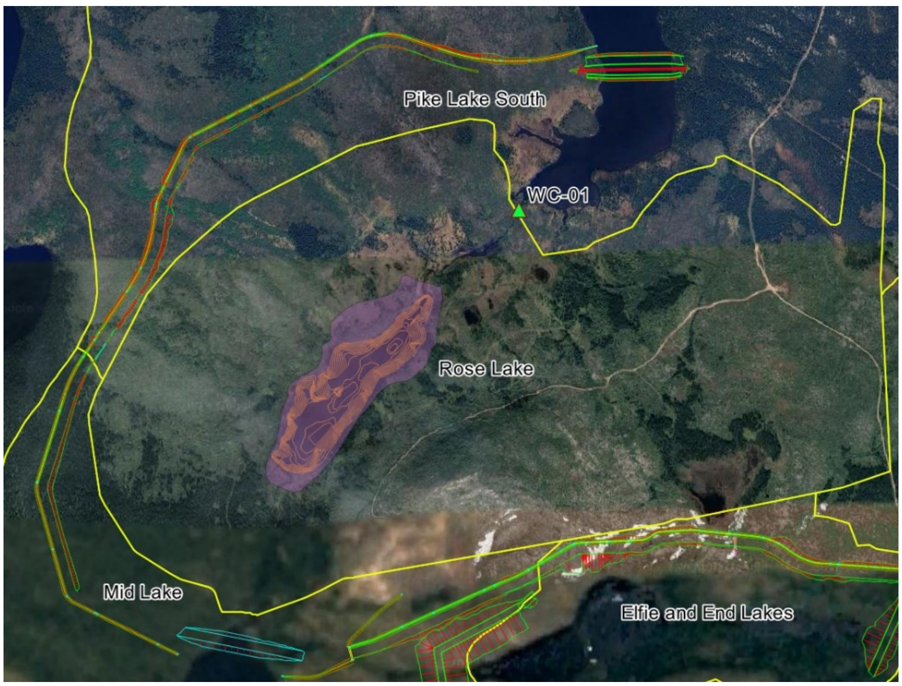


Figure 5-18: Areas of Rose Lake

The analysis considered the flow measured manually by WSP in the summer of 2023 (150 l/s) downstream of the Rose Lake at the location WC-01 (**Figure 5-18**) as a base reference to calculate the regular water supply to the lake. Considering that the dike downstream of Mid Lake will be built prior to emptying Rose Lake, the watershed located upstream of this dike should no longer contribute to Rose Lake's water supply. As a result, the watershed contributing to Rose Lake should be reduced to 48% of its original size. Consequently, a factor of 0.48 was applied to the flow presented above to take into account the reduction in the lake's catchment area.

Several pump flow capacities were tested to calculate the time required to drain Rose Lake. **Table 5-6** presents inflow calculations, tested pumping flow rates and the corresponding time required to drain Rose Lake. **Figure 5-19** shows the variation in emptying time as a function of the pumping rate considered. Based on these calculations, a pumping rate of 468 m³/h would drain Rose Lake in approximately 19 days. The pump on barge planned to empty Pike Lake on the south portion of Pike Dike having a capacity of 495 m³/h, it has been decided to use this pump for both applications. The emptying of Rose Lake will occur at the beginning of the project and the management of the water at the south of Pike Lake is planned a few years later. The infrastructure will be moved from one place to the other.

Table 5-6: Pumping Capacity to Drain Rose Lake

ID	Total Inflow (WSP)	Calculated Flow From Mid Lake	Remaining Flow to Rose Lake	Pumping Rate		Time	
	[l/s]	[l/s]	[l/s]	[m³/s]	[m³/h]	[h]	[d]
1	150	78.6	71.4	0.100	360.0	941.2	39.2
2	150	78.6	71.4	0.115	414.0	617.4	25.7
3	150	78.6	71.4	0.130	468.0	459.4	19.1
4	150	78.6	71.4	0.145	522.0	365.8	15.2
5	150	78.6	71.4	0.160	576.0	303.9	12.7
6	150	78.6	71.4	0.175	630.0	259.9	10.8
7	150	78.6	71.4	0.190	684.0	227.0	9.5
8	150	78.6	71.4	0.205	738.0	201.5	8.4
9	150	78.6	71.4	0.220	792.0	181.2	7.5

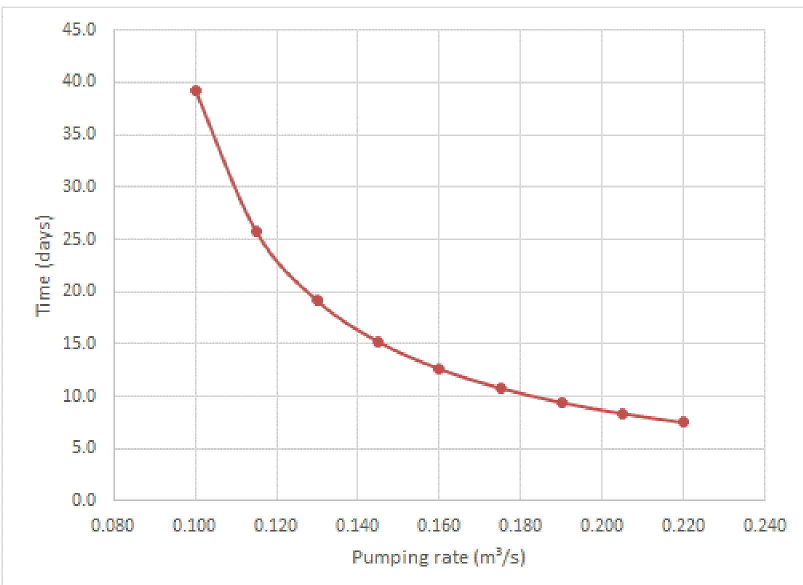


Figure 5-19: Emptying Time as a Function of the Pumping Rate

6.0 Water Management Infrastructure Hydrological Design

6.1 Collection and Diversion Ditches

The ditches and culverts, designed to collect runoff water, are located around the Rose Pit and surround the Rose North and the Rose South stockpiles, as illustrated in **Figure 5-1**. As shown in **Figure 6-1**, the conduit system is composed of trapezoidal ditches built with riprap cover and corrugated steel circular culverts.

Ditches and culverts are designed to adequately convey runoff water during the 24-hour, 100-year flood event, for the 2041–2070 horizon reported in **Table 2-8** and shown in the hydrograph in **Section 2.2.8**.

The general characteristics, flow, velocity and water depth of the ditches and culverts designed for the Kami project are presented in Appendix B. Hydraulic results from PCSWMM for these infrastructures are also shown in Appendix B. Additional tables in this appendix present detailed characteristics of the riprap layer required in the ditches for erosion protectionion. The riprap was calculated in accordance with the stormwater management guideline (MDDEEP, 2023). A summary of the ditches designed for the Kami project is presented in **Table 6-1**.

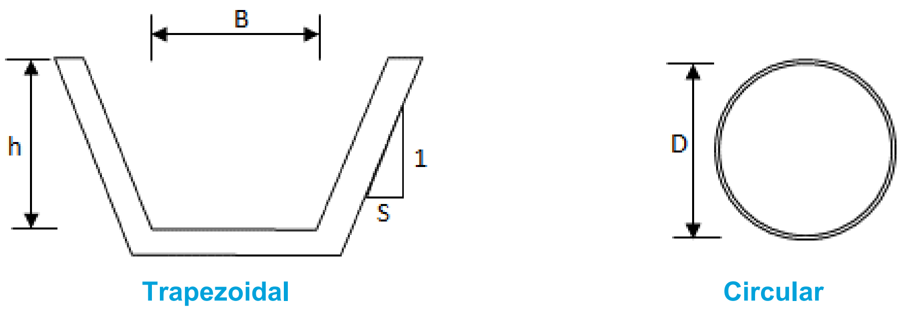


Figure 6-1: General Dimensions of the Ditches and Culverts

Table 6-1: Ditches Design Summary[1]

Location	#Ditch / PM	Selected Width (B) [m]	Side Slope (S) [1:S]	Minimum Depth (h) [m]	D_{50} (Selected)[2] [mm]	Layer Thickness (Selected) [mm]	Drawing
End & Elfie Lake	103, 104, 105 / all	1.0	2.0	1.0	200-300	500	0002 0003
Rose Pit	101 / PM10+000 – 11+200 101 / PM10+600 – 12+586	1.0	2.0	1.0	200-300	500	0002 0003
	101 / PM 11+200 – 11+600	2.0	2.0	1.0	200-300	500	0002 0003
	102 / all	1.0	2.0	1.0	200-300	500	0002 0003
Rose North Overburden Stockpile	201 / PM0 – 1395	1.5	2.0	1.0	200-300	500	0012 0015
	201 / PM1395 – 2886	2.5	2.0	1.5	200-300	500	0012 0015
	202 / PM0 – 1432	1.5	2.0	1.0	200-300	500	0012 0016
	202 / PM1432 - 1776	2.5	2.0	1.5	200-300	500	0012 0016
	203 / PM0 - 240	2.5	2.0	1.5	200-300	500	0012 0015
Rose South Waste Rock Stockpile	301 / PM 0 - 490	1.0	2.0	1.0	200-300	500	0017 0020
	301 / PM 490 - 1127	3.0	2.0	1.0	200-300	500	0017 0020
	302, 303, 304, 305 / all	1.0	2.0	1.0	200-300	500	0017 0020 0021

[1] All selected culverts in End & Elfie Lake area are 900 mm in diameter.

[2] The maximum water velocity allowed in ditches is 2.8 m/s for a rip rap rock diameter between 200 and 300 mm.

6.2 Spillways

A spillway structure was placed in the dike of each water storage to allow discharge when the water level exceeds the level of the weir. These structures were designed to pass the inflow design flood (IDF), routed through the reservoir. The IDF for sizing these hydraulic structures was estimated according to the classification of each dike, as presented in **Table 6-2**. The precipitation for events of 1:100 years (1/100) and 1:1000 years (1/1000) is presented in **Table 2-8** and the PMF event is shown in **Table 2-12**. The hydrographs of these events are presented in **Section 2.2.8**.

The designed spillways are trapezoidal structures built in rock rip rap, geomembrane, and gabions. The Pike Lake Dike spillway was the only one designed as a circular metal pipe. This pipe was designed so as not to affect the geometry of the dike as it was not possible to build a spillway that would cut through the cut-off wall frost protection. **Figure 6-2** illustrates the geometry of the projected spillways for the Kami project.

The spillways sidewalls were designed with 10H:1V slopes to allow the transit of pickups. However, the spillway sidewalls for the Mid Lake Dike were designed with 20H:1V slopes, since a more important volume of vehicles is expected. The general characteristics of the spillways, the water level and freeboard calculated with the PCSWMM model are presented in **Table 6-2**. **Figure 6-3** shows the PCSWMM results for the water level and the water flow through the spillway over time at each storage pond.

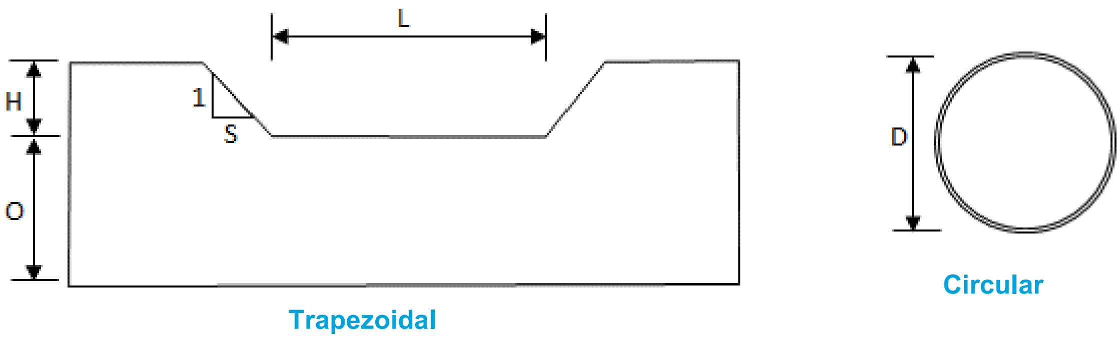
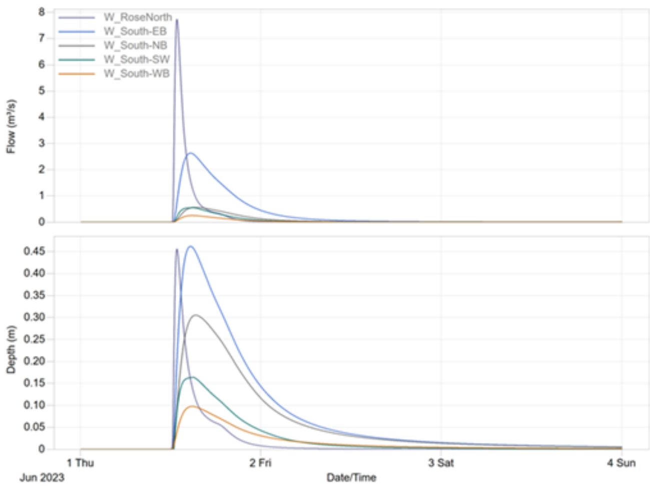


Figure 6-2: General Dimensions of the Spillways

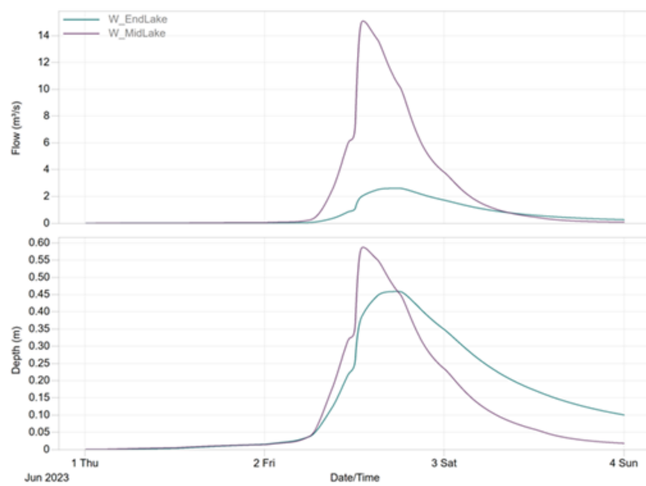
Table 6-2: Spillways Dimensions and Maximum Water Depth

Weir	Class[1]	IDF[1, 2]	Height (H-D[6]) [m]	Length (L) [m]	Side Slope (S) [m/m]	Spillway Invert El.[3] [m]	Max. Water Depth IDF[4] [m]	Max. Water El. IDF [m]	Freeboard [m]
End Lake[5]	Very high	PMF	1.5	5	10	625.5	0.35	625.85	1.16
MidLake	Very high	PMF	1.5	20	20	583.0	0.51	583.51	0.99
Rose North	Low	1/100	1.5	15	10	570.5	0.48	570.98	1.02
South-EB	Significant	1/1000	1.5	5	10	553.5	0.48	553.98	1.02
South-NB	Low	1/100	1.5	2	10	572.5	0.32	572.82	1.19
South-WB	Low	1/100	1.5	5	10	603.5	0.11	603.61	1.40
South-SW	Low	1/100	1.5	5	10	598.0	0.17	598.17	1.34
Pike Lake Dike[6]	Low	1/100	0.9	250	-	569.0	0.46	569.46	1.04

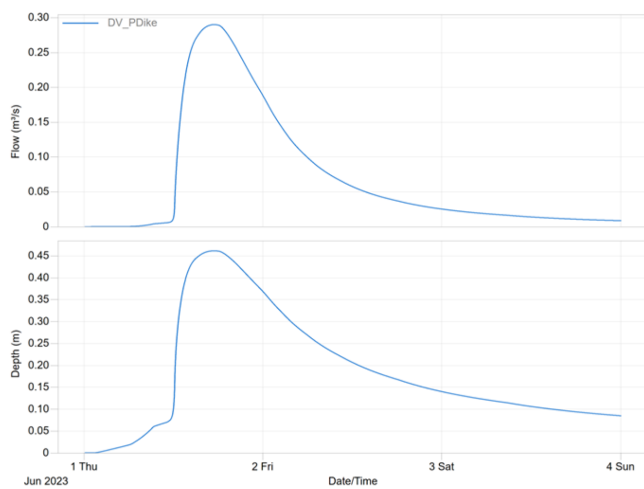
[1] Data from the document of the Design Criteria (SNCL, 2023).
[2] IDF: Inflow Design Flood.
[3] Elevation at spillway invert.
[4] Maximum water level in the weir for the IDF, according to PCSWMM results.
[5] Spillway is located on the dike of End Lake.
[6] H is the height of the spillway. The Spillway for Pike Lake Dike is a circular pipe with a diameter D.



Rose North and Rose South-EB/NB/SW/WB



End Lake and Mid Lake



Pike Lake Dike (circular)

Figure 6-3: Results of Spillways from PCSWMM

6.3 Pumps & Pipes

6.3.1 Hydrological Design End of Mine Life

As mentioned in **Section 5.4**, several pumping systems are required to manage the water in the Kami Mine site. The flood routing done using the software PCSWMM allowed for the calculation of the required capacity for each pumping system, and the results are illustrated in **Table 6-3**. **Figure 6-4** Illustrates the pumping block flow diagram.

The pipeline routes were selected according to the pit outlines, the access and haulage ramps and roads, the location of the mining and water management infrastructure. The drawing 692696-8000-40DD-0011 illustrates the pipeline routes.

Based on the pipeline routes and the required pumping capacities previously calculated, the pumps and pipes were calculated using the software PipeFlo.

Figure 6-4 : Pumping Block Flow Diagram - Rose Pit and Rose Stockpiles

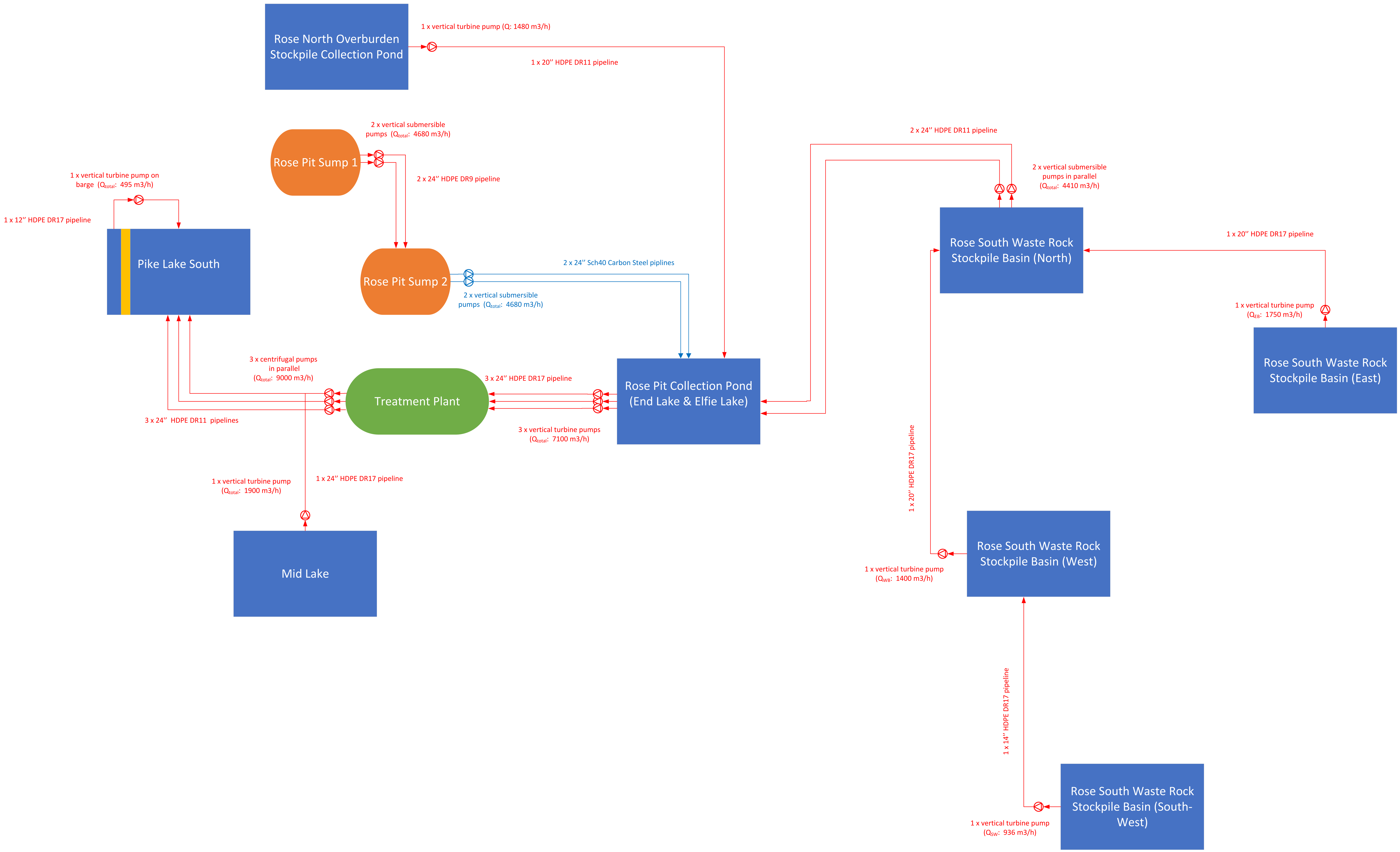


Table 6-3: Pumping and Piping Calculations

Pumping System	Water Storage	Pumping Destination	Type of Pump and Location	Total Flowrate [m3/h]	Number of Pipelines in Parallel [-]	TDH Required per Pipeline [m]	Total Pipeline Length [m]	Pipeline Diameter [in]	Selected Pipeline [-]
1	Rose Pit sump 1	Rose Pit sump 2	Vertical turbine pump on barge	4680	2	168	2610	24	HDPE DR 9
2	Rose Pit sump 2	Rose Pit Collection Pond	Vertical turbine pump on barge	4680	2	291	7160	24	Carbon steel sch40
3	Rose North	Rose Pit Collection Pond	Vertical turbine pump within the dike	1480	1	117	4240	20	HDPE DR 11
4	Downstream of Pike Lake Dike	Pike Lake South	Vertical turbine pump on barge	495	1	12	150	12	HDPE DR 17
5	Rose Pit Collection Pond	Treatment plant	Vertical turbine pump within the dike	7100	3	22	765	24	HDPE DR 17
6	Mid Lake	Treatment plant	Vertical turbine pump within the dike	1900	1	34	585	24	HDPE DR 17
7	Treatment plant	Pike Lake South	Horizontal centrifugal pump after the treatment plant	9000	3	124	14340	24	HDPE DR 11
8	Rose South-SW	Rose South-WB	Vertical turbine pump within the dike	936	1	21	825	14	HDPE DR 17
9	Rose South-WB	Rose South-NB	Vertical turbine pump within the dike	1400	1	7	1955	20	HDPE DR 17
10	Rose South-EB	Rose South-NB	Vertical turbine pump within the dike	1750	1	72	1400	20	HDPE DR 17
11	Rose South-NB	Rose Pit Collection Pond	Vertical turbine pump within the dike	4410	2	118	7620	24	HDPE DR 11

The pumps were selected based on the results presented in **Table 6-3** and in concert with the suppliers. The costs presented in the cost estimate were based on the budgetary quote provided by the supplier.

6.3.2 Hydrological Design First Five Years

As per the calculations presented in **Section 5.4.2**, the required pumping rates from some of the water storage during the first five years will be significantly lower than the ultimate pumping rates at the end of the LOM, which is due to the fact that the Rose Pit and the Rose South Stockpile will have a smaller footprint.

The following table summarizes the infrastructure (pumps and pipes) required to manage the water during the first five years based on the flowrates calculated in **Section 5.4.2**. It should be noted that said calculations were only done for year 5 in order to separate the costs before and after year 5 and thus facilitate the sequencing of the capital costs over the LOM. A more detailed phasing for the first years of operation can be done in the next engineering phase.

Table 6-4: Pumping and Piping Year 5

Pumping System	Water Storage	Pumping Destination	Total Flowrate First Five Years [m³/h]	Total Flowrate at the End of LOM [m³/h]	Infrastructure Required
1	Rose Pit sump 1	Rose Pit sump 2	3600	4680	50% of the pumping and piping required at the end of LOM
2	Rose Pit sump 2	Rose Pit Collection Pond	3600	4680	100% of the pumping and piping required at the end of LOM
3	Rose North	Rose Pit Collection Pond	1480	1480	100% of the pumping and piping required at the end of LOM
4	Downstream of Pike Lake dike	Pike Lake South	495	495	100% of the pumping and piping required at the end of LOM
5	Rose Pit Collection Pond	Treatment plant	7100	7100	100% of the pumping and piping required at the end of LOM
6	Mid Lake	Treatment plant	1900	1900	100% of the pumping and piping required at the end of LOM
7	Treatment plant	Pike Lake South	9000	9000	100% of the pumping and piping required at the end of LOM
8	Rose South-SW	Rose South-WB	0	936	No pumping or piping required before year 5
9	Rose South-WB	Rose South-NB	0	1400	No pumping or piping required before year 5
10	Rose South-EB	Rose South-NB	1750	1750	100% of the pumping and piping required at the end of LOM
11	Rose South-NB	Rose Pit Collection Pond	3000	4410	100% of the pumping and piping required at the end of LOM

6.3.3 Pipeline Bedding and Access Road

The pipelines required for water management will be placed along the roads already planned at the site. Extra road width will have to be planned in order to maintain sufficient space for the pipelines. The extra width is determined by the number of pipelines and their diameters. The extra road widths needed for pipeline routing are presented in **Table 6-5**.

Table 6-5: Extra Widths for The Pipeline Access Roads

Road location	Extra Road Width (m)
Rose North Collection Pond to the east of the pit	1.3
Rose South – North Basin to the main road	3.1
Rose South – East Basin to Rose South NB	1.3
Rose South – West Basin to Rose South NB	1.3
Rose South – South-West Basin to Rose South NB	1.3
Around Mid Lake and west of the Rose Pit	3.1
Section of road leading to End Lake Dam	5.0

6.4 Water Treatment

The dewatering of the Rose Pit will generate an effluent that will be pumped into the Rose Pit Collection Pond along with the runoff water from the overburden and the waste rock stockpiles. A portion of the TSS will be removed in the collection pond and the water will be pumped to the treatment plant afterwards.

As mentioned in **Section 2.3**, the Rose Pit is not expected to generate any adverse environmental effects associated with Acid Rock Drainage (ARD) and Metal Leaching (ML). Therefore, the only contaminants of potential concern would be the ammonia (NH_4^+) and nitrates (NO_3^-) stemming from the use of explosives in the blasting process and the TSS carried by the runoff water. The aim of this section is to present the design criteria for these contaminants and confirm whether or not their treatment is required.

6.4.1 Discharge Criteria

The effluent discharged from the treatment plant to the environment shall comply with the following regulations:

- Newfoundland and Labrador Environmental Control Water and Sewage Regulations (NL Reg. 65/03).
- Metal and Diamond Mining Effluent regulations (MDMER) (SOR/2002-222).
- Wastewater Systems Effluent Regulations (SOR/2012-139).

The following table presents the parameters and their respective discharge criteria according to the aforementioned regulations:

Table 6-6: Water Quality Discharge Criteria

Parameter	Maximum Concentration in mg/l (unless indicated otherwise)				
	NL Reg. 65/03[1]	SOR/2002-222[2]	SOR/2002-222[3]	SOR/2002-222[4]	SOR/2012-139
Temperature (◦C)	32	-	-	-	-
pH	5.5-9	-	-	-	-
B.O.D.	20	-	-	-	25
Coliform – faecal	1000/100 ml	-	-	-	-
Coliform – total	5000/100 ml	-	-	-	-
Solids (dissolved)	1000	-	-	-	-
Solids (suspended)	30	15	22.5	30	25
Oils (ether extract)	15	-	-	-	-
Floating debris, oils, and grease	None to be visible	-	-	-	-
Arsenic	0.5	0.1	0.15	0.2	-
Barium	5	-	-	-	-
Boron	5	-	-	-	-
Cadmium	0.05	-	-	-	-
Chlorine	1	-	-	-	0.02
Chromium (hexavalent)	0.05	-	-	-	-
Chromium (trivalent)	1	-	-	-	-
Copper	0.3	0.1	0.15	0.2	-
Cyanide	0.025	0.5	0.75	1	-
Iron (total)	10	-	-	-	-

Parameter	Maximum Concentration in mg/l (unless indicated otherwise)				
	NL Reg. 65/03[1]	SOR/2002-222[2]	SOR/2002-222[3]	SOR/2002-222[4]	SOR/2012-139
Lead	0.2	0.08	0.12	0.16	-
Mercury	0.005	-	-	-	-
Nickel	0.5	0.25	0.38	0.5	-
Nitrates	10	-	-	-	-
Nitrogen (ammoniacal)	2	-	-	-	-
Unionized ammonia[5]	-	0.5	-	1	1.25
Phenol	0.1	-	-	-	-
Phosphates (total as $P_2 O_5$)	1	-	-	-	-
Phosphorus (elementary)	0.0005	-	-	-	-
Radium 226[6]	-	0.37	0.74	1.11	-
Selenium	0.01	-	-	-	-
Strontium 90[6]	-	-	-	-	-
Sulfides	0.5	-	-	-	-
Silver	0.05	-	-	-	-
Zinc	0.5	0.4	0.6	0.8	-

[1] According to section 6, schedule A and schedule C of NL Reg. 65/03.
[2] Maximum authorized monthly mean concentration according to schedule 4 of SOR/2002-222.
[3] Maximum authorized concentration in a composite sample according to schedule 4 of SOR/2002-222.
[4] Maximum authorized concentration in a grab sample according to schedule 4 of SOR/2002-222.
[5] Unionized ammonia is expressed as nitrogen (N).
[6] Expressed in Bq/L.

It is worth mentioning that the discharged effluent shall also comply with Canadian Water Quality Guidelines (CWQG) for the protection of aquatic life.

6.4.2 Ammonia and Nitrates Design Criteria

The design criteria for ammonia (NH_4^+) and nitrates (NO_3^-) were established using a mass balance around the Rose Pit, the overburden stockpile, and the waste rock stockpile considering the following:

- Three (3) flowrate scenarios were considered:
  - Average: based on the average flowrate for an average year.
  - Maximum: based on the maximum flowrate for an average year.
  - Flood: based on the Environmental Design Flood (EDF).
- The water that will be pumped from the Rose Pit is assumed to be similar, in terms quality, to the water pumped from FBW (Fosse Bloom West) and FP (Fosse Pignac), at Bloom Lake.
- The water stemming from the waste rock stockpile is considered to be similar, in terms of quality, to water from the waste rock stockpiles at Bloom Lake (Principal, Triangle, Dyno).
- The water from overburden stockpile is considered to not contain any ammonia or nitrates.
- The mass balance was based on the average concentrations found at Bloom Lake between October 2020 and May 2023. This was confirmed by a statistical analysis done on the data from Bloom Lake which showed that most of the concentrations are located around or below the average. That is a conservative approach given the fact that, according to Champion, the quantity of explosives that will be used at Kami Mine will be significantly less than that of Bloom Lake.

Based on previous assumptions the design criteria for NH_4^+ and NO_3^- was calculated for the three (3) scenarios and is presented in the following table:

Table 6-7: Design Criteria for NH_4^+ and NO_3^- Concentrations

	Treatment Plant Design Criteria (Average Flowrate)	Treatment Plant Design Criteria (Maximum Flowrate)	Treatment Plant Design Criteria (EDF)	Discharge Criteria (mg N/l)
Flowrate (m3/h)	3099	5325	7100	-
NH4+, NH3 (mg N/l)	3.8	4.7	2.6	2
NH4+, NH3 (Kg N/d)	283	598	451	-
NO3-, NO2- (mg N/l)	14.2	13.8	12.1	10
NO3-, NO2- (Kg N/d)	1053	1760	2059	-

According to the table above, and for the three (3) scenarios, the concentrations of NH_4^+ and NO_3^- are only slightly above the discharge criteria.

It is worth noting that the type of explosives, their application rate and the conditions at the site were not taken into consideration in establishing the design criteria NH_4^+ and NO_3^-. These parameters will be taken into consideration in a water quality model that is being developed (by others). The results of this model will be used for the subsequent engineering phases.

Considering that the quantity of explosives that will be used at Kami Mine will be significantly less than that of Bloom Lake and since the calculated concentrations of NH_4^+ and NO_3^- are only slightly higher than the discharge criteria, there is a strong likelihood that there will be no need for the treatment of nitrogen species. Therefore, it has been decided in concert with Champion that for the present study, the treatment plant will not be designed to treat the nitrogen species.

6.4.3 Total suspended solids (TSS) design criteria

Following the same approach for NH_4^+ and NO_3^-, the design criteria for the TSS were established using a mass balance for the Kami Mine site considering the following assumptions:

- Three (3) flowrate scenarios were considered:
  - Average: based on the average flowrate for an average year.
  - Maximum: based on the maximum flowrate for an average year.
  - Flood: based on the Environmental Design Flood (EDF).
- The water that will be pumped from the Rose Pit is assumed to be similar, in terms of TSS, to the water pumped from FWB and FP, at Bloom Lake.
- The water stemming from the waste rock stockpile is considered to be similar, in terms of TSS, to water from the waste rock stockpiles at Bloom Lake (Principale, Triangle, Dyno).
- Contrary to NH_4^+ and NO_3^-, both the effluents from the overburden stockpile and the waste rock stockpile at Kami Mine are assumed to be of similar quality, in terms of TSS, to the water from the waste rock stockpiles at Bloom Lake (Principale, Triangle, Dyno).

The mass balance was based on the average TSS concentrations found at Bloom Lake between October 2020 and May 2023. This was confirmed by a statistical analysis done on the data from Bloom Lake which showed that most of the concentrations are located around or below the average. The following table presents the TSS design criteria for the three (3) scenarios:

Table 6-8: Design criteria for the TSS

	Treatment Plant Design Criteria (average flowrate)	Treatment Plant Design Criteria (maximum flowrate)	Treatment Plant Design Criteria (EDF)	Discharge Criteria (mg/l)
Flowrate (m3/h)	3099	5325	7100	-
TSS (mg/l)	117	135	93	15
TSS (Kg /d)	8685	17 317	15 785	-

According to the table above, the worst-case scenario corresponds to the maximum flowrate scenario with a TSS concentration of 135 mg/l. In contrast to NH_4^+ and NO_3^-, the treatment of the TSS is required before discharging the water to Pike Lake South. Given the fact that before going to the treatment plant the water will undergo a sedimentation step in the Rose Pit Collection Pond that has a capacity of over 4 Mm3, it will be safe to assume that the treatment plant should be designed for an average TSS of 70 mg/l.

6.4.4 Treatment Period and Capacity

Water from the Rose Pit will be continuously pumped to the collection pond where a portion of the TSS will be removed. However, during the winter months no discharge to the environment shall happen and the water will be stored in the collection pond. Thus, the water treatment plant shall operate from March through mid-

December. It should be noted that the flood routing and all the calculations presented in this report are based on the fact that the treatment plant will be shut down for 2.5 months during the winter.

The water treatment plant shall have the capacity to treat the maximum flowrate pumped from the collection pond during the life of the mine (LOM). This flowrate corresponds to the Environmental Design Flood (EDF) which is 7100 m^3/h. Based on the flood routing calculations done for year 5 (**Section 5.4.2**), the required pumping rate from the Rose Pit Collection Pond at year 5 is 7100 m^3/h, which is equal to the pumping rate required at the end of the LOM. Therefore, by year 5 the treatment plant should be at its ultimate capacity. It should be noted that since information to calculate the pumping rate required from year 0 to year 5 is not currently available, the installation of 75% of the treatment capacity before the year 0 and of the remaining 25% at year 1 was selected as a conservative approach.

6.4.5 Treatment Process

According to the NH_4^+, NO_3^- and TSS mass balance, a treatment plant is necessary to be able to comply with the discharge criteria presented earlier. In this case, the treatment process shall include the following steps:

- A TSS treatment step to remove the suspended solids remaining in the water after the collection pond in order to comply with the discharge criteria, this could be achieved via high-rate clarification.
- A sludge drying step for the sludge stemming from the TSS removal step. This step is necessary to reduce the volume of the sludge produced and thus facilitate its transport and elimination.

A preliminary selection of the treatment process was done in concert with the technology suppliers in order to include the treatment portion in the cost estimate, which includes a high-rate clarification step followed by a sludge drying step along with all the equipment required to operate the treatment plant.

7.0 Annual Water Balance

7.1 Annual Water Balance Tables

A water balance for a typical year was developed for the different water storage of the Kami project. The project site was divided into 10 watersheds, however additional water balances were also developed, one for the natural basin of Pike Lake downstream of Rose Pit, before construction, and one for the treatment plant to estimate the volume of water that will be treated each year and on a monthly basis. To perform these analyses, it was necessary to use information from each basin, such as the runoff coefficient and area, which are shown in **Table 7-1**.

Hydrological inputs data were essential to carry out the water balance analyses. These inputs included precipitation, temperature, snowfall, rainfall, evaporation, and evapotranspiration. The monthly values of these parameters for the Kami project are presented in **Section 2.2**. Another input considered was the flow pumped from the storage ponds to control the water level, whose values are presented in **Table 5-3**.

Hydrological data were also needed to calculate other key parameters such as snowmelt and infiltration. The temperature data are used for the calculation of the snowmelt fraction (SMF), which was needed to obtain the monthly snowmelt. SMF is a coefficient which depends on temperature and was calculated according to the methodology proposed by USGS (McCabe & Markstrom, 2007).

Table 7-1: Runoff Coefficients and Watershed Areas – End of Mine Life

Description	Runoff Coefficient		Rose Pit	Rose North	Rose South EB[3]	Rose South NB[3]	Rose South WB[3]	Rose South SW[3]	End & Elfie Lake	Mid Lake	Pike Lake Dike	Pike Lake S2[1]	Pike Lake South[2]
	Winter	Summer	Area (ha)										
Water surface	1.0	1.00	0.0	2.0	1.2	0.5	0.8	0.6	11.5	19.2	10.3	79.0	124.0
Forest	1.0	0.19	29.2	0.0	0.0	0.0	0.0	0.0	65.3	243.4	37.6	499.0	1324
Road	1.0	0.50	182.1	42.3	7.5	3.6	1.2	3.7	3.1	4.2	7.1	0.0	0.0
Pit walls	1.0	0.90	105.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Overburden stockpile	1.0	0.30	0.0	121.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste rock stockpile	1.0	0.25	0.0	0.0	179.3	136.9	55.1	88.7	0.0	0.0	0.0	0.0	0.0
Total			**317**	**166**	**188**	**141**	**57**	**93**	**80**	**267**	**55**	**578**	**1,448**

[1] Pike Lake South to north of the Pike Lake Dike.
[2] Natural basin before construction.
[3] Some areas differ slightly from the information shown on **Figure 4-4** because the last layout of Rose South Waste Rock Stockpile was not integrated in the annual water balance calculation at this point. Adjustments to surface areas in this sector will be made in conjunction with the integration of the latest topographic information available from new 2023 Lidar as part of the next engineering phase

The annual water balances performed for the Rose Pit, Rose Pit Collection Pond, Pike Lake Dike, and the Treatment Plant of the Kami project are presented from **Table 7-2** to **Table 7-5**. The annual water balances for the other basins are presented in Appendix C.

Additional annual water balances were executed for conditions of dry and wet years. Monthly precipitations for a 100-year return period in dry and wet conditions were used to perform these analyses. The data used for calculations are presented in **Table 2-5** and the annual water balances for wet and dry years can be consulted in Appendix D and Appendix E.

Table 7-2: Annual Water Balance for Rose Pit

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	Ground-Water Inflow[1]	Total Monthly Intake	Monthly Pumped	% of Pump Use (max. 4680 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	(%)
January	53.2	0.8	0.0	0.0	0.0	0.0	0.8	0.8	1,240,000	1,242,664	1,242,664	35.7%
February	40.1	1.3	0.0	0.0	0.0	0.0	1.3	1.3	1,120,000	1,124,033	1,124,033	35.7%
March	51.8	3.2	0.0	0.0	0.0	0.0	3.2	3.2	1,240,000	1,250,117	1,250,117	35.9%
April	42.9	11.4	125.9	0.0	0.0	0.0	137.4	137.4	1,200,000	1,635,436	1,635,436	48.5%
May	16.7	42.1	198.7	42.9	37.2	82.6	197.9	121.0	1,240,000	1,624,909	1,624,909	46.7%
June	1.9	83.5	1.9	85.4	85.4	0.0	0.0	0.0	1,200,000	1,200,000	1,200,000	35.6%
July	0.0	111.9	0.0	111.9	111.9	0.0	0.0	0.0	1,240,000	1,240,000	1,240,000	35.6%
August	0.0	102.9	0.0	97.3	97.3	2.3	5.6	3.3	1,240,000	1,250,523	1,250,523	35.9%
September	4.8	89.1	4.8	54.0	39.6	22.0	39.9	32.2	1,200,000	1,302,626	1,302,626	38.7%
October	37.7	41.1	28.8	2.6	0.3	28.2	67.2	41.3	1,240,000	1,371,586	1,371,586	39.4%
November	61.6	15.5	11.8	0.0	0.0	0.0	27.3	27.3	1,200,000	1,286,522	1,286,522	38.2%
December	61.1	3.5	0.0	0.0	0.0	0.0	3.5	3.5	1,240,000	1,251,075	1,251,075	35.9%
Annual	**372**	**506**	**372**	**394**	**372**	**135**	**484**	**371**	**14,600,000**	**15,779,492**	**15,779,492**	

[1] Subsurface water that flows beneath the land surface towards the excavated Rose Pit.

Table 7-3: Annual Water Balance for Rose Pit Collection Pond (End Lake & Elfie Lake)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input[1]	Monthly Intake	Monthly Pumped	% of Pump Use (max. 7100 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	(%)
January	53.2	0.8	0.0	0.0	0.0	0.0	0.8	0.8	1,242,664	1,243,336	0	0.0%
February	40.1	1.3	0.0	0.0	0.0	0.0	1.3	1.3	1,124,033	1,125,051	0	0.0%
March	51.8	3.2	0.0	0.0	0.0	0.0	3.2	3.2	1,482,909	1,485,463	1,980,900	75.0%
April	42.9	11.4	125.9	0.0	0.0	0.0	137.4	137.4	2,521,419	2,631,308	3,834,000	75.0%
May	16.7	42.1	198.7	42.9	37.2	162.0	197.9	41.6	2,002,607	2,053,876	2,724,134	51.6%
June	1.9	83.5	1.9	85.4	85.4	0.0	0.0	0.0	1,200,000	1,200,000	1,200,000	23.5%
July	0.0	111.9	0.0	111.9	111.9	0.0	0.0	0.0	1,240,000	1,240,000	1,240,000	23.5%
August	0.0	102.9	0.0	97.3	97.3	4.4	5.6	1.1	1,260,857	1,262,277	1,262,277	23.9%
September	4.8	89.1	4.8	54.0	39.6	43.2	39.9	11.1	1,402,685	1,414,870	1,414,870	27.7%
October	37.7	41.1	28.8	2.6	0.3	55.4	67.2	14.2	1,500,688	1,518,168	1,518,168	28.7%
November	61.6	15.5	11.8	0.0	0.0	0.0	27.3	27.3	1,286,522	1,308,357	1,308,357	25.6%
December	61.1	3.5	0.0	0.0	0.0	0.0	3.5	3.5	1,251,075	1,253,870	1,253,870	23.7%
Annual	**372**	**506**	**372**	**394**	**372**	**265**	**484**	**241**	**17,515,459**	**17,736,576**	**17,736,576**	

[1] Water flow coming from pumping of the Rose Pit, Rose North, Rose South-EB, Rose South-NB, Rose South-WB, and Rose South-SW.

Table 7-4: Annual Water Balance for Pike Lake Dike

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Input	Monthly Intake	Monthly Pumped	% of Pump Use (max. 495 m^3/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m^3)	(m^3)	(m^3)	(%)
January	53.2	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	463	0	0.0%
February	40.1	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	700	0	0.0%
March	51.8	3.2	0.0	0.0	0.0	0.0	3.2	3.2	0	1,757	19,871	10.8%
April	42.9	11.4	125.9	0.0	0.0	0.0	137.4	137.4	0	75,625	75,625	21.2%
May	16.7	42.1	198.7	42.9	37.2	154.8	197.9	48.7	0	42,238	42,238	11.5%
June	1.9	83.5	1.9	85.4	85.4	0.0	0.0	0.0	0	0	0	0.0%
July	0.0	111.9	0.0	111.9	111.9	0.0	0.0	0.0	0	0	0	0.0%
August	0.0	102.9	0.0	97.3	97.3	4.2	5.6	1.3	0	1,171	1,171	0.3%
September	4.8	89.1	4.8	54.0	39.6	41.3	39.9	13.0	0	9,931	9,931	2.8%
October	37.7	41.1	28.8	2.6	0.3	52.9	67.2	16.7	0	14,398	14,398	3.9%
November	61.6	15.5	11.8	0.0	0.0	0.0	27.3	27.3	0	15,027	0	0.0%
December	61.1	3.5	0.0	0.0	0.0	0.0	3.5	3.5	0	1,923	0	0.0%
Annual	**372**	**506**	**372**	**394**	**372**	**253**	**484**	**253**	**0**	**163,234**	**163,234**	

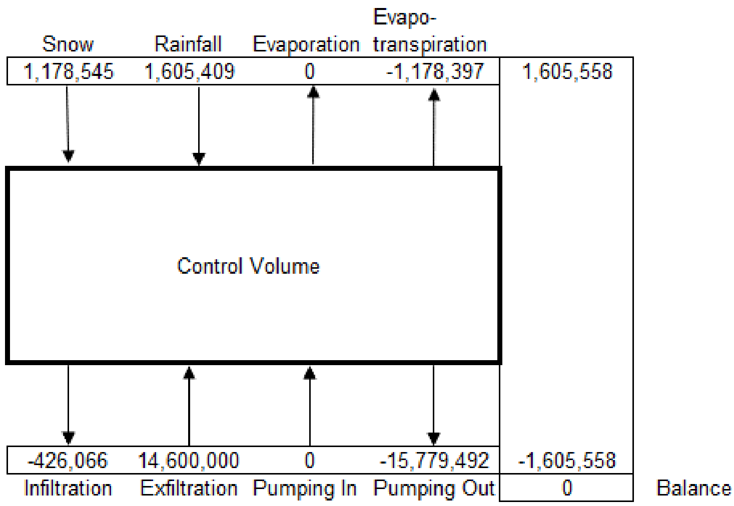
Table 7-5: Annual Water Balance for the Treatment Plant

Month	Monthly Intake[1]	Average Pumping Capacity		% of Pump Use (7100 m³/h)
	(m³)	(m³/day)	(m³/h)	(%)
January	0	0	0	0.0%
February	0	0	0	0.0%
March	1,980,900	127,800	5,325	75.0%
April	3,834,000	127,800	5,325	75.0%
May	2,724,134	87,875	3,661	51.6%
June	1,200,000	40,000	1,667	23.5%
July	1,240,000	40,000	1,667	23.5%
August	1,262,277	40,719	1,697	23.9%
September	1,414,870	47,162	1,965	27.7%
October	1,518,168	48,973	2,041	28.7%
November	1,308,357	43,612	1,817	25.6%
December	1,253,870	40,447	1,685	23.7%
Annual	**17,736,576**			

[1] Water flow coming from pumping of the End & Elfie Lake.

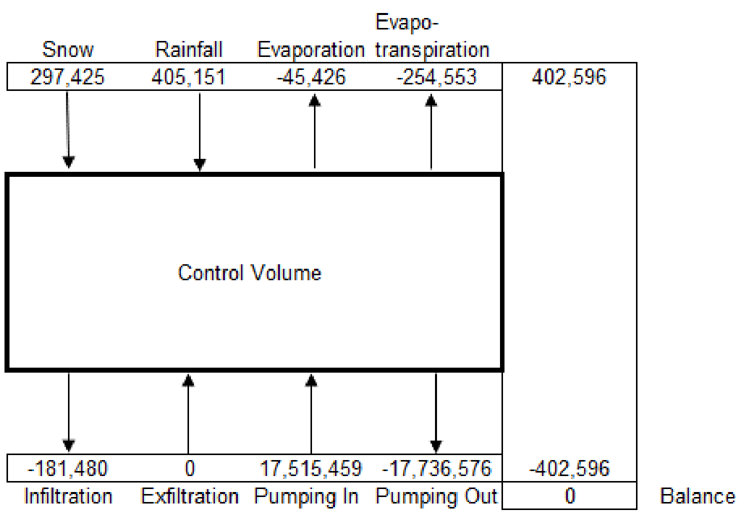
7.2 Water Balance Graphic

Three examples are presented to show how the water volumes are managed. **Figure 7-1** shows the annual water balance for the Rose Pit, **Figure 7-2** for the End & Elfie Lake (Rose Pit Collection Pond), and **Figure 7-3** for the Pike Lake Dike.



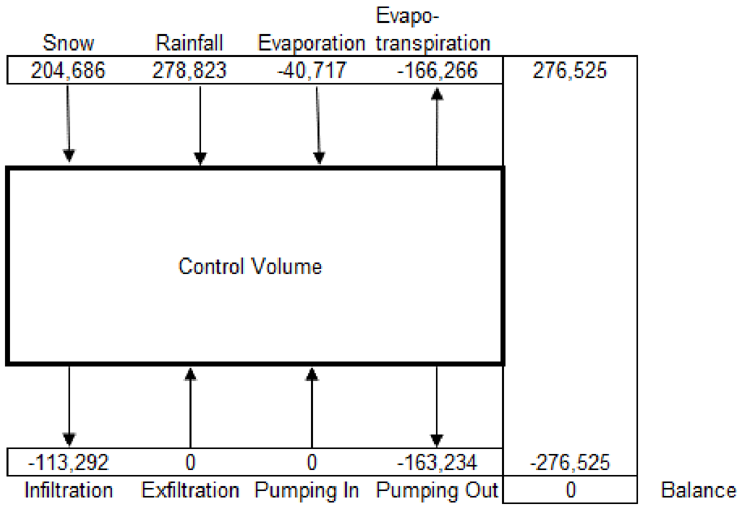
Note: Infiltration = Infiltration in soil, roads, and pads
Exfiltration = Groundwater inflow in the pit

Figure 7-1: Annual Balance for Rose Pit (m^3)



Note: Infiltration = Infiltration in soil, roads, and pads
Exfiltration = Groundwater inflow in the pit

Figure 7-2: Annual Balance for End & Elfie Lake (Rose Pit Collection Pond) (m^3)



Note: Infiltration = Infiltration in soil, roads, and pads
Exfiltration = Groundwater inflow in the pit

Figure 7-3: Annual Balance for Pike Lake Dike (m³)

7.3 Discussion on the Water Balance

Water balance analysis allowed to calculate the amount of water inflow in the basins each month and to assess the pumping flow required to manage water levels in those basins. The tables in **Section 7.1** present the percentage of the pumps system maximum capacity that is required to manage water levels during an average precipitation year. It should be noted that for the stockpiles basins and Pike Lake Dike, the flow rate of the pumping systems reach approximately 20% of their maximum capacity. For Mid Lake it is 27%, for Rose Pit 48%, and for End Lake and Elfie Lake (Rose Pit Collection Pond) it reaches 75%. The percentages calculated considering the average precipitation during the wet year (see Appendix D) are close to 30% for the stockpiles basins and Pike Lake Dike, 42% for Mid Lake, 56% for Rose Pit and 100% for Rose Pit Collection Pond. During the dry year (see Appendix E), those percentages are reduced to nearly 11% for the stockpiles basins and Pike Lake Dike, 15% for Mid Lake, 43% for Rose Pit and 75% for End Lake and Elfie Lake (Rose Pit Collection Pond). Pump capacities were estimated based on the flood routing performed in PSCWMM for the spring event, see **Table 5-3**.

From an annual basis, 17.7 million m³ of water need to be pumped from Rose Pit Collection Pond to the Treatment Plant (19.8 million m³ for a wet year, 16.5 million m³ for a dry year). A large amount of this water comes from the Rose Pit, where 15.8 million m³ of water (16.6 million m³ for a wet year, 15.3 million m³ for a dry year) need to be pumped to the Rose Pit Collection Pond, of which 14.6 million m³ come from the groundwater exfiltration. Therefore, from the 17.7 million sent to the Treatment Plant, 15,8 million m³ come from Rose Pit exfiltration and approximately 3.1 million m³ (5.2 million m³ for a wet year, 1.9 million m³ for a dry year) come from the runoff water caught by the different basins on the site. This volume does not consider the water pumped from Mid Lake and Pike Lake Dike, which discharges directly into Pike Lake South.

Before the construction of the mine, Pike Lake South receives approximately 3.7 million m³ (see Appendix C) of water each year (6.2 million m³ for a wet year, 2.2 million m³ for a dry year) and after the construction, this volume would increase to 20.1 million m³ per year (23.8 million m³ for a wet year, 17.9 million m³ for a dry year). This represents an increase of 16.4 m³ per year (17.6 million m³ for a wet year, 15.7 million m³ for a dry year) when comparing the final state of the mine with the initial natural state of the site. As mentioned above, a large amount of this additional water would come from water infiltration pumped from the Rose Pit, which infiltrates mainly from the Pike Lake South itself (see **Table 2-16**).

8.0 Dams and Dike Geotechnical Design

At this stage of engineering, no geotechnical field campaign has been done for the water management infrastructures, therefore infrastructures were designed using conservative assumptions. No geotechnical information is available in the alignment of the dams and dike and boreholes located at sometimes more than 200 m were used as a reference for overburden and bedrock conditions. Assumptions include the following:

- Overburden is permeable and grouting or sealing with geosynthetics is necessary.
- Overburden thickness varies between:
  - 6 m and 17 m at Elfie Lake West Dam;
  - 4 m and 11 m at End Lake East Dam;
  - 24 m and 42 m at Mid Lake Dam;
  - 27 m and 32 m at Pike Lake Dike.

To improve the design and determine if grouting is required, additional field data is required. The next stages of engineering will require a geotechnical campaign.

Typical cross sections for End Lake East Dam, Elfie Lake West Dam, Mid Lake Dam, Pike Lake Dike, Rose North/South Stockpile basins are available in Appendix F. **Table 8-1** presents the main design elements for each dam and dike.

Table 8-1: Design Elements for Dams and Dike

	Crest Total Width (m)	Crest Elevation (m)	Maximum Height (m)	Upstream / Downstream Slope	Spillway Elevation	Max IDF / Max EDF / LOWL
Elfie Lake West Dam	21.6	627.0	19	4:1 / 2.5:1	625.5	626.0 / 625.5 / 609.0
End Lake East Dam	21.6	627.0	12	4:1 / 2.5:1	625.5	626.0 / 625.5 / 609.0
Mid Lake Dam	31.8 for section without piping. 36.9 for section with piping.	584.5	5.5	4:1 / 2.5:1	583.0	583.5 / 583.0 / 579.9
Pike Lake Dike	77.3	Crest: 574.0 Intermediate platforms: 573.0 570.5	6	2:1 / 2:1	569.0	569.5 / 569.0 / 566.9
Rose North Overburden Stockpile Collection Pond	21.6	572.0	5	3:1 / 2:1	570.5	571.0 / 570.5 / 568.2
Rose South Waste Rock Stockpile Basins: East Basin North Basin West Basin South-West Basin	21.6 for the dike crest. Between 10.8 m and 15.8 m.	555.0 574.0 599.5 605.0	9.0 10.0 4.5 5.0	3:1 / 2.5:1 (same for all)	553.5 572.5 598.0 603.5	554.0 / 553.5 / 549.0 573.0 / 572.5 / 566.0 598.5 / 598.0 / 596.1 604.0 / 603.5 / 601.0

The general plan available in Appendix F (plan #692696-8000-40DD-0001) presents the dam and dike alignments. Typical sections of End Lake East Dam, Elfie Lake West Dam, Mid Lake Dam and Pike Lake Dike are available on drawings 0005, 0007, 0008 and 0009 in Appendix F respectively.

Mid Lake Dam is at the nearest 100 m away from the pit (distance from dam toe) and is aligned with the ring road. The 100 m set back distance from the pit rim was set as a safety measure. Elfie Lake West Dam and End Lake East Dam are placed to close the natural valley and create a pond area (Collection Pond). Pike Lake Dike is placed approximately 300 m away from the pit as its goal is to seclude Pike Lake's water further away from the pit. Dams for the Rose North/South Stockpile basins are placed at low topographic points to allow for gravity drainage from the stockpile toe to the basin.

8.1 Site Classification

Based on available data, the studied area can mostly be classified as "C" which refers to "Very dense" soils according to the 2020 National Building Code of Canada (NBC) (Ref.: Table 4.1.8.4.B). However, some sectors where a thick layer of loose to compact overburden was encountered are classified as "D" which refers to "Stiff" soils. It should be noted that this assessment can be optimized following the geotechnical campaign.

8.2 Liquefaction Assessment

Section 3.0 of this report details the dam class for each infrastructure and associated design earthquakes.

A liquefaction assessment of the overburden was carried out using a return period 1/2 between 1/2 475 and 1/10 000. This return period is suggested for dams classified as "Very High" according to the CDA guidelines.

The following table shows the values extrapolated by SNC-Lavalin for the selected return period for different site classes.

Table 8-2: Peak Horizontal Ground Accelerations (PGA) for Different Site Classes

Site class	PGA for return period 1/2 between 1/2 475 and 1/10 000
C	0.0884
D	0.1410
E	0.1549

For stability analyses, following the National Earthquake Hazards Reduction Program (2003) recommendation, in presence of limited data, it is suggested to take the most conservative site class. The liquefaction assessment carried out using a site class "D" suggests that sectors surrounding boreholes ROB-11-01 and ROB-11-04 show a risk of liquefaction. Note, however, that boreholes ROB-11-01 and ROB-11-04 are far from any of the dams/dike.

As it was identified that the soils may be susceptible to liquefaction, the site should be classified as "F" and a site-specific analysis is therefore required. Since performing a site-specific analysis with the limited information available is not effective, the site will conservatively be classified as "E". Consequently, the PGA was increased to 0.1549, which corresponds to a site class "E".

Possibility of liquefaction should **not** be ruled out at this stage and liquefaction should be re-evaluated following the geotechnical campaign.

8.3 Materials

Dams consists of rockfill with a sand & gravel transition zone, sand, and an upstream impermeable barrier (geotextile, clay liner and HDPE liner). Over the geosynthetics, sand, sand & gravel and riprap are needed on the upstream slope to prevent the erosion of the dam. Jet grout curtain (in soil) and grout curtain (in rock) are planned at the upstream toe to limit seepage.

Pike Lake Dike will consist of rockfill, with a sand & gravel transition zone, sand, and a cement soil bentonite cutoff wall. Jet grout curtain (in soil) and grout curtain (in rock) are planned.

The main materials used are the following:

- **Compacted till:** remaining material from excavations can be reused provided the till has a sufficient percentage of fines and is exempt from cobbles and boulders.
- **Geotextile/Geomembrane:**
  - Texel (918 – 407 g/m^2);
  - Texel (912 – 250 g/m^2);
  - Geosynthetic Clay Liner (GCL);
  - HDPE Liner Type Micro-Spike (textured).
- **Riprap 200-300 mm and 400-600 mm:** riprap of 200-300 and 400-600 mm calibre is to be used to prevent erosion on all dams (calibre varies from one structure to another). Riprap materials should be NPAG and non-metal leaching.
- **Riprap 100-200 mm:** riprap of 100-200 mm calibre is to be used as the gabion mattress for the emergency spillways.
- **NPAG rockfill 0 – 1000 mm:** rockfill materials should be NPAG, non-metal leaching and durable.
- **Sand and Sand bedding:** sand materials should be well graded, non-frost susceptible and allow for proper draining.
- **Sand & Gravel:** sand and gravel is to be used as a transition between NPAG rockfill and sand. This material should be well graded, non-frost susceptible and allow for proper draining.
- **Road structure:** BBA is responsible for the design of permanent roads. Mid Lake Dam will require a road structure since the dam will be connected to the ring road.
- **Jet grout curtain (in soil) and grout curtain (in rock):** this work must be carried out by a specialized contractor.
- **Cement soil bentonite cutoff wall:** this work must be carried out by a specialized contractor.

Table 8-3 presents the material proposed for each dam/dike.

Table 8-3: Materials per Infrastructure

Material	Elfie Lake West Dam	End Lake East Dam	Mid Lake Dam	Pike Lake Dike	Rose North Overburden Stockpile Collection Pond	Rose South Waste Rock Stockpile Basins
Compacted till	X	X	X		X	
Geotextile (Texel 918 – 407 g/m^2) Geosynthetic Clay Liner (GCL) HDPE Liner Type Micro-Spike	X X X	X X X	X X X	X	X X X	X X X
Riprap 400-600 mm	X	X	X			
Riprap 200-300 mm					X	X
Riprap 100-200 mm	X	X	X	X	X	X
NPAG rockfill	X	X	X	X		X
Sand	X	X	X	X		
Sand bedding	X	X	X		X	X
Sand and gravel	X	X	X	X	X	X
Jet grout curtain (in soil)	X	X	X	X		
Grout curtain (in rock)	X	X	X	X		
Cement soil bentonite cutoff wall				X		

X: material is needed for the infrastructure

Compacted till (with a high percentage of fine content) could be used as the main embankment material. However, it was mentioned that the Tailings Storage Facility would be using available impermeable till.

For Elfie Lake West Dam, End Lake Dam and Mid Lake Dam, a jet grout curtain (in soil) and a grout curtain (in rock) are proposed to limit seepage in the dam foundation and underlying overburden. Grouting has been planned at this stage because it is unknown if the overburden contains sufficient fines to be considered as an impervious foundation. Information from nearby boreholes suggest that grouting will most likely be required.

Rose North/Rose South Stockpile Basins seepage will be contained using a geomembrane placed over the full surface of the basins, therefore avoiding the necessity for grouting. The installation of geosynthetics as a sealing method for the ponds is more practical since these ponds are being constructed at virgin locations (as opposed to Mid Lake Dam, Elfie and End Lake Dam and Pike Dike, whose reservoirs are constituted of natural lakes).

The seepage control method for the dams could be reviewed with additional geotechnical information. If the overburden contains enough fines, grouting could be avoided if it is demonstrated that seepage in the natural foundation is acceptable.

Also, if overburden depth is significantly thicker then assumed, quantities of jet grout curtain (in soil) and the depth of grout curtain (in rock) would increase. If so, sealing the ponds related to Elfie and End Lake dams with a geomembrane would provide an alternative. This would require installing a geomembrane for the full surface of the ponds. Before opting for this alternative, availability and costs of manpower will need to be assessed.

Lastly, according to the study carried out by WorleyParsons in 2014, the Waldorf River Esker was identified as a construction borrow source for clean sands and gravel. Material borrow sources have not been analysed by SNCL as part of this study. Since these materials will be used for the Tailings Management Facility and other mining infrastructures, overall availability of material on a site wide perspective falls under the scope of the project integrator (BBA). Materials used need to be non-potentially acid generating (NPAG) and non-metal leaching for the proposed infrastructures. Proper screening and verification to confirm material viability is needed.

8.4 Stability and Seepage Analyses

8.4.1 Material Properties

Stability analyses were performed using SLOPE/W from the GeoStudio software (GeoStudio International Ltd, 2021). The input parameters retained for the granular materials are based on a combination of field data provided by the Client (Stantec 2012c 2010-2012 field campaign) and conservative assumptions made by SNC-Lavalin. Properties for the geosynthetics were estimated from the literature and **Table 8-4** below summarizes the different material properties used in the analyses.

Table 8-4: Geotechnical Properties for Stability Analyses

Material	Saturated Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Effective Friction Angle (º) or strength ratio	Strength Ratio S_u/σ'_v
Overburden – Loose to compact till	18	0	31	-
Overburden – Loose to compact till (residual)	18	-	-	0.05 (minimum strength of 10 kPa)
Compacted till	18	0	31	-
Sand	19	0	30	-
Sand and gravel	22	0	35	-
Riprap	22	0	38	-
Rockfill	22	0	(Leps 1970, Lower bound)	-
Bedrock (fractured)	26	150	30	-
Geosynthetics	0.1	0	16	-

Seepage analyses were performed using SEEP/W from the GeoStudio software. Overburden and bedrock saturation properties were estimated with the conceptual 3D hydrogeological model, following a hydrogeological data review (see **Section 2.4**). The hydraulic conductivity and volumetric water content for the dams/dikes granular materials were estimated using GeoStudio built-in functions.

Table 8-5 below summarizes the hydraulic properties for the different materials.

Table 8-5: Hydraulic Properties for Seepage Analyses

Material	Hydraulic Material Model	Volumetric Water Content Function	K-Function	Saturated Permeability (m/sec)
Overburden – Loose to compact till	Saturated only	-	-	1e-06
Overburden – Loose to compact till (residual)	Saturated only	-	-	1e-06
Compacted till	Saturated only	-	-	1e-06
Sand	Saturated/Unsaturated	Sand VWC function (WC=0,3)	Sand K function (WC=0,3)	-
Sand and gravel	Saturated/Unsaturated	Sand VWC function (WC=0,3)	Sand and Gravel K function (WC=0,3)	-
Riprap (400-600mm)	Saturated only	-	-	0.01
Rockfill	Saturated/Unsaturated	Gravel VWC function (WC=0,3)	Gravel K function (manual)	-
Bedrock	Saturated only	-	-	5e-08
Grouting	Saturated only	-	-	1e-09
Geosynthetic (GCL)	Saturated only	-	-	1e-09

The level of the water table was deduced from the results of the seepage analysis and were integrated to the stability analysis.

Note that the geotechnical properties and the hydraulic parameters have been selected in a conservative manner and will need to be re-assessed in the next engineering stages, once more field data is gathered.

8.4.2 Stability Analyses Scenarios

Stability was analyzed for the most critical infrastructures:

- Elfie Lake West Dam;
- Mid Lake Dam;
- Pike Lake Dike.

Since Elfie Lake West Dam and End Lake East Dam have the same geometry with similar overburden conditions, only the highest dam of the two was analyzed. A distinct analysis for End Lake East Dam will be relevant once more data on the overburden and bedrock are available.

An upstream analysis was conducted for Elfie Lake West Dam to confirm the stability of the upstream slope when the collection pond is empty. **Table 8-6** details the different analyses scenarios.

Table 8-6: Stability Analyses Scenarios

Infrastructure	Analysis	Crest Elevation (m)	Cross-Section Height (m)	Water Elevation (m)
Elfie Lake West Dam	Upstream – Long term	627.0	20.0	609.0
	Upstream – Long term (Geotextile stability)			
	Downstream – Long term, pseudo-static, post-seismic	627.0	20.0	626.0
Mid Lake Dam	Downstream – Long term, pseudo-static, post-seismic	584.5	6.5	583.5
Pike Lake Dike	Downstream – Long term, pseudo-static, post-seismic	Crest: 573.0 Intermediate platforms: 572.0 569.5	6.5 5.5 3.0	568.0

8.4.3 Stability Analyses Results

The results of the stability analyses are presented in **Table 8-7** below. Figures showing the results are also available in Appendix G.

Table 8-7: Stability Analyses Results

Infrastructure	Analysis	Required Safety Factor (CDA guidelines)	Safety Factor	Figure
Elfie Lake West Dam	Static – Short term Upstream	1.3	2.34	G-2
	Static – Short term Upstream (Geotextile stability)	1.3	1.32	G-3
	Static – Long term	1.5	1.90	G-5
	Pseudo-static	1.0	1.14	G-6
	Post-seismic	1.2	1.19	G-7
Mid Lake Dam	Static – Long term	1.5	1.90	G-9
	Pseudo-static	1.0	1.18	G-10
	Post-seismic	1.2	1.25	G-11
Pike Lake Dike	Static – Long term	1.5	1.71	G-13
	Pseudo-static	1.0	1.09	G-14
	Post-seismic	1.2	1.71	G-15

With current dam/dike locations, critical slip surfaces never reach the pit. Also, a pit slope stability analysis is currently being conducted and results will be presented in a separate report.

Dams and dike are expected to be stable, and they meet the design criteria.

8.4.4 Seepage Analysis Results

Results of the seepage analysis for Elfie Lake West Dam, Mid Lake Dam and Pike Lake Dike are shown in Appendix G. The 2D SEEP/W model allowed to estimate the water table elevation for each infrastructure. These water elevations were then integrated to the stability analyses.

An analysis was also conducted to assess Pike Lake Dike's effectiveness in reducing the daily water influx to the pit. These results are presented in Appendix H.

For this analysis, two main scenarios were analyzed:

Scenario 1: Permeability of the bedrock was set to 1e-05 m/sec, which corresponds to a fractured bedrock. This analysis simulates a scenario where the fault would be perpendicular to the dike.

Scenario 2: Permeability of the bedrock was set to 5e-08 m/sec, which corresponds to a good quality bedrock. This analysis simulates a scenario where the fault does not cross the Pike Lake Dike.

Results are as follows for the 2D SLOPE/W model and the 3D FEFLOW model.

Table 8-8: Pike Lake Dike's Effect on Seepage Reduction

Scenario	2D SEEP/W Seepage reduction	3D FEFLOW Seepage reduction
Fractured bedrock crossing the lake downstream of Pike Dike	25 %	31 %
Good quality bedrock crossing the lake downstream of Pike Dike	38 %	2 %

In the Seep model, for the first scenario, by adding the dike and secluding the water further from the pit, the inflow was reduced by 25%. In the second scenario, water seepage was reduced by 38%.

For the 3D Hydrogeological model, results tend to show that a seepage reduction is only noticeable for the scenario where the fault is set to cross the dike. However, following the data review, the current assumption is that the fault does not cross the dike. If the fault does not cross the dike, almost no difference is noticed in the infiltration rate whether Pike Lake Dike is built or not. The next hydrogeological field campaign will allow for increased certainty about these analyses.

It should be noted that, regardless of seepage results, the main purpose of Pike Lake Dike is to seclude the water further from the pit and to secure the mining operations.

8.5 Rose Pit Ring Road

BBA is responsible for the design of the Rose Pit ring road; however, the alignment of the road has been provided by SNC-Lavalin since it must match the drainage system at the perimeter of the pit. The following information has been provided:

Typical Access Road Section

- Circulating width of 10.5 m.
- Safety berms are 1.0 m high by 3.0 m wide.
- Road structure is 0.7 m thick.

Typical Haul Road Section

- Circulating width of 21 m.
- Safety berms are 1.8 m high by 5.4 m wide.
- Road structure is 1.0 m thick.

These road designs have been included in the plan #692696-8000-40DD-0001 and #692696-8000-40DD-0002 to 0004 presented in Appendix F.

It should be noted that the road width has been adapted to include room for the pipeline routing from the treatment plant to the effluent of Pike Lake (see **Section 6.3.3**).

Sections of the road along the collection pond will require additional attention. Indeed, space is limited between the open pit and the maximum water level of the pond. Large amounts of fill are to be expected in this area. Also, if the road is widened, it could be necessary to have it relocated to the south side of the collection pond.

Note that as Mid Lake Dam is connected to the ring road, 1.0 m road structure have been integrated to the dam design. Same comment applies for the Pike Lake Dike.

8.6 Rose North Overburden Stockpile Collection Pond

The Rose North Overburden Stockpile Collection Pond will be built through a cut and fill construction method and will have capacity at spillway's invert of roughly 60,000 m^3. Design elements are presented in **Table 8-1** (**Section 8.0**).

The infrastructure of the dam containing the pond consists of till in place, a sand & gravel transition zone, sand, and an upstream impermeable barrier (geotextile, clay liner and HDPE liner). Riprap with a diameter of 200-300 mm will be placed on the upstream slope and on the extension of the impermeable barrier covering the basin's foundation to prevent erosion.

Plans #692696-8000-40DD-0013 and 0014 (Appendix F) present the plan view of the Rose North Overburden Basin and a typical cross section.

8.7 Rose South Waste Rock Stockpile Basins

Four (4) collection ponds will collect the runoff water from the Rose South Waste Rock Stockpile:

- North Basin (NB);
- East basin (EB);
- West Basin (WB);
- South-West Basin (SW).

The basins will have capacities at spillway's invert of 93,700 m^3, 182,198m^3, 44,803 m^3, and 32,910 m^3 respectively for the North Basin, the East Basin, the West Basin, and the South-West Basin. Design elements are presented in **Table 8-1** (**Section 8.0**).

The infrastructure of the dam containing the basin consists of till in place, a sand & gravel transition zone, sand, and an upstream impermeable barrier (geotextile, clay liner and HDPE liner). Riprap with a diameter of 200-300 mm will be placed on the upstream slope and on the extension of the impermeable barrier covering the basin's foundation to prevent erosion.

Plans #692696-8000-40DD-0017 to 0019 (Appendix F) present the plan view of the Rose South Waste Rock Stockpile – North Basin and a typical cross section.

9.0 Material Take-Off

The following infrastructures have been considered in the material take-off:

- Rose Pit water management infrastructures.
- Mid Lake Dam and related infrastructures.
- Rose Pit Collection Pond and related infrastructures.
- Pike Lake Dike and related infrastructures.
- Rose North Overburden Stockpile water management infrastructures.
- Rose South Waste Rock Stockpile water management infrastructures.

Additional details on the scope of work and methodology can be found in the Basis of Estimate (Ref. #692696-8000-33KA-0001).

The quantities were calculated based on topographic data (see **Section 2.1**) and a 3D model produced in AutoCAD.

Quantities were estimated based on the final design of the water management infrastructure. These quantities were spread over different years, according to anticipated water management needs. Note that this quantity breakdown does not take into consideration additional or temporary work or materials that may be required with a phased construction.

Table 9-1 shows the total quantities of granular materials that are required. The full list of materials is presented in the Basis of Estimate.

Table 9-1: Quantities of Granular Materials

Material	Quantity (m³)
Compacted till	93,789
Riprap 100-200 mm Riprap 200-300 mm Riprap 400-600 mm	6,068 275,426 69,339
NPAG rockfill 0-1000 mm (years -3/-2) NPAG rockfill 0-1000 mm (years -1/0) NPAG rockfill 0-1000 mm (year 1 and above)	955,738 377,856 476,723
Sand	14,161
Sand bedding	459,235
Sand and gravel transition	378,269
Sand and gravel (Road surface)	400,876

Significant quantities of NPAG rockfill are required and approximately 74% of that amount is needed in years -3 to 0 inclusively. Adequately coordinating mining activities with the required quantities of granular materials will allow to limit expenses. Indeed, soils and rock from excavations could be reused provided they meet set standards.

Table 9-2 presents total excavation quantities.

Table 9-2: Total Amounts of Excavation

Excavation	Quantity (m^3)
Stripping of organics (estimated 0.5 m thick)	655,732
Stripping of organics (estimated 1 m thick)	226,535
Excavation (soil) and key trench excavation	1,077,100
Excavation (rock)	27,965

For this estimate, the stripping of organics was estimated to be 0.5 m thick in the Rose North/South stockpiles sectors. For all other sectors, the stripping of organics was estimated to be 1 m thick. This amounts to a total amount of 882,267 m^3 needing to be stacked in the overburden stockpile. This represents approximately 1.5% of the overburden stockpile's capacity.

Excavations of soil and rock are respectively estimated at 1,077,100 m^3 and 27,965 m^3.

Quantities of geosynthetics are also important to mention since they will need to be delivered to the site. **Table 9-3** shows the required quantities of geotextiles and liners.

Table 9-3: Quantities of Geosynthetics

Material	Total (m^2)
Geotextile (Texel 918 – 407 g/m^2)	544,184
Geotextile (Texel 912 – 250 g/m^2)	302,286
Geosynthetic Clay Liner (GCL)	389,619
HDPE Liner Type Micro-Spike	389,619

10.0 Rose North Overburden Stockpile and Rose South Waste Rock Stockpile Stability Analyses

Rose North Overburden Stockpile and Rose South Waste Rock Stockpile are designed by BBA and Champion mandated SNCL to revise the stability of the stockpiles.

Stability analyses have been conducted considering the available geotechnical information from Stantec 2012c, Stantec 2013, Golder 2012, WorleyParsons (2015), and the latest geometry of the stockpile designed by BBA. The results of this review are presented in a separate deliverable.

11.0 Conclusions and Discussion

The water management plan for Rose Pit, Rose North Overburden Stockpile, and Rose South Waste Rock Stockpile was based on available data in Q3 2023. Possible optimizations have been identified and will be discussed in the following section.

11.1 Possible Optimizations

There are a lot of possibilities regarding the flow routing of the entire site. The current water management plan has been developed to be conservative. The following lines present some optimizations possible:

- Consider that the water treatment plant is in operation all year round. Capacity of the Rose Pit Collection Pond could be reduced, with no need to accumulate the pit dewatering water during the coldest winter months. Elfie and End Lake Dams height would be reduced. Year long treatment would also reduce the risk of affecting Pike Lake water level due to mining operation, allowing water to be pumped back in the lake all year round to compensate for losses through infiltration in the pit.
- Consider that runoff from Rose North Overburden Stockpile does not need to be treated and can be diverted directly in Pike Lake, with no pumping system. Not sealing the pond with a geomembrane could also be considered.
- Divert runoff from Rose South Waste Rock Stockpile towards the TSF, which is a shorter distance allowing savings on piping and a reduction of infrastructures at the Rose Pit collection pond and treatment plant.
- Not building the Mid Lake Dam. Keep the lake dry and use the natural capacity to manage flood. This would require accepting that the pit could be flooded more frequently and would need a specific flood assessment for this condition. The savings in Mid Lake Dam construction would be significant on the project costs.
- A staged approach with the construction of Elfie Lake and End Lake Dam is also a possible optimization. The infiltration will not be at its maximum at the beginning of the mining sequence, and it will be possible to adapt the dam's height over time with field experience in the rate of infiltration. It is possible that the actual planned height would never be reached.

Optimizations concerning infrastructure design are also possible.

- Realize a comparative study for the sealing of the Rose Pit collection pond (Elfie Lake and End Lake) between, the use of jet grouting and grout curtain to seal the dikes or the installation of a geomembrane on the entire basin.
- Water treatment plant process can be optimized once ongoing studies (geochemical assessment, site-wide water balance) have been completed.
- Move Mid Lake Dam out of the lake footprint to avoid construction in the lake if there is no stability issue confirmed with the pit slope stability study.
- Use till to seal the dike instead of geomembrane if sufficient good-quality till becomes available.
- Once the entire detailed topography will be available at the Rose South Waste Rock Stockpile location, optimization in the location of ponds, dike height and ditches path might be possible. A trade-off could also be conducted to compare current basin design with dikes versus a combination of excavation and embankments.
- Optimize the thickness of dams zoning material considering the type and number of construction equipment vehicles that could be used for the construction.

11.2 Path Forward

The following lines list all the tasks recommended to reach a detailed engineering level:

- Hydrogeological drilling campaign (ongoing Q4 2023).
- Hydrogeological pumping tests.
- Hydrogeological model update, including coupled surface water/groundwater model.
- Complete site-wide water balance and geochemical assessment (in progress).
- Complete pit slope stability update (in progress).
- Geotechnical survey in the alignment of future dams. It is important to note that some information can be obtained in winter only, as some surveys have to be done on the frozen lake (Pike Dike footprint, sediment sampling).
- Update infrastructure design with new information, including the planning of a staged approach for the construction of infrastructures.
- Update treatment plant design with results from site-wide water balance and geochemical assessment.
- Refine planning of staged approach, considering supplementary work that could be necessary to proceed by stages.
- Assessment on site-wide material balance and borrow pits.

12.0 Personnel

This report has been prepared and revised by the team indicated below.

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We trust that this report is to your satisfaction. Should you have any question, please do not hesitate to contact us.

SNC-LAVALIN INC.

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Appendix A

Design Criteria

SNC • LAVALIN	TECHNICAL NOTE Rose Pit Water Management Infrastructures Design Criteria - Kami Mine	Prepared by: P. Pasquis, S. Nachet, M-H Paquette Reviewed by: M.-H. Paquette, F-A Desrochers		
		Rev.	Date	Page
	692696-8000-40EC-0001	00	July 21, 2023	i

Title of document: **Rose Pit Water Management Infrastructures Design Criteria - Kami Mine**

Client: **MINERAI DE FER QUÉBEC**

Project: **Kami Mine Water Management Infrastructures**

Prepared by (under ICS[1]):	Pamela Pasquis, CPI #OIQ: 6042274	
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Reviewed by:	Félix-Antoine Desrochers, Eng #PEGNL : 11203	2023.07.21 09:44:58 -04'00'
Reviewed by:	Marie-Hélène Paquette, Eng., M. Env. #PEGNL: 07899	2023-07-20

[1] *ICS: Immediate control and supervision.*
In terms of supervising the engineering activities and supervision of people who are not engineers or junior engineers, the Ordre des ingénieurs du Québec uses a term often used in its regulation: Immediate control and supervision (ICS). In other words, an engineer must be involved in a continuous and active manner throughout the reserved tasks entrusted to him, and not just before or after.

LIST OF REVISIONS

Revision					Pages Revised	Remarks
#	Prep.	Rev.	App.	Date		
PA	P. Pasquis, S. Nachet, M-H Paquette	--	--	2023-03-15		Issue for internal comments
PB	P. Pasquis, S. Nachet, M-H Paquette	M.-H. Paquette, F-A Desrochers	M.-H. Paquette	2023-03-17	All	Issue for client's comments
PC	P. Pasquis, S. Nachet, M-H Paquette	M.-H. Paquette, F-A Desrochers	M.-H. Paquette	2023-05-03	All	Addition of criteria relative to Stockpile water management infrastructures – for client's comments
00	P. Pasquis, S. Nachet, M-H Paquette	M.-H. Paquette, F-A Desrochers	M.-H. Paquette	2023-07-21	All	Final version

NOTICE TO READER

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1.0 Introduction

Minerai de Fer Québec is proposing to develop the Kami Iron Ore Project which consists of an open-pit iron ore mine in western Labrador and to build associated infrastructure at the Port of Sept-Îles, Quebec. The project is expected to produce up to eight (8) million metric tonnes of iron ore concentrate per year that will be transported by existing railway to the Port of Sept-Îles, Quebec.

Minerai de Fer Québec (MFQ) has mandated SNC-Lavalin to design the water management infrastructures related to the planned Rose Pit to a feasibility level.

1.1 Context

The Kami Mine project includes construction, operation, and closure / decommissioning of the following primary components:

- The open pit mine (the Rose Pit).
- The Rose North and Rose South waste rock disposal areas (WRDA).
- The processing infrastructures including crushing, grinding, spiral concentration, magnetic separation, and tailings thickening areas.
- The tailings management facility (TMF).
- The ancillary infrastructure to support the mine and process plant.
- A rail transportation component including spur line construction to connect the mine site to the Quebec North Shore & Labrador (QNSL) Railway.

SNC-Lavalin's mandate is limited to the design of the water management infrastructures related to the Rose Pit.

1.2 Mandate

To manage infiltration and runoff in the Rose Pit, several water management infrastructures will be designed as part of the Kami mine Feasibility study.

- Perimeter diversion channel around Rose Pit.
- Diversion dam and pipe upstream of Rose Pit (Mid-Lake dam).
- Dewatering pumping facilities to dewater groundwater seepage and surface runoff from Rose Pit.
- Rose Pit sedimentation pond to collect groundwater seepage and surface runoff from Rose Pit.
- Perimeter diversion channel around Rose Pit sedimentation pond.
- A treatment plant to treat water from the sedimentation pond before discharging to the environment.
- A dike to seclude Pike Lake water further from Rose Pit (Pike dike).
- Dewatering facilities to empty Pike Lake upstream of Pike dike.
- Perimeter diversion channel around Rose North Stockpile (overburden stockpile).

- Pond to collect runoff from Rose North Stockpile (overburden stockpile).
- Perimeter diversion channel around Rose South Stockpile (waste rock stockpile).
- Ponds to collect runoff from Rose South Stockpile (waste rock stockpile).

This document presents the design criteria for these infrastructures.

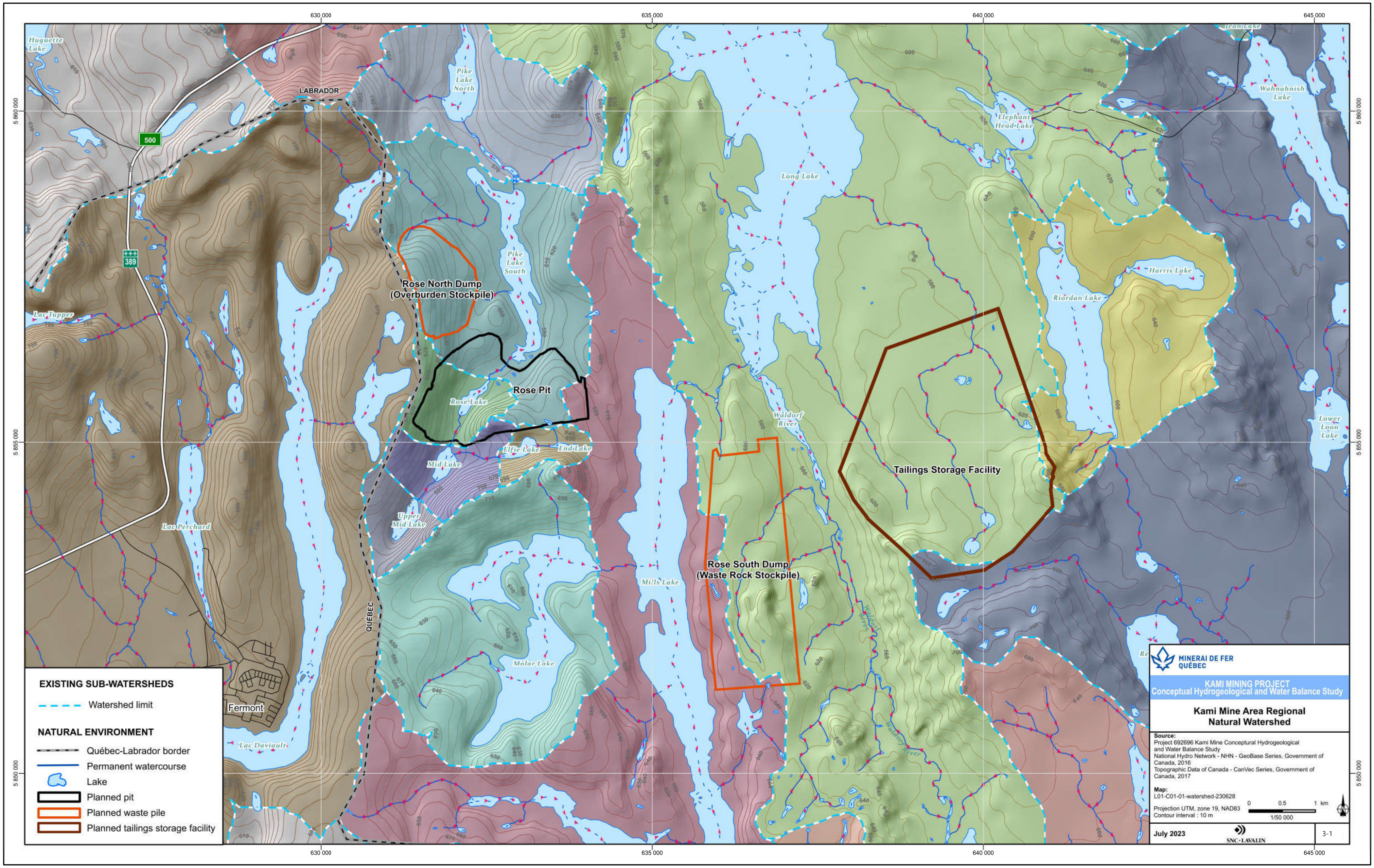
2.0 Applicable Regulations and Guidelines

The design criteria are based on the following regulation and standards:

- Metal and Diamond Mining Effluent regulations (MDMER) (SOR/2002-222).
- Canadian Water Quality Guidelines (CWQG) for the protection of aquatic life.
- Newfoundland and Labrador Environmental Control Water and Sewage Regulations (NL Reg. 65/03).
- Wastewater Systems Effluent Regulations (SOR/2012-139).
- Newfoundland and Labrador Environmental Assessment Regulations, 2003.
- NL Water Resources Act and Regulations.
- Canadian Dam Association Dams Safety Guidelines (CDA 2013).
- Canadian Dam Association, Application of Dams Safety Guidelines to Mining Dams (CDA 2014).
- Canadian Dam Association, Technical Bulletin, Application of Dam Safety Guidelines to Mining Dams (CDA 2019).
- Newfoundland and Labrador Dam Safety Program, Department of Environment & Conservation Water Resources Management Division (2015).

3.0 Water Management Schematic Plan

The following figures present an overview of the site in its natural state, show current watershed, and map the approximate location of proposed dams and dikes.



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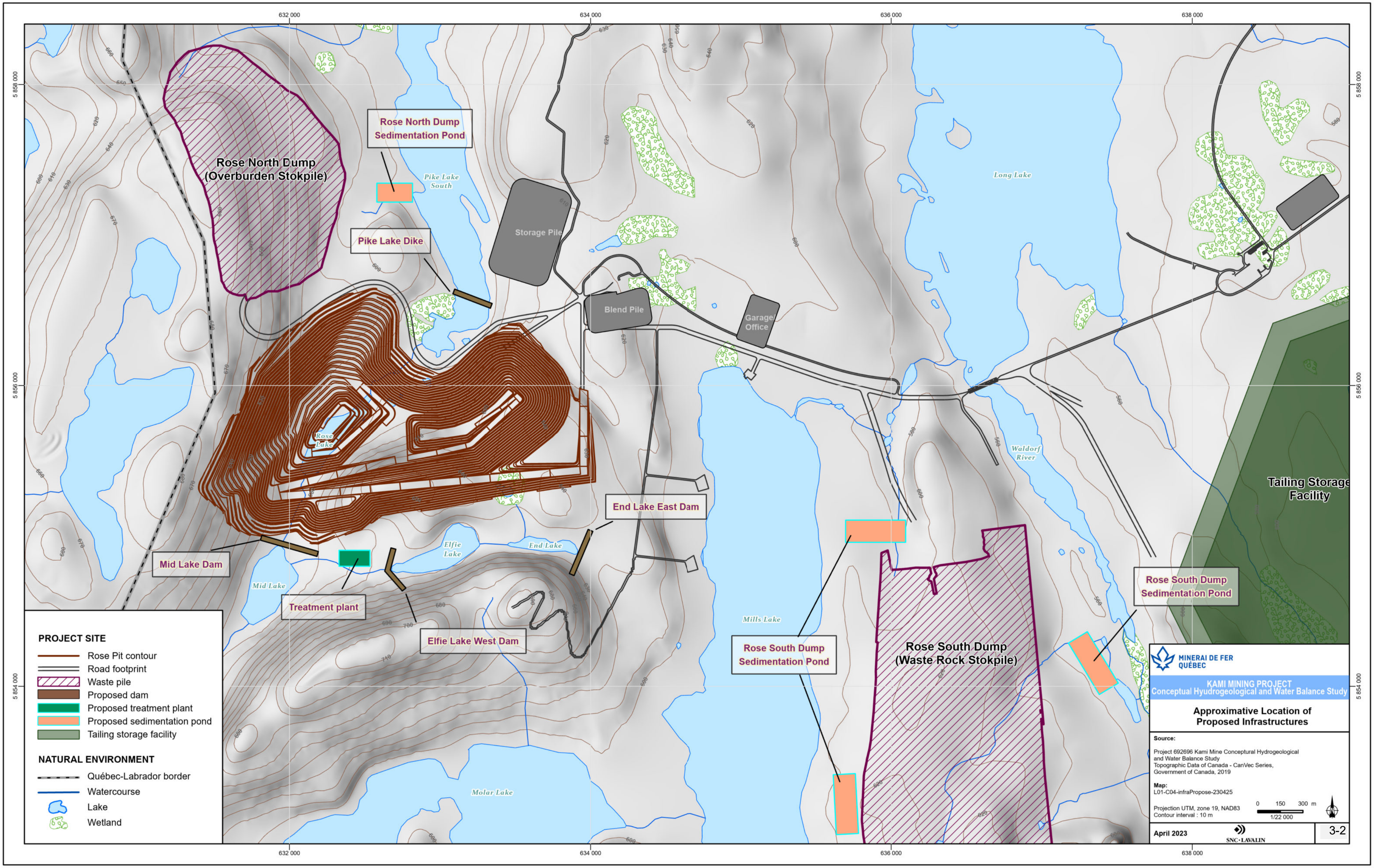

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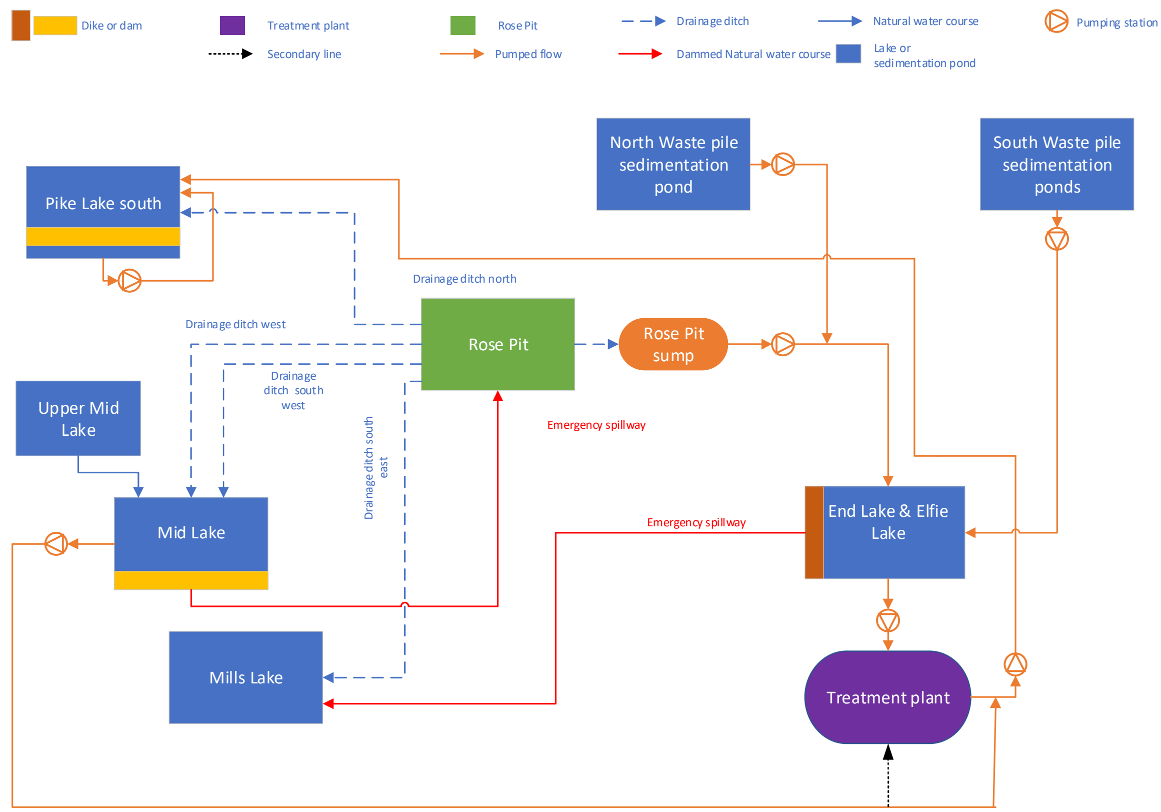
End Lake and Elfie Lake will be used as a sedimentation pond for the water pumped from the Rose Pit and Rose North and Rose South stockpiles. The following figure illustrate the water management schematic.

Figure 3-3: Water Management Schematic Plan (End Lake and Elfie Lake as a sedimentation pond)



As illustrated in the **Figure 3-3**, the runoff and infiltration water that will accumulate in the Rose Pit will be collected in a sump and will be pumped to the sedimentation pond (End Lake & Elfie Lake). After the sedimentation pond water will be pumped to the treatment plant where the ammonia species will be removed, and the treated water will be pumped to Pike Lake South. The water from Mid Lake will also be pumped to Pike Lake South, with the possibility to treat it at the treatment plant beforehand.

As for the water flowing towards the Rose Pit from the other watersheds, four (4) drainage ditches will convey water to Mills Lake, Mid Lake, and Pike Lake south. Furthermore, and to ensure that the untreated water doesn't flow into Mid Lake, a dike will be built at the outlet of Elfie Lake.

It is worth noting that to ensure that the Rose Pit doesn't get flooded, a dam will be built at the outlet of Mid Lake and the inlet of Pike Lake south. The downstream portion of Pike Lake south will be dewatered and kept dry to avoid the backflow of water to the Rose Pit and minimize the seepage towards the pit. The runoff water generated at the Rose North and South Stockpiles will be collected in ponds and will be pumped into the Rose Pit sedimentation pond (End Lake & Elfie Lake) to be treated at the water treatment plant afterwards. Given the fact that, at this point, the water quality of these two effluents hasn't been assessed yet, the Rose Pit sedimentation pond and water treatment plant will be designed for the worst-case scenario, which is to treat both of the effluents. However, considering that the Rose North Stockpile will only contain overburden, its runoff water might not require ammonia treatment..

4.0 Dams Classification (CDA)

The water management infrastructures will include dams. This section presents the proposed dam classification.

The classification criteria used in this technical note are based on the Dam Safety Guidelines of the CDA (2013). The classification of a dam according to the CDA's Dam Safety Guidelines (see **Table 4-1**) is based on the incremental consequences of failure. To summarize, dams are classified as low, significant, high, very high, or extreme, depending on the estimated loss or damage with respect to five categories:

1. Loss of life;
2. Environmental damage;
3. Damage to infrastructure;
4. Economic loss to another party; and
5. Damage to a site of cultural or historic significance.

Possible economic losses and costs to the owner/operator of the mine are not considered in the classification of the dams.

Table 4-1: Dam Classification (CDA, 2013)

Dam Class	Population at Risk [note 1]	Incremental Losses		
		Loss of Life [note 2]	**Environment and Cultural/Historic**	**Infrastructures and Economic**
Low	None	0	Minimal short-term loss 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 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)

Note 1. *Definitions for population at risk:*

None *– There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventures.*
Temporary *– People are only temporarily in the dam-breach inundation zone (eg., seasonal cottage use, passing through on transportation routes, participating in recreational activities).*
Permanent *– The population at risk is ordinarily located in the dam breach inundation zone (eg., as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out)*

Note 2*. Implications for loss of life:*

Unspecified *– The appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.*

Table 4-2: List of Infrastructures to be Classified

No.	Infrastructure	Class	Notes
1	Mid Lake dam	Very high	In the event of a breakage, the risk area is located north of Mid Lake Dam, towards the Rose Pit. The following points are considered: - Presence of 100 or fewer workers; - No significant loss or deterioration of critical fish or wildlife habitat; - Low economic losses.
2	End Lake East dam	Very High	The risk area located downstream of the dam is a low risk area, however, the End Lake East Dam being part of the Rose pit sedimentation pond system with the Elfie lake West dam, issues with the End Lake East dam could lead to spill at the Elfie Lake West dam, which is classified as Very High. Consequently, this dam is also classified as Very High.
3	End Lake West dam	Very high	The risk area is located west of the dam. It is assumed that in the event of a breakage *Elfie Lake West dam* and *Mid Lake dam* would overflow. Therefore, the risk area extends to the Rose Pit. The following points are considered: - Presence of 100 or fewer workers; - No significant loss or deterioration of critical fish or wildlife habitat; - Low economic losses.
4	Elfie Lake West dam	Very high	The risk area is located west of the dam. It is assumed that in the event of a breakage *Mid Lake dam* would overflow. Therefore, the risk area extends to the Rose Pit. The following points are considered: - Presence of 100 or fewer workers; - Unknown significance to loss or deterioration of critical fish or wildlife habitat; - Low economic losses.
5	Pike Lake dike	Low	The risk area is located south of Pike dike, towards the Rose Pit. However, the purpose of this dike is only to seclude water from Pike Lake and to limit water infiltration to the pit. Therefore, the existing topography will be able to take back and to contain the stored water in case of a breakage. The following points are considered: - No population at risk - No significant loss or deterioration of critical fish or wildlife habitat; Low economic losses.
6	Rose North Stockpile Pond Dike	Low	The risk area is located east of the dike. The following points are considered: - No population at risk - Unknown significance to loss or deterioration of critical fish or wildlife habitat; Low economic losses.
7	Rose South Stockpile Pond Dikes (Ponds North and West side)	Low	The risk area are located west and north of the dikes. The following points are considered: - No population at risk - Unknown significance to loss or deterioration of critical fish or wildlife habitat; Low economic losses.
8	Rose South Stockpile Pond Dikes (Pond East side)	Significant	The risk area is located east of the dike, towards a wetland. The following points are considered: - No population at risk - Assumption of loss of a marginal habitat; Low economic losses.

5.0 Geotechnical Criteria

5.1 Loading Cases and Stability Criteria - Dams

Table 5-1 Geotechnical factors of safety - Dams

Loading condition	Minimum FoS Recommended (CDA, 2014)
Static – End of construction	> 1,3
Static – Long Term	1,5
Pseudo-static	1,0
Post-seismic	1.2

5.2 Loading Cases and Stability Criteria – Stockpiles

Table 5-2 Geotechnical factors of safety - Stockpiles

Loading condition	Minimum FoS[(1)]
Static – End of construction	> 1,3
Static – Long Term	1,5
Pseudo-static	1,0
Post-seismic	1.2

[(1)] Based on MERN (2022) and British Columbia Mine Waste Rock Pile Research Committee (1991). No specific guideline applicable in Newfoundland & Labrador

5.3 Design Earthquake

It is assumed that all dams related to Rose Pit will be dismantled after closure. Therefore, the Construction, Operation and Transition criteria (CDA, 2014) are selected.

Table 5-3: Target Levels for Earthquake Hazards – Construction, Operation and Transition Phases (CDA, 2014)

Dam Classification	Annual Exceedance Probability (AEP) – Earthquakes (1)
Low	1/100 AEP
Significant	Between 1/100 and 1/1 000
High	1/2 475 (2)
Very High	1/2 between 1/2 475 (note 2) and 1/10 000 or MCE (3)
Extreme	1/10 000 or MCE (3)

Notes:

Acronyms: MCE, Maximum Credible Earthquake; AEP, annual exceedance probability

1. *Mean values of the estimated range in AEP levels for earthquakes should be used. The earthquake(s) with the AEP as defined above is(are) then input as the contributory earthquake(s) to develop the Earthquake Design Ground Motion (EDGM) parameters as described in Section 6.5 of the Dam Safety Guidelines (CDA 2013).*
2. *This level has been selected for consistency with seismic design levels given in the National Building Code of Canada.*
3. *MCE has no associated AEP.*

Based on dam classification, the following criteria will be considered for the Design Earthquake of each dam.

Table 5-4: Design Earthquake for Selected Dams

No.	Infrastructure	Class	Earthquakes
1	Mid Lake dam	Very high	1/2 between 1/2 475 and 1/10 000 or MCE
2	End Lake East dam	Very High	1/2 between 1/2 475 and 1/10 000 or MCE
3	End Lake West dam	Very high	1/2 between 1/2 475 and 1/10 000 or MCE
4	Elfie Lake West dam	Very high	1/2 between 1/2 475 and 1/10 000 or MCE
5	Pike Lake dike	Low	1/100 AEP
6	Rose North Stockpile Dike	Low	1/100 AEP
7	Rose South Stockpile Pond Dikes (Ponds North and West side)	Low	1/100 AEP
8	Rose South Stockpile Pond Dikes (Pond East side)	Significant	Between 1/100 and 1/1 000

5.4 Seismic Parameters

The seismic parameters for Kami site were extracted from the 2020 National Building Code of Canada Seismic Hazard Tool. According to available information, the first 30 m of soil is generally assumed to be of site Class C (very dense soil and soft rock) with some sectors being of site Class D (stiff soils).

Table 5-5: Seismic Parameters, Kami Site, Class C and Class D

Return Period	Peak Horizontal Ground Acceleration (PGA)	
	Class C	Class D
1:475	0.0185	0.0289
1:1000	0.0296	0.0467
1:2475	0.0518	0.0820
1: 5000	0.0800	0.1270
1:10000	0.1250	0.2000

The PGA for a 5 000-year and 10 000-year return period was extrapolated based on the 2020 National Building Code of Canada Seismic Hazard Tool.

The seismic stability will be examined using pseudo-static analyses, using 80% of the peak strength for fine-grained foundation materials (reference: Hynes-Griffin and Franklin). The post-seismic stability will also be assessed, using residual strength parameters if the soils are found to be liquefiable.

For the pseudo-static analyses, a seismic coefficient (K_h) equivalent to half of the peak ground acceleration (PGA) will be used.

5.5 Geometrical Parameters

The permanent roads surrounding the Rose Pit will have a width of approximately 30 m. This parameter was provided by GMining and is set to allow for bidirectional traffic of mining trucks (100 tons), or one directional traffic of 300 tons trucks. A safety berm is included in this width.

The dam crest width considered will be sufficient for one way passage of a CAT 777 truck (+/- 15 m). CAT 777 trucks are assumed to be used for construction.

Safety berms will be planned on all dams and dikes crests.

5.6 Material

Water management infrastructures will be built with the available material on site.

Information on the characteristics of available material on site will be based on former field investigations realized by Stantec (2012), WorleyParsons (2013) and Golder (2018).

Material properties for stability and seepage analyses will be based on information available in previous site wide geotechnical studies.

As the majority of the good quality till will be used for the construction of the tailings storage facility, geomembrane will be prioritized as the sealing method for the dams related to the Rose Pit water management. Cut-off key trench will also be considered for foundation design.

For the sedimentation ponds associated with Rose North Stockpile and Rose South Stockpile, they will be constructed using cut&fill methodology and the embankment will also be sealed with a geomembrane.

6.0 Hydrological Criteria

The groundwater, seepage water and the runoff that will accumulate in the Rose Pit shall be managed as follows:

- Perimeter diversion channels shall be built around the Rose Pit to prevent external surface runoff from entering the Rose Pit.
- A diversion dam and pipe shall be built to attenuate and divert the runoff from headwaters areas upstream of the Rose Pit.
- Dewatering pumping facilities shall be built to dewater groundwater seepage and surface runoff from the Rose Pit. The water will be pumped to the Rose Pit sedimentation pond. Elfie Lake will be used as a sedimentation pond.
- An treatment plant shall be built to treat the water from the sedimentation pond before discharging into the environment.
- The dewatering pumping facilities shall operate all year-round. However, the treatment plant will not be operating in the winter months. Therefore, no discharge from the sedimentation pond to the environment shall occur during the winter months.

Table 6-1: Water Management Design Criteria for Rose Pit Water Management Infrastructures

	Rose Pit Sump	Rose Pit Sedimentation Pond	Mid-Lake Dam	South Pike Lake and Pike Dike	Rose North Stockpile sedimentation pond	Rose South Stockpile sedimentation pond
Water type	**Contact**	**Contact**	**Non-Contact**	**Non-Contact**	**Non-Contact**	**Contact**
Environmental Design Flood (EDF to be contained above the NOWL)	Most critical of: 30 days 100-yr rainfall plus snowmelt events or 24 hours 100-yr rainfall events	Most critical of: 30 days 100-yr rainfall plus snowmelt events or 24 hours 100-yr rainfall events	Most critical of: 30 days 100-yr rainfall plus snowmelt events or 24 hours 100-yr rainfall events The trade-off between the risk of evacuation of the pit during the life of mine and the need to design for the EDF will be studied.	N/A Design will be based on the natural water level of Pike Lake + freeboard. Available natural variation of lakes in the area will be analyzed in order to define a reasonable criteria.	Most critical of: 30 days 100-yr rainfall plus snowmelt events or 24 hours 100-yr rainfall events	Most critical of: 30 days 100-yr rainfall plus snowmelt events or 24 hours 100-yr rainfall events
Inflow Design Flood (IDF) (to be evacuated by Emergency Spillway)	N/A	See **Table 6-3**	See **Table 6-3**	See **Table 6-3**	See **Table 6-3**	See **Table 6-3**
Other water input	Infiltration in the pit. To be determined with conceptual hydrogeological model.	--	--	--	--	--
LOWL (Low Operating Water Level) and NOWL (Normal Operating Water Level)	Evaluated based on annual water balance computed on a monthly basis considering average, 1:100 years wet and 1:100 years dry years	Evaluated based on annual water balance computed on a monthly basis considering average, 1:100 years wet and 1:100 years dry years	Evaluated based on annual water balance computed on a monthly basis considering average, 1:100 years wet and 1:100 years dry years	N/A South part of Pike Lake will be kept empty	Evaluated based on annual water balance computed on a monthly basis considering average, 1:100 years wet and 1:100 years dry years	Evaluated based on annual water balance computed on a monthly basis considering average, 1:100 years wet and 1:100 years dry years
Water Quality Criteria	--	Remove TSS to reach concentrations that are below the discharge criteria	--	--		

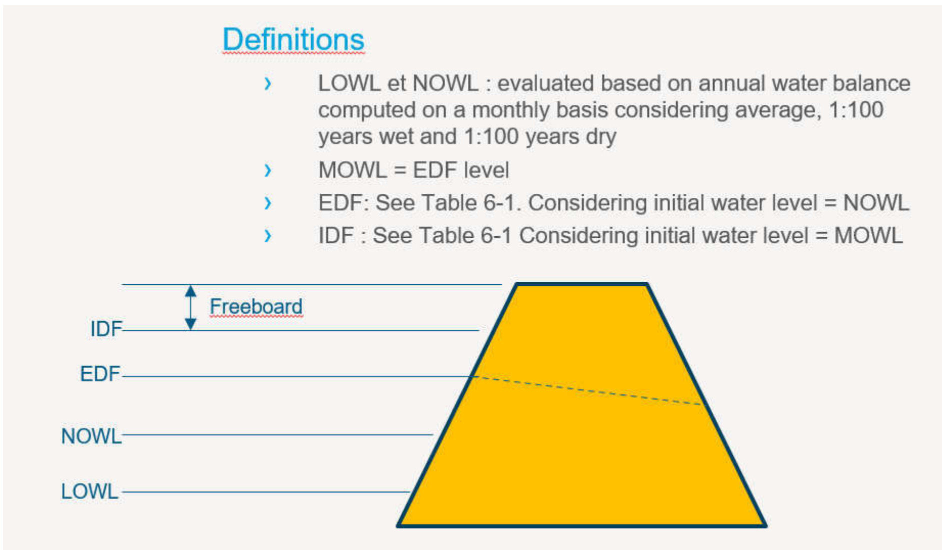
	Rose Pit Sump	Rose Pit Sedimentation Pond	Mid-Lake Dam	South Pike Lake and Pike Dike	Rose North Stockpile sedimentation pond	Rose South Stockpile sedimentation pond
Water type	**Contact**	**Contact**	**Non-Contact**	**Non-Contact**	**Non-Contact**	**Contact**
Water Treatment	No	Yes (see **Section 7.0**)	No	No	Yes (see **Section 7.0**) *This non contact water will be diverted to Rose pit sedimentation pond (Elfie Lake & End Lake) so it will go through the water treatment	Yes (see **Section 7.0**)
Specific gravity of particles to settle	--	2,65	--	--	2.65	2.65
Waterproofing of the bottom of infrastructure	No	No To be confirmed following reception of Bloom Lake water quality data	No	No	Yes	Yes
Dead volume for sediments	0 m	Min 1 m above bottom of basin	Min 1 m above bottom of basin	Min 1 m above bottom of basin	Min 1 m above bottom of basin	Min 1 m above bottom of basin
Pump intake	Bottom of basin	Min 1 m above bottom of basin	Min 1 m above bottom of basin	Min 1 m above bottom of basin	Min 1 m above bottom of basin	Min 1 m above bottom of basin
Minimum Water Level	Same as pump intake	Same as pump intake	Same as pump intake	Same as pump intake	Same as pump intake	Same as pump intake
Freeboard	0 m	According to CDA for wind and wave action	According to CDA for wind and wave action	According to CDA for wind and wave action	According to CDA for wind and wave action	According to CDA for wind and wave action
Ice Cover	0 m	2 m, considered for the purpose of equipment position	2 m, considered for the purpose of equipment position	2 m, considered for the purpose of equipment position	2 m, considered for the purpose of equipment position	2 m, considered for the purpose of equipment position
Pumping – period	12 month / year	No pumping and treatment during November, December, January, February. Beginning of treatment/pumping: mid-March 2 weeks before spring freshet [(1)].	No pumping during November, December, January, February. Beginning of pumping: mid-March 2 weeks before the spring freshet.	From South Pike Lake to Pike Lake: No pumping during November, December, January, February. Beginning of pumping: mid-March 2 weeks before the spring freshet.	No pumping and treatment during November, December, January, February. Beginning of treatment/pumping: mid-March 2 weeks before spring freshet.	No pumping and treatment during November, December, January, February. Beginning of treatment/pumping: mid-March 2 weeks before spring freshet.

	Rose Pit Sump	**Rose Pit Sedimentation Pond**	**Mid-Lake Dam**	**South Pike Lake and Pike Dike**	**Rose North Stockpile sedimentation pond**	**Rose South Stockpile sedimentation pond**
Water type	**Contact**	**Contact**	**Non-Contact**	**Non-Contact**	**Non-Contact**	**Contact**
Pumping - capacity	Pumping to accommodate Environmental design flood (EDF). Consider two weeks to empty the Sump after the EDF. In the case where pumping capacity required to accommodate this criterion would be unrealistic, probability of flooding during the LoM (Life of Mine) will be evaluated and a possible modification of criteria will be discussed with MFQ.	Pumping to accommodate Environmental design flood (EDF). Consider 1 month to reach the NOWL after the EDF.	Pumping to accommodate Environmental design flood (EDF). The trade-off between the cost and the risk of evacuation of the pit and the increase of the pumping capacity will be studied. Consider 1 month to reach the NOWL after the EDF.	Consider 1 month to empty the south part of Pike Lake after the normal spring freshet.	Pumping to accommodate Environmental design flood (EDF). Consider 1 month to reach the NOWL after the EDF.	Pumping to accommodate Environmental design flood (EDF). Consider 1 month to reach the NOWL after the EDF.
Piping – Location	Rose Pit sump to Rose Pit sedimentation pond.	Sedimentation pond to treatment Pike Lake.	Mid-Lake Dam to Long Lake (or Pike Lake). Trade-off for sedimentation pond to Pike Lake will be considered.	South Pike Lake to Pike Lake.	Rose North Stockpile sedimentation pond to Rose Pit sedimentation pond (End Lake & Elfie Lake)	Rose South Stockpile sedimentation pond to Rose Pit sedimentation pond (End Lake & Elfie Lake)
Piping - type	Above ground pipe, heat traced.	Above ground pipe, heat traced.	Above ground HDPE pipe.	Above ground HDPE pipe.	Above ground HDPE pipe.	Above ground HDPE pipe.
Diversion Ditches	Minimum slope 0,5% Transversal slope min. 2H:1V Design flow: 100 years – duration for the concentration time Freeboard: 0.3 m	Minimum slope 0,5% Transversal slope min. 2H:1V Design flow: 100 years – duration for the concentration time Freeboard: 0.3 m	--	--	Minimum slope 0,5% Transversal slope min. 2H:1V Design flow: 100 years – duration for the concentration time Freeboard: 0.3 m	Minimum slope 0,5% Transversal slope min. 2H:1V Design flow: 100 years – duration for the concentration time Freeboard: 0.3 m

(1) : The pumping period could be adjusted during the mandate if the pond capacity is not sufficient due to the amount of dewatering water evaluated for Rose pit.

6.1 Typical Schematic - EDF Storage and IDF Conveyance

Figure 6-1: EDF Storage and IDF Conveyance Schematic



Note: *LOWL = Low Operating Water Level*
NOWL = Normal Operating Water Level
MOWL = Maximum Operating Water Level

6.2 Inflow Design Flood (IDF)

It is assumed that all dams related to Rose Pit will be dismantled after closure. Therefore, the Construction, Operation and Transition criteria (CDA, 2014) are selected.

Table 6-2: Target Levels for Flood Hazards, Standards-Based Assessments, for Construction, Operation, and Transition Phases

Dam Classification	Annual Exceedance Probability – Floods (1)
Low	1/100
Significant	Between 1/100 and 1/1 000 (2)
High	1/3 Between 1/1000 and PMF (3)
Very High	2/3 Between 1/1000 and PMF (3)
Extreme	PMF (3)

Notes:
Acronyms: PMF, Probable Maximum Flood; AEP, annual exceedance probability
1. *Simple extrapolation of flood statistics beyond 10^{-3} AEP is not acceptable*
2. *Selected on basis of incremental flood analysis, exposure, and consequence of failure*
3. *PMF has no associated AEP*

Based on dam classification, the following criteria will be considered for the IDF of each dam.

Table 6-3: IDF for Selected Dams

No.	Infrastructure	Class	IDF
1	Mid Lake dam	Very high	2/3 Between 1/1000 and PMF
2	End Lake East dam	Very high	2/3 Between 1/1000 and PMF
3	End Lake West dam	Very high	2/3 Between 1/1000 and PMF
4	Elfie Lake West dam	Very high	2/3 Between 1/1000 and PMF
5	Pike Lake dike	Low	1/100
6	Rose North Stockpile Dike	Low	1/100
7	Rose South Stockpile Pond Dikes (Ponds North and West side)	Low	1/100
8	Rose South Stockpile Pond Dikes (Pond East side)	Significant	Between 1/100 and 1/1 000

6.3 Hydrological Data

The hydrological data that will be used to design the water management infrastructures are provided in **Table 6-4** to **Table 6-9**.

Table 6-4: Rainfall, Snowfall and Precipitation for the Kami Mine Site

Month	Rainfall (mm)[(1)]	Snowfall (cm)	Precipitation (mm)[(1)]
January	0.8	53.2	54.0
February	1.3	40.1	41.4
March	3.2	51.8	55.0
April	11.4	42.9	54.3
May	42.1	16.7	58.7
June	83.5	1.9	85.4
July	111.9	0.0	111.9
August	102.9	0.0	102.9
September	89.1	4.8	93.9
October	41.1	37.7	78.8
November	15.5	61.6	77.2
December	3.5	61.1	64.6
Annual	**506.3**	**371.8**	**878.1**

[(1)]: *Calculated from Wabush Lake A station data (1961-2012).*

The 100-years wet and dry year precipitation have been evaluated using Gumbel distribution.

Table 6-5 : 100-years Wet and Dry Precipitations(1)

Month	100-years Dry (mm)	100-year Wet (mm)
January	33,3	83,0
February	24,8	64,0
March	30,8	86,4
April	15,1	94,9
May	34,4	91,4
June	77,6	115,6
July	109,9	146,4
August	96,3	137,6
September	92,2	122,9
October	67,3	109,4
November	54,3	114,4
December	39,8	99,3
Annual	**675,8**	**1265,1**

(1): *Calculated from Wabush Lake A station data (1961-2012).*

Table 6-6: IDF Curves for 2041 – 2070 Time Horizon, Wabush Lake A, Office of Climate Change and Energy Efficiency, Government of Newfoundland, and Labrador

Duration	Return Interval (years)					
	2	5	10	25	50	100
5-min	5.8	7.9	9.4	11.2	12.5	13.8
10-min	8.1	11.1	13.2	15.7	17.5	19.3
15-min	9.7	13.3	15.8	18.8	21.0	23.2
30-min	13.2	17.9	21.3	25.2	28.1	30.9
1-hr	16.1	21.9	26.0	30.8	34.4	37.9
2-hr	19.2	25.2	29.4	34.4	38.0	41.7
6-hr	24.9	31.0	35.1	40.2	44.0	47.7
12-hr	33.2	41.3	46.8	53.7	58.7	63.7
24-hr	41.3	51.0	57.6	65.7	71.7	77.6

Table 6-7: Long-Term Rain-on-Snow Events for Various Durations

Duration (days)	Rain-on-snow depth [(1)] (mm)					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
1	50.59+/-1.64	66.87+/-2.77	77.65+/-3.74	91.27+/- 5.05	101.37+/- 6.04	111.40+/- 7.03
2	83.97+/-2.67	110.42+/-4.50	127.94+/-6.08	150.07+/- 8.20	166.49+/- 9.81	182.79+/-11.43
3	108.20+/-3.16	139.43+/-5.31	160.11+/-7.18	186.23+/- 9.68	205.61+/-11.58	224.85+/-13.49
4	128.64+/-3.48	163.10+/-5.86	185.92+/-7.92	214.75+/-10.68	236.13+/-12.78	257.36+/-14.89
5	147.52+/-3.86	185.75+/-6.51	211.07+/-8.79	243.05+/-11.85	266.78+/-14.18	290.33+/-16.52
6	165.55+/-4.31	208.24+/-7.26	236.51+/-9.81	272.22+/-13.23	298.72+/-15.83	325.02+/-18.44
7	183.03+/-4.90	231.54+/-8.26	263.66+/-11.15	304.24+/-15.0	334.35+/-17.99	364.23+/-20.96
8	199.87+/-5.17	251.07+/-8.71	284.96+/-11.77	327.79+/-15.86	359.56+/-18.98	391.09+/-22.11
9	215.00+/-5.39	268.37+/-9.08	303.70+/-12.27	348.35+/-16.54	381.47+/-19.79	414.35+/-23.05
10	228.92+/-5.60	284.36+/-9.43	321.06+/-12.74	367.44+/-17.18	401.84+/-20.56	435.99+/-23.95
15	285.17+/-6.14	345.91+/-0.34	386.13+/-13.96	436.94+/-18.82	474.64+/-22.52	512.06+/-26.24
20	330.36+/-6.62	395.92+/11.16	439.33+/-15.07	494.17+/-20.32	534.86+/-24.31	575.24+/-28.32
25	358.86+/-7.10	429.11+/-11.95	475.62+/-16.15	534.39+/-21.77	577.99+/-26.05	621.27+/-30.35
30	388.15+/-7.28	460.23+/-12.26	507.95+/-16.57	568.24+/-22.34	612.97+/-26.73	657.37+/-31.13

(1): Obtained from Environment and Climate Change Canada based on the model 3 (Western Canadian Mountain Basin) at the Wabush Lake A Station for the period of record between 1961 and 2013.

Table 6-8: Maximum Snow Cover and Water Equivalent, Wabush Lake A, 1961-2012

Return Period	Snow Cover (cm)	Water Equivalent (mm)[(1)]
2	102	307
5	139	416
10	163	488
25	193	578
100	237	712
1000	311	933
2000	333	999
10000	384	1153

(1): The average density of the snow cover was set at 300 kg/m^3 (British Columbia Ministry of Environment. (2023)

Table 6-9: Evaporation, Evapotranspiration, Based Thornthwaite Method, Wabush Lake A, 1961-2012

Month	Lake Evaporation (mm)	Evapotranspiration (mm)
January	0.0	0.0
February	0.0	0.0
March	0.0	0.0
April	0.0	0.0
May	42.9	37.2
June	95.3	95.3
July	117.5	117.5
August	97.3	97.3
September	54.0	39.6
October	2.6	0.3
November	0.0	0.0
December	0.0	0.0
Annual	**409.8**	**387.3**

Note that for coherence purpose, when available, the evaporation values estimated by WSP for the tailings storage facility water management could be used instead of the value presented above.

Table 6-10: Mean Monthly Air Temperature and Wind Speed

Month	Temperature (°C)(1)	Wind speed (Km/h)(2)
January	-22.0	13.8
February	-20.5	13.8
March	-13.7	14.9
April	-4.8	14.9
May	3.5	13.8
June	10.2	14.3
July	13.8	12.7
August	12.5	12.8
September	7.1	14.4
October	0.4	15.2
November	-7.9	14.7
December	-17.3	13.2
Annual	**-3.2**	**14.0**

(1): Calculated from data from Wabush Lake A (1961-2013) for Temperature and Wabush Lake A (1981 – 2010) for wind speed.

6.4 Probable Maximum Flood (PMF)

The summer-fall PMP (Probable Maximum Precipitation) evaluated based on CEHQ (2004) is:

- 356,3 mm for a 72 hours event.

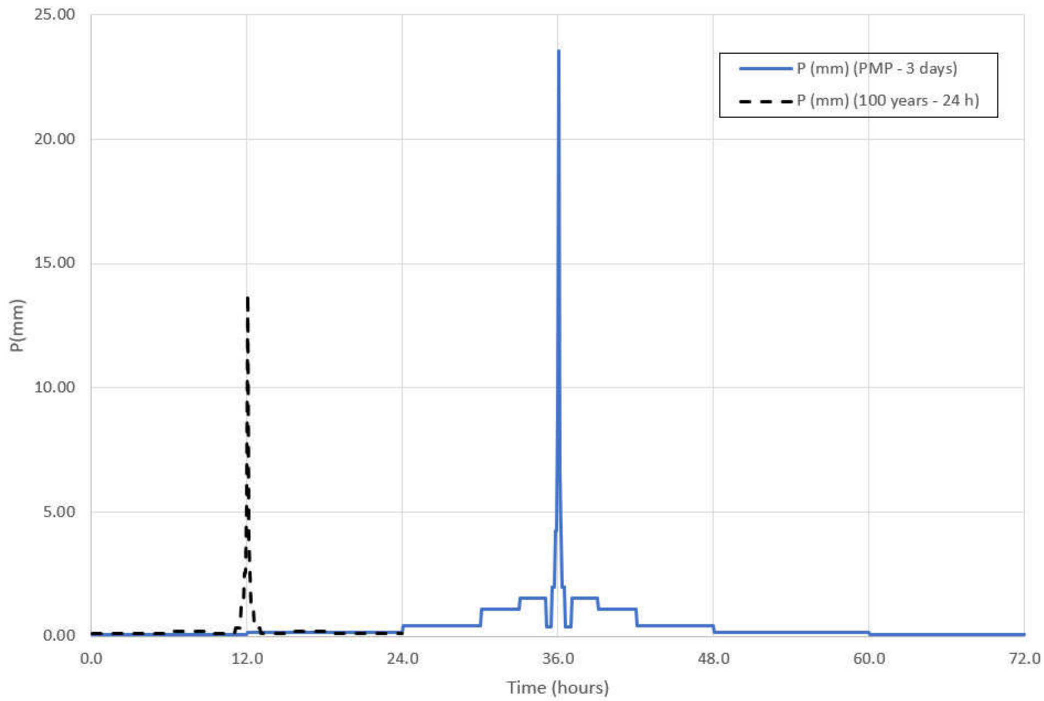
PMP alone (no spring freshet considered) will be used for IDF evaluation assuming summer-fall PMP will produce the most critical conditions for spillway design.

Note that for coherence purpose, when available, the PMP value estimated by WSP for the tailings storage facility water management could be used instead of the value presented above.

6.5 Hydrograph Shape

When computing a flood routing with a rain event, typical symmetrical hydrograph based on the IDF curves will be used.

Figure 6-2 : Symmetrical Hydrograph



6.6 Runoff Coefficient

Runoff coefficient will be used for the design of infrastructures using flood events, and for the annual water balance. Two sets of runoff coefficients will be used for those two types of calculation. For the flood events, the runoff coefficients will be evaluated through numerical modeling with PCSWMM™ software where runoff will be evaluated based on Manning Coefficient and Infiltration Coefficient. With this methodology, runoff coefficient will vary depending on the modeled meteorological event.

The proposed runoff coefficient presented in **Table 6-11** for the flood event were calculated with the PCSWMM models considering specific sets of infiltration parameters for the spring event and for the summer-fall event. Those coefficients were generated when simulating the 1:100 year spring event (30 days melting of the rain-on-snow depth) and the summer-fall 24h 1:100 year event.

For annual water balance, runoff coefficients are based on litterature.

The following Table shows the runoff coefficient to be used as part of the project. Concerning the runoff coefficient of the Rose pit, it has been determined based on the proportion of horizontal surfaces of compacted rock versus the surfaces of bare rock pit walls.

Table 6-11 : Proposed Runoff Coefficients

	Flood Event Proposed runoff coefficient			Annual Water Balance Proposed runoff coefficient		
Surface Type	Spring	Summer / Fall	Reference	Winter	Summer / Fall	Reference
Natural ground - forest	0.87	0.27	PCSWMM model 2023	1.00	0.19	Mailhot, A. et al (2021)
Roads and Pads	0.94	0.78	PCSWMM model 2023	1.00	0.50	Mailhot, A. et al (2021)
Pit	0.95	0.70	PCSWMM model 2023	1.00	0.59	
Overburden stockpile	0.86	0.38	PCSWMM model 2023	1.00	0.30	Mailhot, A. et al (2021)
Waste rock stockpile	0.84	0.30	PCSWMM model 2023	1.00	0.25	Mailhot, A. et al (2021)

7.0 Water Treatment Design Criteria

The Rose Pit is not expected to generate any adverse environmental effects associated with Acid Rock Drainage (ARD)/Metal Leaching (ML) and Red Water. Therefore, water quality treatment for ARD/ML is not required. However, total suspended solids (TSS) shall be removed before discharging the water into the environment. Moreover, and given the fact that nitrogen-based explosives will be used in the Rose Pit, an ammonia treatment plant might be required. The concentrations and loading rates of nitrogen species expected in Kami Mine will be determined based on a few hypotheses made in concert with MFQ and the water quality at Bloom Lake, which is open-pit iron ore mine operated by MFQ and located a few kilometers away from Kami Mine.

7.1 Treatment Period and Capacity

Water from the Rose Pit will be continuously pumped to the sedimentation pond where a portion of the TSS will be removed. However, during the winter months no discharge to the environment shall happen and the water will be stored in sedimentation pond. Thus, the water treatment plant shall operate from March through mid-December.

The water treatment plant shall have the capacity to treat the maximum flow rate pumped from the sedimentation pond during the life of the mine (LOM). This flow rate will be calculated based on the hydrological design criteria while considering maximum flowrates from the Rose Pit, the overburden and wasterock stockpiles and the water level in the sedimentation pond.

7.2 Treatment Process

If an ammonia treatment plant is deemed necessary, it shall be able to treat the ammonia species and reach concentrations that are below the discharge criteria presented in the following section. Based on the water quality sampling at Lake Bloom, the main ammonia species that need to be treated are the ionized ammonia (NH_4^+) and nitrates (NO_3^-). The removal of NH_4^+ can be achieved through biological nitrification or ion exchange. Nitrate removal can only be achieved through a biological denitrification process. The adequate treatment process shall be selected based on the capital and operational costs, the constructability, and constraints of the Kami Mine site.

In case the nitrogen species treatment is required, a TSS removal stage will be necessary to remove the biomass stemming from the biological process. Since the sedimentation will not be designed to remove 100% of TSS in the water below the discharge criteria, the TSS removal stage will still be required even without a nitrogen treatment plant.

7.3 Discharge Criteria

The effluent discharged from the treatment plant to the environment shall comply with the following regulations:

- Newfoundland and Labrador Environmental Control Water and Sewage Regulations (NL Reg. 65/03).
- Metal and Diamond Mining Effluent regulations (MDMER) (SOR/2002-222).
- Wastewater Systems Effluent Regulations (SOR/2012-139).

The following table presents the parameters and their respective discharge criteria according to the aforementioned regulations:

Table 7-1: Discharge criteria

Parameter	Maximum concentration in mg/l (unless indicated otherwise)				
	NL Reg. 65/03 (1)	SOR/2002-222 (2)	SOR/2002-222 (3)	SOR/2002-222 (4)	SOR/2012-139
Temperature (◦C)	32	-	-	-	-
pH	5.5-9	-	-	-	-
B.O.D.	20	-	-	-	25
Coliform - faecal	1000/100 ml	-	-	-	-
Coliform - total	5000/100 ml	-	-	-	-
Solids (dissolved)	1000	-	-	-	-
Solids (suspended)	30	15	22.5	30	25
Oils (ether extract)	15	-	-	-	-
Floating debris, oils, and grease	None to be visible	-	-	-	-
Arsenic	0.5	0.1	0.15	0.2	-
Barium	5	-	-	-	-
Boron	5	-	-	-	-
Cadmium	0.05	-	-	-	-
Chlorine	1	-	-	-	0.02
Chromium (hexavalent)	0.05	-	-	-	-
Chromium (trivalent)	1	-	-	-	-
Copper	0.3	0.1	0.15	0.2	-
Cyanide	0.025	0.5	0.75	1	-
Iron (total)	10	-	-	-	-
Lead	0.2	0.08	0.12	0.16	-
Mercury	0.005	-	-	-	-
Nickel	0.5	0.25	0.38	0.5	-
Nitrates	10	-	-	-	-
Nitrogen (ammoniacal)	2	-	-	-	-
Unionized ammonia (5)	-	0.5	-	1	1.25

Parameter	Maximum concentration in mg/l (unless indicated otherwise)				
	NL Reg. 65/03 (1)	SOR/2002-222 (2)	SOR/2002-222 (3)	SOR/2002-222 (4)	SOR/2012-139
Phenol	0.1	-	-	-	-
Phosphates (total as P_2O_5)	1	-	-	-	-
Phosphorus (elementary)	0.0005	-	-	-	-
Radium 226 (6)	-	0.37	0.74	1.11	-
Selenium	0.01	-	-	-	-
Strontium 90 (6)	-	-	-	-	-
Sulfides	0.5	-	-	-	-
Silver	0.05	-	-	-	-
Zinc	0.5	0.4	0.6	0.8	-

(1): According to section 6, schedule A and schedule C of NL Reg. 65/03.
(2): Maximum authorized monthly mean concentration according to schedule 4 of SOR/2002-222.
(3): Maximum authorized concentration in a composite sample according to schedule 4 of SOR/2002-222.
(4): Maximum authorized concentration in a grab sample according to schedule 4 of SOR/2002-222.
(5): Unionized ammonia is expressed as nitrogen (N).
(6): Expressed in Bq/L.

It is worth mentioning that the discharged effluent shall also comply with Canadian Water Quality Guidelines (CWQG) for the protection of aquatic life.

8.0 References

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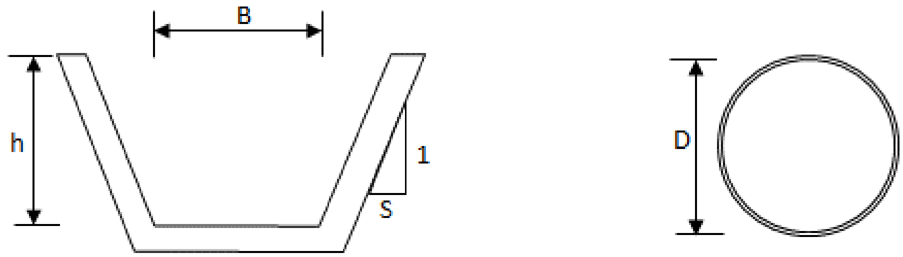
Appendix B

Dimensions of Hydraulic Conduction Structures



Trapezoidal

Circular

Figure B-1: General Dimensions of the Ditches and Culverts

End & Elfie Lake ditch 4:

Table B-1: Ditches and Culverts Dimensions for End & Elfie Lake

Conduit	Section Type	Height(h) / Diameter(D)	Width (B)	Side Slope (S)	Max. Flow	Max. Velocity	Max. Water Depth
		[m]	[m]	[m/m]	[m³/s]	[m/s]	[m]
C1_1	Trapezoidal	1.00	1.0	2.0	0.178	1.190	0.13
C1_11	Trapezoidal	1.00	1.0	2.0	0.347	2.150	0.13
C1_12	Trapezoidal	1.00	1.0	2.0	0.347	1.840	0.15
C1_13	Trapezoidal	1.00	1.0	2.0	0.347	1.220	0.32
C1_14	Trapezoidal	1.00	1.0	2.0	0.305	0.600	0.31
C1_15	Trapezoidal	1.00	1.0	2.0	0.303	1.100	0.20
C1_16	Trapezoidal	1.00	1.0	2.0	0.302	0.560	0.40
C1_17	Circular	0.60	0.0	0.0	0.471	2.220	0.53
C1_2	Trapezoidal	1.00	1.0	2.0	0.175	0.800	0.19
C1_3	Circular	0.60	0.0	0.0	0.173	2.750	0.16
C1_4	Trapezoidal	1.00	1.0	2.0	0.173	1.190	0.12
C1_5	Trapezoidal	1.00	1.0	2.0	0.173	1.020	0.13
C1_6	Trapezoidal	1.00	1.0	2.0	0.194	1.040	0.17
C1_7	Trapezoidal	1.00	1.0	2.0	0.192	0.800	0.18
C1_8	Trapezoidal	1.00	1.0	2.0	0.192	1.060	0.14
C1_9	Trapezoidal	1.00	1.0	2.0	0.192	0.650	0.36

Appendix B

Dimensions of Hydraulic Conduction Structures

Table B-2: Ditches Rock Revetment for End & Elfie Lake

Conduit	Section Type	Size	D_{50} (theoretical)	D_{50} (selected)	Layer Thickness (theoretical)	Layer Thickness (selected)
		[mm]	[mm]	[mm]	[mm]	[mm]
C1_1	Trapezoidal	0-200	100	200-300	300	500
C1_11	Trapezoidal	100-200	150	200-300	300	500
C1_12	Trapezoidal	0-200	100	200-300	300	500
C1_13	Trapezoidal	0-200	100	200-300	300	500
C1_14	Trapezoidal	0-200	100	200-300	300	500
C1_15	Trapezoidal	0-200	100	200-300	300	500
C1_16	Trapezoidal	0-200	100	200-300	300	500
C1_17	Circular					
C1_2	Trapezoidal	0-200	100	200-300	300	500
C1_3	Circular					
C1_4	Trapezoidal	0-200	100	200-300	300	500
C1_5	Trapezoidal	0-200	100	200-300	300	500
C1_6	Trapezoidal	0-200	100	200-300	300	500
C1_7	Trapezoidal	0-200	100	200-300	300	500
C1_8	Trapezoidal	0-200	100	200-300	300	500
C1_9	Trapezoidal	0-200	100	200-300	300	500

Appendix B

Dimensions of Hydraulic Conduction Structures

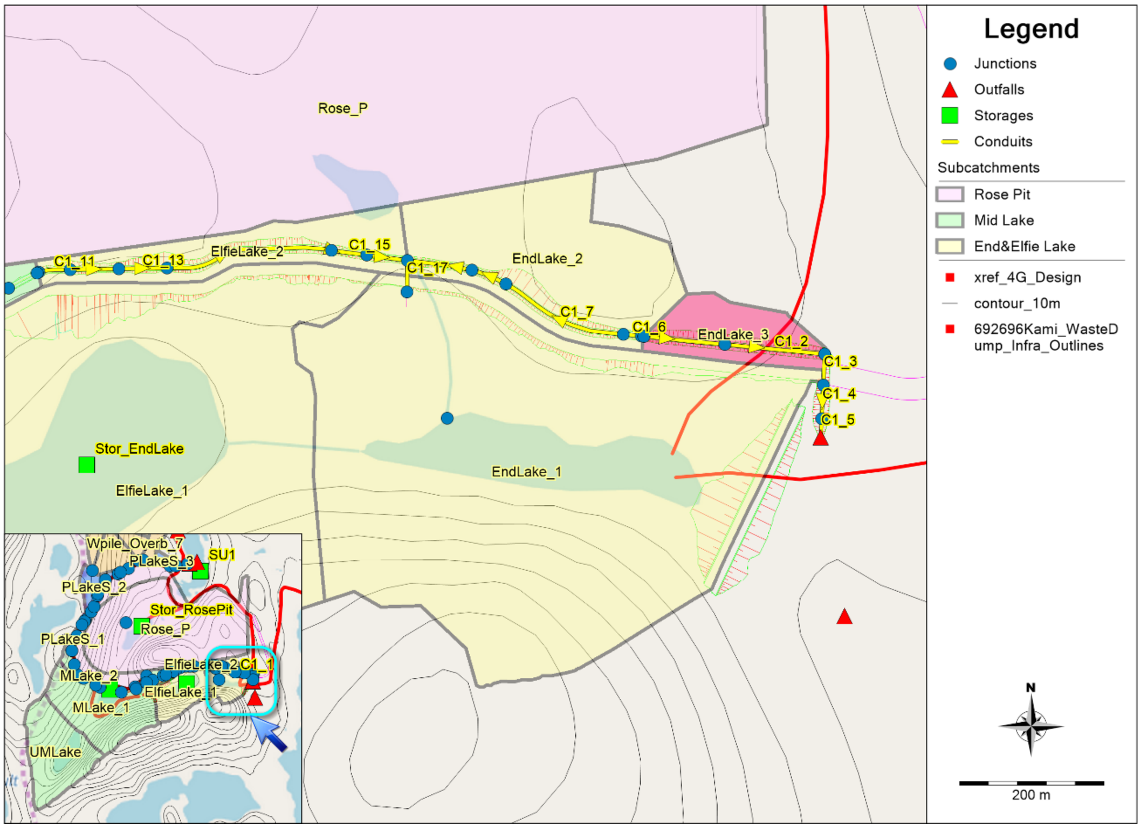


Figure B-2: Location of Ditches and Culverts for End & Elfie Lake

Appendix B

Dimensions of Hydraulic Conduction Structures

Mid Lake ditches 3 and 5:

Table B-3: Ditches and Culverts Dimensions for Mid Lake – East

Conduit	Section Type	Height(h) / Diameter(D)	Width (B)	Side Slope (S)	Max. Flow	Max. Velocity	Max. Water Depth
		[m]	[m]	[m/m]	[m³/s]	[m/s]	[m]
C2_1	Trapezoidal	1.00	1.0	2.0	0.563	2.310	0.18
C2_10	Trapezoidal	1.00	1.0	2.0	0.641	1.350	0.30
C2_11	Trapezoidal	1.00	1.0	2.0	0.101	0.640	0.18
C2_2	Trapezoidal	1.00	1.0	2.0	0.562	1.960	0.20
C2_3	Trapezoidal	1.00	1.0	2.0	0.562	1.980	0.20
C2_4	Trapezoidal	1.00	1.0	2.0	0.562	2.510	0.17
C2_5	Trapezoidal	1.00	1.0	2.0	0.561	2.070	0.20
C2_6	Trapezoidal	1.00	1.0	2.0	0.561	1.890	0.21
C2_7	Trapezoidal	1.00	1.0	2.0	0.560	1.690	0.26
C2_8	Trapezoidal	1.00	1.0	2.0	0.558	1.300	0.28
C2_9	Circular	0.60	0.0	0.0	0.625	3.750	0.37

Table B-4: Ditches Rock Revetment for Mid Lake – East

Conduit	Section Type	Size	D_{50} (theoretical)	D_{50} (selected)	Layer Thickness (theoretical)	Layer Thickness (selected)
		[mm]	[mm]	[mm]	[mm]	[mm]
C2_1	Trapezoidal	200-300	250	200-300	500	500
C2_10	Trapezoidal	0-200	100	200-300	300	500
C2_11	Trapezoidal	0-200	100	200-300	300	500
C2_2	Trapezoidal	0-200	100	200-300	300	500
C2_3	Trapezoidal	0-200	100	200-300	300	500
C2_4	Trapezoidal	200-300	250	200-300	500	500
C2_5	Trapezoidal	100-200	150	200-300	300	500
C2_6	Trapezoidal	0-200	100	200-300	300	500
C2_7	Trapezoidal	0-200	100	200-300	300	500
C2_8	Trapezoidal	0-200	100	200-300	300	500
C2_9	Circular					

Appendix B

Dimensions of Hydraulic Conduction Structures

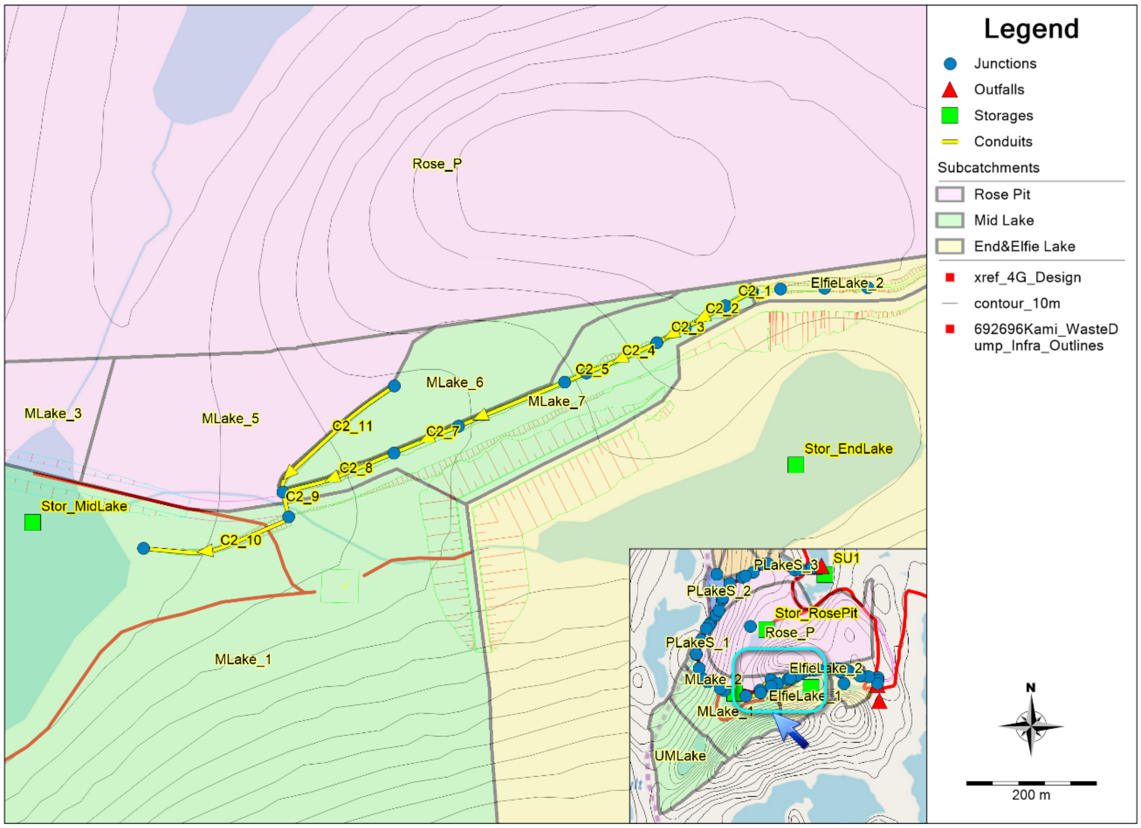


Figure B-3: Location of Ditches and Culverts for Mid Lake – East

Appendix B

Dimensions of Hydraulic Conduction Structures

Rose Pit ditch 2:

Table B-5: Ditches and Culverts Dimensions for Mid Lake – West

Conduit	Section Type	Height(h) / Diameter(D)	Width (B)	Side Slope (S)	Max. Flow	Max. Velocity	Max. Water Depth
		[m]	[m]	[m/m]	[m³/s]	[m/s]	[m]
C3_1	Trapezoidal	1.00	1.0	2.0	0.247	1.680	0.12
C3_2	Trapezoidal	1.00	1.0	2.0	0.246	1.830	0.11
C3_3	Trapezoidal	1.00	1.0	2.0	0.245	2.750	0.08
C3_4	Trapezoidal	1.00	1.5	2.0	0.358	2.550	0.08
C3_5	Trapezoidal	1.00	1.0	2.0	0.358	2.250	0.13
C3_6	Trapezoidal	1.00	1.0	2.0	0.357	1.000	0.25

Table B-6: Ditches Rock Revetment for Mid Lake – West

Conduit	Section Type	Size	D_{50} (theoretical)	D_{50} (selected)	Layer Thickness (theoretical)	Layer Thickness (selected)
		[mm]	[mm]	[mm]	[mm]	[mm]
C3_1	Trapezoidal	0-200	100	200-300	300	500
C3_2	Trapezoidal	0-200	100	200-300	300	500
C3_3	Trapezoidal	200-300	250	200-300	500	500
C3_4	Trapezoidal	200-300	250	200-300	500	500
C3_5	Trapezoidal	100-200	150	200-300	300	500
C3_6	Trapezoidal	0-200	100	200-300	300	500

Appendix B

Dimensions of Hydraulic Conduction Structures

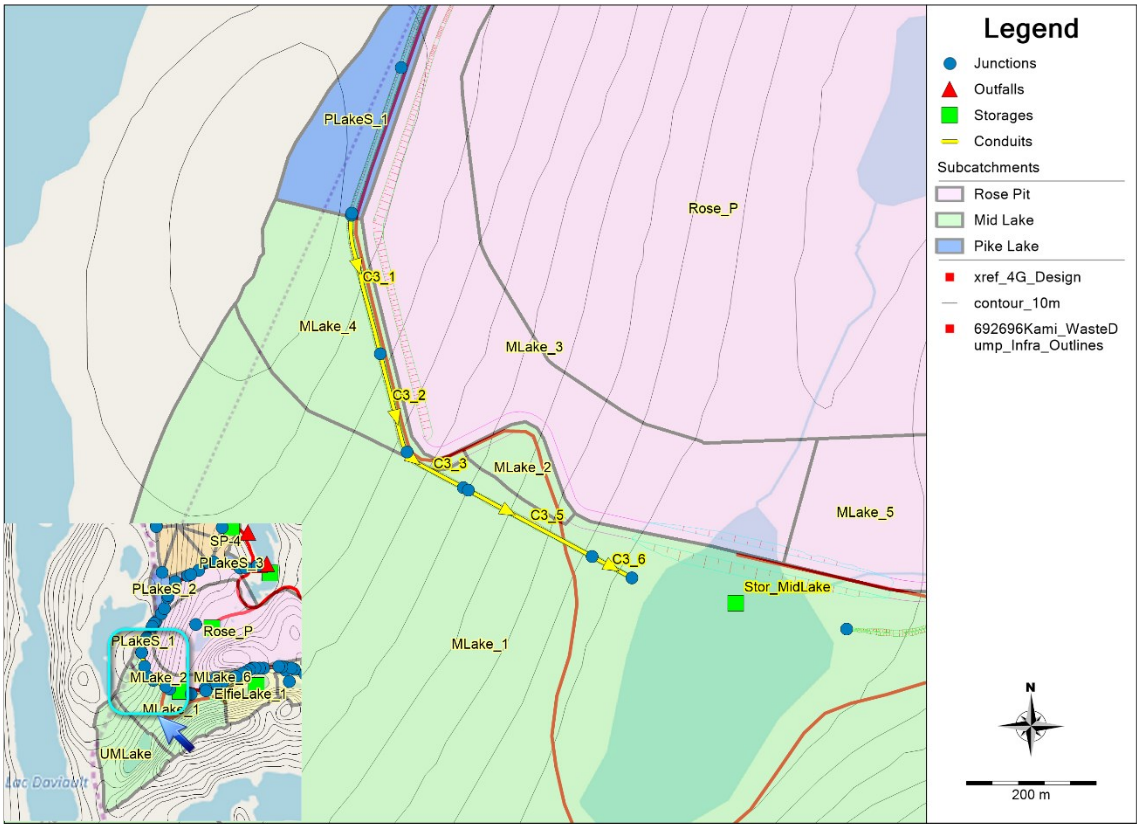


Figure B-4: Location of Ditches and Culverts for Mid Lake – West

Appendix B

Dimensions of Hydraulic Conduction Structures

Table B-7: Ditches and Culverts Dimensions for Pike Lake

Conduit	Section Type	Height(h) / Diameter(D)	Width (B)	Side Slope (S)	Max. Flow	Max. Velocity	Max. Water Depth
		[m]	[m]	[m/m]	[m³/s]	[m/s]	[m]
C4_1	Trapezoidal	1.00	1.0	2.0	0.193	1.130	0.13
C4_10	Trapezoidal	1.00	2.0	2.0	0.937	2.530	0.16
C4_11	Trapezoidal	1.00	1.5	2.0	0.937	2.470	0.20
C4_12	Trapezoidal	1.00	1.0	2.0	0.937	2.260	0.27
C4_13	Trapezoidal	1.00	1.0	2.0	1.095	1.550	0.55
C4_14	Trapezoidal	1.00	1.0	2.0	1.030	0.920	0.54
C4_15	Trapezoidal	1.00	1.0	2.0	1.027	2.200	0.29
C4_16	Trapezoidal	1.00	1.0	2.0	1.026	1.890	0.33
C4_17	Trapezoidal	1.00	1.0	2.0	1.026	1.740	0.35
C4_2	Trapezoidal	1.00	1.0	2.0	0.191	1.120	0.21
C4_3	Trapezoidal	1.00	1.0	2.0	0.188	0.680	0.20
C4_4	Trapezoidal	1.00	1.0	2.0	0.188	0.300	0.36
C4_5	Trapezoidal	1.00	1.0	2.0	0.948	1.110	0.45
C4_6	Trapezoidal	1.00	1.0	2.0	0.948	1.620	0.37
C4_7	Trapezoidal	1.00	1.0	2.0	0.946	1.670	0.34
C4_8	Trapezoidal	1.00	1.0	2.0	0.946	2.420	0.54
C4_9	Trapezoidal	1.00	1.0	2.0	0.938	0.870	0.53

Appendix B

Dimensions of Hydraulic Conduction Structures

Table B-8: Ditches Rock Revetment for Pike Lake

Conduit	Section type	Size	D_{50} (theoretical)	D_{50} (selected)	Layer Thickness (theoretical)	Layer Thickness (selected)
		[mm]	[mm]	[mm]	[mm]	[mm]
C4_1	Trapezoidal	0-200	100	200-300	300	500
C4_10	Trapezoidal	200-300	250	200-300	500	500
C4_11	Trapezoidal	200-300	250	200-300	500	500
C4_12	Trapezoidal	100-200	150	200-300	300	500
C4_13	Trapezoidal	0-200	100	200-300	300	500
C4_14	Trapezoidal	0-200	100	200-300	300	500
C4_15	Trapezoidal	100-200	150	200-300	300	500
C4_16	Trapezoidal	0-200	100	200-300	300	500
C4_17	Trapezoidal	0-200	100	200-300	300	500
C4_2	Trapezoidal	0-200	100	200-300	300	500
C4_3	Trapezoidal	0-200	100	200-300	300	500
C4_4	Trapezoidal	0-200	100	200-300	300	500
C4_5	Trapezoidal	0-200	100	200-300	300	500
C4_6	Trapezoidal	0-200	100	200-300	300	500
C4_7	Trapezoidal	0-200	100	200-300	300	500
C4_8	Trapezoidal	200-300	250	200-300	500	500
C4_9	Trapezoidal	0-200	100	200-300	300	500
C4_1	Trapezoidal	0-200	100	200-300	300	500

Appendix B

Dimensions of Hydraulic Conduction Structures

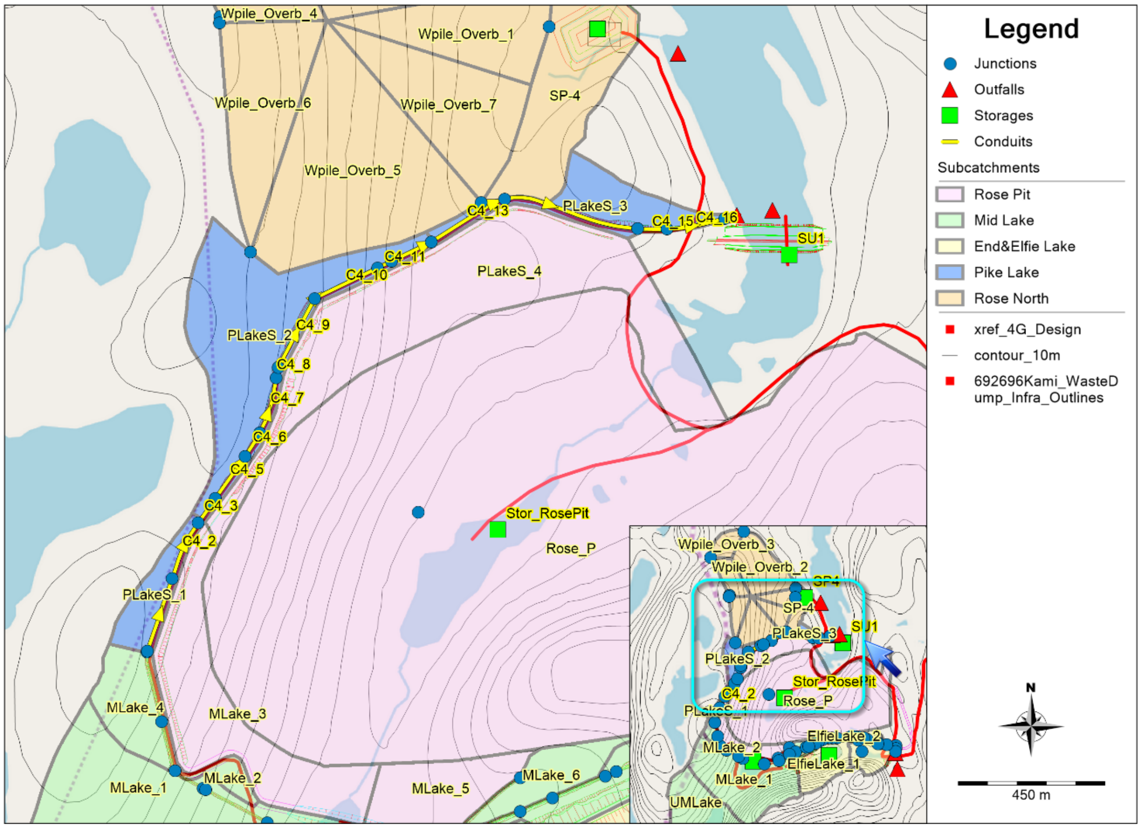


Figure B-5: Location of Ditches and Culverts for Pike Lake

Appendix B

Dimensions of Hydraulic Conduction Structures

Rose North ditches:

Table B-9: Ditches Dimensions for Rose North

Conduit	Section Type	Height(h) / Diameter(D)	Width (B)	Side Slope (S)	Max. Flow	Max. Velocity	Max. Water Depth
		[m]	[m]	[m/m]	[m³/s]	[m/s]	[m]
C5_1	Trapezoidal	1.00	1.5	2.0	2.408	2.680	0.43
C5_2	Trapezoidal	1.00	1.5	2.0	3.737	2.550	0.62
C5_3	Trapezoidal	1.50	2.5	2.0	7.052	2.360	0.83
C5_4	Trapezoidal	1.50	2.5	2.0	7.111	1.330	1.19
C5_5	Trapezoidal	1.00	1.5	2.0	1.544	2.120	0.41
C5_6	Trapezoidal	1.00	1.5	2.0	2.645	2.720	0.37
C5_7	Trapezoidal	1.50	2.5	2.0	3.401	1.900	0.72

Table B-10: Ditches Rock Revetment for Rose North

Conduit	Section Type	Size	D_{50} (theoretical)	D_{50} (selected)	Layer Thickness (theoretical)	Layer Thickness (selected)
		[mm]	[mm]	[mm]	[mm]	[mm]
C5_1	Trapezoidal	0-200	100	200-300	300	500
C5_2	Trapezoidal	200-300	250	200-300	500	500
C5_3	Trapezoidal	200-300	250	200-300	500	500
C5_4	Trapezoidal	100-200	150	200-300	300	500
C5_5	Trapezoidal	0-200	100	200-300	300	500
C5_6	Trapezoidal	0-200	100	200-300	300	500
C5_7	Trapezoidal	100-200	150	200-300	300	500

Appendix B

Dimensions of Hydraulic Conduction Structures

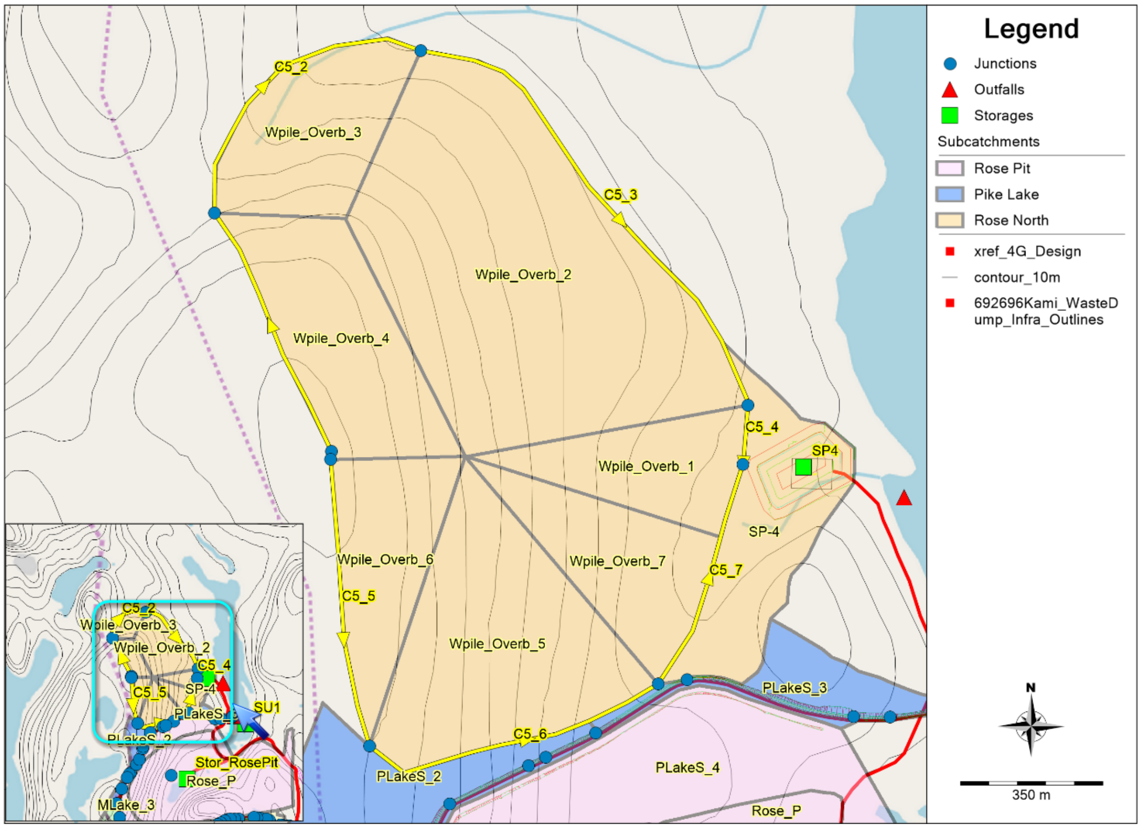


Figure B-6: Location of Ditches for Rose North

Appendix B

Dimensions of Hydraulic Conduction Structures

Rose South ditches:

Table B-11: Ditches Dimensions for Rose South

Conduit	Section Type	Height(h) / Diameter(D)	Width (B)	Side Slope (S)	Max. Flow	Max. Velocity	Max. Water Depth
		[m]	[m]	[m/m]	[m³/s]	[m/s]	[m]
C6_1	Trapezoidal	1.00	1.0	2.0	0.285	1.060	0.27
C6_10	Trapezoidal	1.00	1.0	2.0	0.853	1.930	0.28
C6_11	Trapezoidal	1.00	1.0	2.0	0.848	2.340	0.41
C6_12	Trapezoidal	1.00	1.0	2.0	0.879	1.300	0.51
C6_13	Trapezoidal	1.00	1.0	2.0	0.772	1.230	0.57
C6_14	Trapezoidal	1.00	1.0	2.0	0.972	2.000	0.60
C6_2	Trapezoidal	1.00	1.0	2.0	1.300	1.310	0.58
C6_3	Trapezoidal	1.00	1.0	2.0	2.950	2.420	0.57
C6_4	Trapezoidal	1.00	1.0	2.0	2.930	2.190	0.61
C6_5	Trapezoidal	1.00	1.0	2.0	0.947	1.390	0.47
C6_6	Trapezoidal	1.00	3.0	2.0	1.996	0.720	0.68
C6_7	Trapezoidal	1.00	1.0	2.0	0.234	0.930	0.19
C6_8	Trapezoidal	1.00	1.0	2.0	0.234	0.400	0.35
C6_9	Trapezoidal	1.00	1.0	2.0	0.828	0.650	0.59

Appendix B

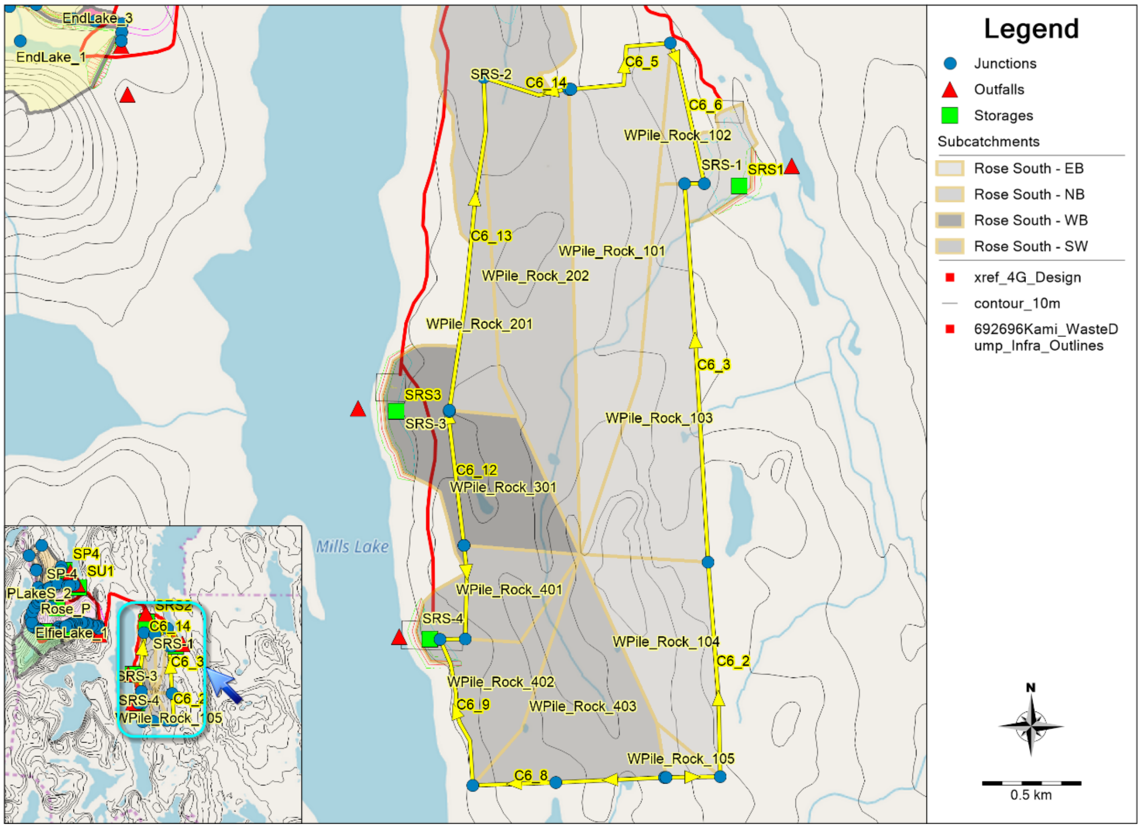
Dimensions of Hydraulic Conduction Structures

Table B-12: Ditches Rock Revetment for Rose South

Conduit	Section Type	Size	D_{50} (theoretical)	D_{50} (selected)	Layer Thickness (theoretical)	Layer Thickness (selected)
		[mm]	[mm]	[mm]	[mm]	[mm]
C6_1	Trapezoidal	0-200	100	200-300	300	500
C6_10	Trapezoidal	0-200	100	200-300	300	500
C6_11	Trapezoidal	200-300	250	200-300	500	500
C6_12	Trapezoidal	0-200	100	200-300	300	500
C6_13	Trapezoidal	0-200	100	200-300	300	500
C6_14	Trapezoidal	100-200	150	200-300	300	500
C6_2	Trapezoidal	0-200	100	200-300	300	500
C6_3	Trapezoidal	200-300	250	200-300	500	500
C6_4	Trapezoidal	100-200	150	200-300	300	500
C6_5	Trapezoidal	0-200	100	200-300	300	500
C6_6	Trapezoidal	0-200	100	200-300	300	500
C6_7	Trapezoidal	0-200	100	200-300	300	500
C6_8	Trapezoidal	0-200	100	200-300	300	500
C6_9	Trapezoidal	0-200	100	200-300	300	500

Appendix B

Dimensions of Hydraulic Conduction Structures



Note: A slight change in the geometry of the north-east sector of the stockpile has not been integrated to the calculation illustrated on this figure. This slight change does not affect ditch design.

Figure B-7: Location of Ditches for Rose South

Appendix C

Annual Balances for Years of Normal Precipitations

Table C-1: Annual Water Balance for Rose North

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Input	Monthly Intake	Monthly Pumped	% of Pump Use (1480 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	53.2	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	1,395	0	0.0%
February	40.1	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	2,112	0	0.0%
March	51.8	3.2	0.0	0.0	0.0	0.0	3.2	3.2	0	5,298	59,912	10.9%
April	42.9	11.4	125.9	0.0	0.0	0.0	137.4	137.4	0	228,020	228,020	21.4%
May	16.7	42.1	198.7	42.9	37.2	132.0	197.9	71.6	0	121,296	121,296	11.0%
June	1.9	83.5	1.9	85.4	85.4	0.0	0.0	0.0	0	0	0	0.0%
July	0.0	111.9	0.0	111.9	111.9	0.0	0.0	0.0	0	0	0	0.0%
August	0.0	102.9	0.0	97.3	97.3	3.6	5.6	2.0	0	3,319	3,319	0.3%
September	4.8	89.1	4.8	54.0	39.6	35.2	39.9	19.1	0	32,087	32,087	3.0%
October	37.7	41.1	28.8	2.6	0.3	45.1	67.2	24.5	0	41,459	41,459	3.8%
November	61.6	15.5	11.8	0.0	0.0	0.0	27.3	27.3	0	45,308	0	0.0%
December	61.1	3.5	0.0	0.0	0.0	0.0	3.5	3.5	0	5,799	0	0.0%
Annual	**372**	**506**	**372**	**394**	**372**	**216**	**484**	**291**	**0**	**486,094**	**486,094**	

Appendix C

Annual Balances for Years of Normal Precipitations

Table C-2: Annual Water Balance for Rose South EB

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Input	Monthly Intake	Monthly Pumped	% of Pump Use (1750 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	53.2	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	1,580	0	0.0%
February	40.1	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	2,392	0	0.0%
March	51.8	3.2	0.0	0.0	0.0	0.0	3.2	3.2	0	6,000	67,853	10.4%
April	42.9	11.4	125.9	0.0	0.0	0.0	137.4	137.4	0	258,240	258,240	20.5%
May	16.7	42.1	198.7	42.9	37.2	150.6	197.9	52.9	0	101,295	101,295	7.8%
June	1.9	83.5	1.9	85.4	85.4	0.0	0.0	0.0	0	0	0	0.0%
July	0.0	111.9	0.0	111.9	111.9	0.0	0.0	0.0	0	0	0	0.0%
August	0.0	102.9	0.0	97.3	97.3	4.1	5.6	1.4	0	2,771	2,771	0.2%
September	4.8	89.1	4.8	54.0	39.6	40.2	39.9	14.1	0	26,850	26,850	2.1%
October	37.7	41.1	28.8	2.6	0.3	51.5	67.2	18.1	0	34,624	34,624	2.7%
November	61.6	15.5	11.8	0.0	0.0	0.0	27.3	27.3	0	51,313	0	0.0%
December	61.1	3.5	0.0	0.0	0.0	0.0	3.5	3.5	0	6,568	0	0.0%
Annual	**372**	**506**	**372**	**394**	**372**	**246**	**484**	**260**	**0**	**491,633**	**491,633**	

Appendix C

Annual Balances for Years of Normal Precipitations

Table C-3: Annual Water Balance for Rose South NB

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Input	Monthly Intake	Monthly Pumped	% of Pump Use (4410 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	53.2	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	1,185	0	0.0%
February	40.1	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	1,794	0	0.0%
March	51.8	3.2	0.0	0.0	0.0	0.0	3.2	3.2	121,990	126,490	172,880	10.5%
April	42.9	11.4	125.9	0.0	0.0	0.0	137.4	137.4	464,282	657,962	657,962	20.7%
May	16.7	42.1	198.7	42.9	37.2	151.4	197.9	52.2	182,067	256,402	256,402	7.8%
June	1.9	83.5	1.9	85.4	85.4	0.0	0.0	0.0	0	0	0	0.0%
July	0.0	111.9	0.0	111.9	111.9	0.0	0.0	0.0	0	0	0	0.0%
August	0.0	102.9	0.0	97.3	97.3	4.1	5.6	1.4	4,982	7,015	7,015	0.2%
September	4.8	89.1	4.8	54.0	39.6	40.4	39.9	13.9	48,216	67,972	67,972	2.1%
October	37.7	41.1	28.8	2.6	0.3	51.8	67.2	17.8	62,232	87,643	87,643	2.7%
November	61.6	15.5	11.8	0.0	0.0	0.0	27.3	27.3	0	38,484	0	0.0%
December	61.1	3.5	0.0	0.0	0.0	0.0	3.5	3.5	0	4,926	0	0.0%
Annual	**372**	**506**	**372**	**394**	**372**	**248**	**484**	**259**	**883,770**	**1,249,874**	**1,249,874**	

Appendix C

Annual Balances for Years of Normal Precipitations

Table C-4: Annual Water Balance for Rose South WB

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Input	Monthly Intake	Monthly Pumped	% of Pump Use (1400 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	53.2	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	479	0	0.0%
February	40.1	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	725	0	0.0%
March	51.8	3.2	0.0	0.0	0.0	0.0	3.2	3.2	33,565	35,385	54,138	10.4%
April	42.9	11.4	125.9	0.0	0.0	0.0	137.4	137.4	127,746	206,042	206,042	20.4%
May	16.7	42.1	198.7	42.9	37.2	151.6	197.9	52.0	50,049	80,773	80,773	7.7%
June	1.9	83.5	1.9	85.4	85.4	0.0	0.0	0.0	0	0	0	0.0%
July	0.0	111.9	0.0	111.9	111.9	0.0	0.0	0.0	0	0	0	0.0%
August	0.0	102.9	0.0	97.3	97.3	4.1	5.6	1.4	1,369	2,210	2,210	0.2%
September	4.8	89.1	4.8	54.0	39.6	40.4	39.9	13.9	13,272	21,366	21,366	2.1%
October	37.7	41.1	28.8	2.6	0.3	51.8	67.2	17.8	17,108	27,608	27,608	2.6%
November	61.6	15.5	11.8	0.0	0.0	0.0	27.3	27.3	0	15,558	0	0.0%
December	61.1	3.5	0.0	0.0	0.0	0.0	3.5	3.5	0	1,991	0	0.0%
Annual	**372**	**506**	**372**	**394**	**372**	**248**	**484**	**258**	**243,109**	**392,137**	**392,137**	

Appendix C

Annual Balances for Years of Normal Precipitations

Table C-5: Annual Water Balance for Rose South SW

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Input	Monthly Intake	Monthly Pumped	% of Pump Use (936 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	53.2	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	782	0	0.0%
February	40.1	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	1,183	0	0.0%
March	51.8	3.2	0.0	0.0	0.0	0.0	3.2	3.2	0	2,968	33,565	9.6%
April	42.9	11.4	125.9	0.0	0.0	0.0	137.4	137.4	0	127,746	127,746	19.0%
May	16.7	42.1	198.7	42.9	37.2	150.6	197.9	52.9	0	50,049	50,049	7.2%
June	1.9	83.5	1.9	85.4	85.4	0.0	0.0	0.0	0	0	0	0.0%
July	0.0	111.9	0.0	111.9	111.9	0.0	0.0	0.0	0	0	0	0.0%
August	0.0	102.9	0.0	97.3	97.3	4.1	5.6	1.4	0	1,369	1,369	0.2%
September	4.8	89.1	4.8	54.0	39.6	40.2	39.9	14.1	0	13,272	13,272	2.0%
October	37.7	41.1	28.8	2.6	0.3	51.5	67.2	18.1	0	17,108	17,108	2.5%
November	61.6	15.5	11.8	0.0	0.0	0.0	27.3	27.3	0	25,383	0	0.0%
December	61.1	3.5	0.0	0.0	0.0	0.0	3.5	3.5	0	3,249	0	0.0%
Annual	**372**	**506**	**372**	**394**	**372**	**246**	**484**	**260**	**0**	**243,109**	**243,109**	

Appendix C

Annual Balances for Years of Normal Precipitations

Table C-6: Annual Water Balance for Mid Lake

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Input	Monthly Intake	Monthly Pumped	% of Pump Use (1900 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m^3)	(m^3)	(m^3)	
January	53.2	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	2,242	0	0.0%
February	40.1	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	3,394	0	0.0%
March	51.8	3.2	0.0	0.0	0.0	0.0	3.2	3.2	0	8,512	96,264	13.6%
April	42.9	11.4	125.9	0.0	0.0	0.0	137.4	137.4	0	366,371	366,371	26.8%
May	16.7	42.1	198.7	42.9	37.2	163.8	197.9	39.7	0	136,313	136,313	9.6%
June	1.9	83.5	1.9	85.4	85.4	0.0	0.0	0.0	0	0	0	0.0%
July	0.0	111.9	0.0	111.9	111.9	0.0	0.0	0.0	0	0	0	0.0%
August	0.0	102.9	0.0	97.3	97.3	4.5	5.6	1.1	0	3,757	3,757	0.3%
September	4.8	89.1	4.8	54.0	39.6	43.7	39.9	10.6	0	33,875	33,875	2.5%
October	37.7	41.1	28.8	2.6	0.3	56.0	67.2	13.6	0	46,523	46,523	3.3%
November	61.6	15.5	11.8	0.0	0.0	0.0	27.3	27.3	0	72,798	0	0.0%
December	61.1	3.5	0.0	0.0	0.0	0.0	3.5	3.5	0	9,318	0	0.0%
Annual	**372**	**506**	**372**	**394**	**372**	**268**	**484**	**238**	**0**	**683,102**	**683,102**	

Appendix C

Annual Balances for Years of Normal Precipitations

Table C-7: Annual Water Balance for Pike Lake South (water released to the north of the lake)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	53.2	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	4,858	0	0.0%
February	40.1	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	7,354	0	0.0%
March	51.8	3.2	0.0	0.0	0.0	0.0	3.2	3.2	2,757,335	2,775,781	0	0.0%
April	42.9	11.4	125.9	0.0	0.0	0.0	137.4	137.4	4,285,954	5,079,904	0	0.0%
May	16.7	42.1	198.7	42.9	37.2	164.9	197.9	38.7	2,232,428	2,581,739	0	0.0%
June	1.9	83.5	1.9	85.4	85.4	0.0	0.0	0.0	1,200,000	1,200,000	0	0.0%
July	0.0	111.9	0.0	111.9	111.9	0.0	0.0	0.0	1,240,000	1,240,000	0	0.0%
August	0.0	102.9	0.0	97.3	97.3	4.5	5.6	1.1	1,267,204	1,276,878	0	0.0%
September	4.8	89.1	4.8	54.0	39.6	44.0	39.9	10.3	1,458,675	1,541,634	0	0.0%
October	37.7	41.1	28.8	2.6	0.3	56.4	67.2	13.2	1,579,089	1,698,186	0	0.0%
November	61.6	15.5	11.8	0.0	0.0	0.0	27.3	27.3	1,308,357	1,466,116	0	0.0%
December	61.1	3.5	0.0	0.0	0.0	0.0	3.5	3.5	1,253,870	1,274,063	0	0.0%
Annual	**372**	**506**	**372**	**394**	**372**	**270**	**484**	**237**	**18,582,912**	**20,146,513**	**0**	

[1] Water flow coming from pumping of the End & Elfie Lake, Mid Lake, and Pike Lake Dike.

Appendix C

Annual Balances for Years of Normal Precipitations

Table C-8: Annual Water Balance for Pike Lake South (natural basin before construction)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Input	Monthly Intake	Monthly Pumped	% of Pump Use
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m^3)	(m^3)	(m^3)	
January	53.2	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	12,169	0	0.0%
February	40.1	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	18,423	0	0.0%
March	51.8	3.2	0.0	0.0	0.0	0.0	3.2	3.2	0	46,213	0	0.0%
April	42.9	11.4	125.9	0.0	0.0	0.0	137.4	137.4	0	1,988,996	0	0.0%
May	16.7	42.1	198.7	42.9	37.2	164.9	197.9	38.7	0	757,535	0	0.0%
June	1.9	83.5	1.9	85.4	85.4	0.0	0.0	0.0	0	0	0	0.0%
July	0.0	111.9	0.0	111.9	111.9	0.0	0.0	0.0	0	0	0	0.0%
August	0.0	102.9	0.0	97.3	97.3	4.5	5.6	1.1	0	20,905	0	0.0%
September	4.8	89.1	4.8	54.0	39.6	44.0	39.9	10.3	0	185,998	0	0.0%
October	37.7	41.1	28.8	2.6	0.3	56.4	67.2	13.2	0	258,471	0	0.0%
November	61.6	15.5	11.8	0.0	0.0	0.0	27.3	27.3	0	395,217	0	0.0%
December	61.1	3.5	0.0	0.0	0.0	0.0	3.5	3.5	0	50,588	0	0.0%
Annual	**372**	**506**	**372**	**394**	**372**	**270**	**484**	**237**	**0**	**3,734,515**	**0**	

Appendix D

Annual Balances for Wet Years

Table D-1: Annual Water Balance for Rose Pit (wet year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	Underground Inlet	Monthly Intake	Monthly Pumped	% of Pump Use (4680 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	81.7	1.3	0.0	0.0	0.0	0.0	1.3	1.3	1,240,000	1,244,091	1,244,091	35.7%
February	62.1	2.0	0.0	0.0	0.0	0.0	2.0	2.0	1,120,000	1,126,238	1,126,238	35.8%
March	81.4	5.0	0.0	0.0	0.0	0.0	5.0	5.0	1,240,000	1,255,894	1,255,894	36.1%
April	74.9	20.0	196.5	0.0	0.0	0.0	216.4	216.4	1,200,000	1,886,019	1,886,019	56.0%
May	25.9	65.5	309.9	42.9	37.2	137.2	332.4	200.9	1,240,000	1,879,300	1,879,300	54.0%
June	2.5	113.1	2.5	95.3	95.3	8.2	20.2	12.0	1,200,000	1,238,280	1,238,280	36.7%
July	0.0	146.4	0.0	117.5	117.5	11.7	28.9	17.2	1,240,000	1,294,709	1,294,709	37.2%
August	0.0	137.6	0.0	97.3	97.3	16.3	40.3	23.9	1,240,000	1,316,122	1,316,122	37.8%
September	6.2	116.6	6.2	54.0	39.6	33.8	68.8	49.4	1,200,000	1,357,355	1,357,355	40.3%
October	52.4	57.0	39.9	2.6	0.3	39.2	94.3	57.5	1,240,000	1,422,826	1,422,826	40.9%
November	91.3	23.0	17.3	0.0	0.0	0.0	40.3	40.3	1,200,000	1,327,756	1,327,756	39.4%
December	93.9	5.4	0.0	0.0	0.0	0.0	5.4	5.4	1,240,000	1,257,012	1,257,012	36.1%
Annual	**572**	**693**	**572**	**410**	**387**	**247**	**855**	**631**	**14,600,000**	**16,605,603**	**16,605,603**	

Appendix D

Annual Balances for Wet Years

Table D-2: Annual Water Balance for Rose North (wet year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use (1480 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	81.7	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	2,142	0	0.0%
February	62.1	2.0	0.0	0.0	0.0	0.0	2.0	2.0	0	3,267	0	0.0%
March	81.4	5.0	0.0	0.0	0.0	0.0	5.0	5.0	0	8,323	89,541	16.3%
April	74.9	20.0	196.5	0.0	0.0	0.0	216.4	216.4	0	359,240	359,240	33.7%
May	25.9	65.5	309.9	42.9	37.2	219.3	332.4	118.9	0	201,537	201,537	18.3%
June	2.5	113.1	2.5	95.3	95.3	13.1	20.2	7.1	0	12,074	12,074	1.1%
July	0.0	146.4	0.0	117.5	117.5	18.8	28.9	10.2	0	17,257	17,257	1.6%
August	0.0	137.6	0.0	97.3	97.3	26.1	40.3	14.2	0	24,011	24,011	2.2%
September	6.2	116.6	6.2	54.0	39.6	54.0	68.8	29.3	0	49,349	49,349	4.6%
October	52.4	57.0	39.9	2.6	0.3	62.7	94.3	34.0	0	57,621	57,621	5.2%
November	91.3	23.0	17.3	0.0	0.0	0.0	40.3	40.3	0	66,901	0	0.0%
December	93.9	5.4	0.0	0.0	0.0	0.0	5.4	5.4	0	8,908	0	0.0%
Annual	**572**	**693**	**572**	**410**	**387**	**394**	**855**	**484**	**0**	**810,630**	**810,630**	

Appendix D

Annual Balances for Wet Years

Table D-3: Annual Water Balance for Rose South – EB (wet year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use (1750 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	81.7	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	2,426	0	0.0%
February	62.1	2.0	0.0	0.0	0.0	0.0	2.0	2.0	0	3,699	0	0.0%
March	81.4	5.0	0.0	0.0	0.0	0.0	5.0	5.0	0	9,426	101,408	15.6%
April	74.9	20.0	196.5	0.0	0.0	0.0	216.4	216.4	0	406,850	406,850	32.3%
May	25.9	65.5	309.9	42.9	37.2	250.2	332.4	87.9	0	168,288	168,288	12.9%
June	2.5	113.1	2.5	95.3	95.3	15.0	20.2	5.3	0	10,081	10,081	0.8%
July	0.0	146.4	0.0	117.5	117.5	21.4	28.9	7.5	0	14,408	14,408	1.1%
August	0.0	137.6	0.0	97.3	97.3	29.8	40.3	10.5	0	20,047	20,047	1.5%
September	6.2	116.6	6.2	54.0	39.6	61.6	68.8	21.6	0	41,263	41,263	3.3%
October	52.4	57.0	39.9	2.6	0.3	71.6	94.3	25.1	0	48,118	48,118	3.7%
November	91.3	23.0	17.3	0.0	0.0	0.0	40.3	40.3	0	75,767	0	0.0%
December	93.9	5.4	0.0	0.0	0.0	0.0	5.4	5.4	0	10,089	0	0.0%
Annual	**572**	**693**	**572**	**410**	**387**	**450**	**855**	**428**	**0**	**810,462**	**810,462**	

Appendix D

Annual Balances for Wet Years

Table D-4: Annual Water Balance for Rose South – NB (wet year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use (4410 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	81.7	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	1,820	0	0.0%
February	62.1	2.0	0.0	0.0	0.0	0.0	2.0	2.0	0	2,775	0	0.0%
March	81.4	5.0	0.0	0.0	0.0	0.0	5.0	5.0	182,318	189,388	258,374	15.7%
April	74.9	20.0	196.5	0.0	0.0	0.0	216.4	216.4	731,465	1,036,603	1,036,603	32.6%
May	25.9	65.5	309.9	42.9	37.2	251.4	332.4	86.7	302,495	425,977	425,977	13.0%
June	2.5	113.1	2.5	95.3	95.3	15.1	20.2	5.2	18,121	25,517	25,517	0.8%
July	0.0	146.4	0.0	117.5	117.5	21.5	28.9	7.4	25,899	36,469	36,469	1.1%
August	0.0	137.6	0.0	97.3	97.3	29.9	40.3	10.3	36,036	50,742	50,742	1.5%
September	6.2	116.6	6.2	54.0	39.6	61.9	68.8	21.3	74,124	104,454	104,454	3.3%
October	52.4	57.0	39.9	2.6	0.3	71.9	94.3	24.8	86,488	121,798	121,798	3.7%
November	91.3	23.0	17.3	0.0	0.0	0.0	40.3	40.3	0	56,825	0	0.0%
December	93.9	5.4	0.0	0.0	0.0	0.0	5.4	5.4	0	7,567	0	0.0%
Annual	**572**	**693**	**572**	**410**	**387**	**452**	**855**	**426**	**1,456,947**	**2,059,935**	**2,059,935**	

Appendix D

Annual Balances for Wet Years

Table D-5: Annual Water Balance for Rose South – WB (wet year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use (1400 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	81.7	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	736	0	0.0%
February	62.1	2.0	0.0	0.0	0.0	0.0	2.0	2.0	0	1,122	0	0.0%
March	81.4	5.0	0.0	0.0	0.0	0.0	5.0	5.0	50,165	53,022	80,910	15.5%
April	74.9	20.0	196.5	0.0	0.0	0.0	216.4	216.4	201,261	324,615	324,615	32.1%
May	25.9	65.5	309.9	42.9	37.2	251.8	332.4	86.3	83,148	134,206	134,206	12.8%
June	2.5	113.1	2.5	95.3	95.3	15.1	20.2	5.2	4,981	8,041	8,041	0.8%
July	0.0	146.4	0.0	117.5	117.5	21.6	28.9	7.4	7,118	11,491	11,491	1.1%
August	0.0	137.6	0.0	97.3	97.3	30.0	40.3	10.3	9,904	15,989	15,989	1.5%
September	6.2	116.6	6.2	54.0	39.6	62.0	68.8	21.2	20,392	32,862	32,862	3.3%
October	52.4	57.0	39.9	2.6	0.3	72.0	94.3	24.7	23,774	38,371	38,371	3.7%
November	91.3	23.0	17.3	0.0	0.0	0.0	40.3	40.3	0	22,972	0	0.0%
December	93.9	5.4	0.0	0.0	0.0	0.0	5.4	5.4	0	3,059	0	0.0%
Annual	**572**	**693**	**572**	**410**	**387**	**452**	**855**	**425**	**400,744**	**646,485**	**646,485**	

Appendix D

Annual Balances for Wet Years

Table D-6: Annual Water Balance for Rose South – SW (wet year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use (936 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	81.7	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	1,200	0	0.0%
February	62.1	2.0	0.0	0.0	0.0	0.0	2.0	2.0	0	1,830	0	0.0%
March	81.4	5.0	0.0	0.0	0.0	0.0	5.0	5.0	0	4,663	50,165	14.4%
April	74.9	20.0	196.5	0.0	0.0	0.0	216.4	216.4	0	201,261	201,261	29.9%
May	25.9	65.5	309.9	42.9	37.2	250.2	332.4	87.9	0	83,148	83,148	11.9%
June	2.5	113.1	2.5	95.3	95.3	15.0	20.2	5.3	0	4,981	4,981	0.7%
July	0.0	146.4	0.0	117.5	117.5	21.4	28.9	7.5	0	7,118	7,118	1.0%
August	0.0	137.6	0.0	97.3	97.3	29.8	40.3	10.5	0	9,904	9,904	1.4%
September	6.2	116.6	6.2	54.0	39.6	61.6	68.8	21.6	0	20,392	20,392	3.0%
October	52.4	57.0	39.9	2.6	0.3	71.6	94.3	25.1	0	23,774	23,774	3.4%
November	91.3	23.0	17.3	0.0	0.0	0.0	40.3	40.3	0	37,481	0	0.0%
December	93.9	5.4	0.0	0.0	0.0	0.0	5.4	5.4	0	4,991	0	0.0%
Annual	**572**	**693**	**572**	**410**	**387**	**450**	**855**	**428**	**0**	**400,744**	**400,744**	

Appendix D

Annual Balances for Wet Years

Table D-7: Annual Water Balance for End & Elfie Lake (wet year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use (7100 m^3/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m^3)	(m^3)	(m^3)	
January	81.7	1.3	0.0	0.0	0.0	0.0	1.3	1.3	1,244,091	1,245,124	0	0.0%
February	62.1	2.0	0.0	0.0	0.0	0.0	2.0	2.0	1,126,238	1,127,812	0	0.0%
March	81.4	5.0	0.0	0.0	0.0	0.0	5.0	5.0	1,603,809	1,607,820	1,980,900	75.0%
April	74.9	20.0	196.5	0.0	0.0	0.0	216.4	216.4	3,281,862	3,454,990	3,834,000	75.0%
May	25.9	65.5	309.9	42.9	37.2	269.1	332.4	69.1	2,506,815	2,592,404	3,961,800	75.0%
June	2.5	113.1	2.5	95.3	95.3	16.1	20.2	4.1	1,275,871	1,281,036	1,532,485	30.0%
July	0.0	146.4	0.0	117.5	117.5	23.0	28.9	5.9	1,348,434	1,355,815	1,355,815	25.7%
August	0.0	137.6	0.0	97.3	97.3	32.0	40.3	8.2	1,390,876	1,401,145	1,401,145	26.5%
September	6.2	116.6	6.2	54.0	39.6	66.2	68.8	17.0	1,511,158	1,530,727	1,530,727	29.9%
October	52.4	57.0	39.9	2.6	0.3	77.0	94.3	19.7	1,602,245	1,626,638	1,626,638	30.8%
November	91.3	23.0	17.3	0.0	0.0	0.0	40.3	40.3	1,327,756	1,359,998	1,359,998	26.6%
December	93.9	5.4	0.0	0.0	0.0	0.0	5.4	5.4	1,257,012	1,261,305	1,261,305	23.9%
Annual	**572**	**693**	**572**	**410**	**387**	**483**	**855**	**394**	**19,476,168**	**19,844,814**	**19,844,814**	

Appendix D

Annual Balances for Wet Years

Table D-8: Annual Water Balance for Mid Lake (wet year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use (1900 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m^3)	(m^3)	(m^3)	
January	81.7	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	3,442	0	0.0%
February	62.1	2.0	0.0	0.0	0.0	0.0	2.0	2.0	0	5,248	0	0.0%
March	81.4	5.0	0.0	0.0	0.0	0.0	5.0	5.0	0	13,373	143,870	20.4%
April	74.9	20.0	196.5	0.0	0.0	0.0	216.4	216.4	0	577,208	577,208	42.2%
May	25.9	65.5	309.9	42.9	37.2	272.1	332.4	66.0	0	227,129	227,129	16.1%
June	2.5	113.1	2.5	95.3	95.3	16.3	20.2	4.0	0	13,666	13,666	1.0%
July	0.0	146.4	0.0	117.5	117.5	23.3	28.9	5.6	0	19,531	19,531	1.4%
August	0.0	137.6	0.0	97.3	97.3	32.4	40.3	7.9	0	27,175	27,175	1.9%
September	6.2	116.6	6.2	54.0	39.6	67.0	68.8	16.2	0	53,412	53,412	3.9%
October	52.4	57.0	39.9	2.6	0.3	77.8	94.3	18.9	0	64,815	64,815	4.6%
November	91.3	23.0	17.3	0.0	0.0	0.0	40.3	40.3	0	107,493	0	0.0%
December	93.9	5.4	0.0	0.0	0.0	0.0	5.4	5.4	0	14,313	0	0.0%
Annual	**572**	**693**	**572**	**410**	**387**	**489**	**855**	**389**	**0**	**1,126,806**	**1,126,806**	

Appendix D

Annual Balances for Wet Years

Table D-9: Annual Water Balance for Pike Lake Dike (wet year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use (495 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	81.7	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	711	0	0.0%
February	62.1	2.0	0.0	0.0	0.0	0.0	2.0	2.0	0	1,083	0	0.0%
March	81.4	5.0	0.0	0.0	0.0	0.0	5.0	5.0	0	2,760	29,697	16.1%
April	74.9	20.0	196.5	0.0	0.0	0.0	216.4	216.4	0	119,146	119,146	33.4%
May	25.9	65.5	309.9	42.9	37.2	257.2	332.4	81.0	0	70,545	70,545	19.2%
June	2.5	113.1	2.5	95.3	95.3	15.4	20.2	4.8	0	4,259	4,259	1.2%
July	0.0	146.4	0.0	117.5	117.5	22.0	28.9	6.9	0	6,088	6,088	1.7%
August	0.0	137.6	0.0	97.3	97.3	30.6	40.3	9.6	0	8,470	8,470	2.3%
September	6.2	116.6	6.2	54.0	39.6	63.3	68.8	19.9	0	16,021	16,021	4.5%
October	52.4	57.0	39.9	2.6	0.3	73.5	94.3	23.2	0	20,099	20,099	5.5%
November	91.3	23.0	17.3	0.0	0.0	0.0	40.3	40.3	0	22,188	0	0.0%
December	93.9	5.4	0.0	0.0	0.0	0.0	5.4	5.4	0	2,955	0	0.0%
Annual	**572**	**693**	**572**	**410**	**387**	**462**	**855**	**416**	**0**	**274,325**	**274,325**	

Appendix D

Annual Balances for Wet Years

Table D-10: Annual Water Balance for Pike Lake South (north of the lake – wet year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m^3)	(m^3)	(m^3)	
January	81.7	1.3	0.0	0.0	0.0	0.0	1.3	1.3	0	7,460	0	0.0%
February	62.1	2.0	0.0	0.0	0.0	0.0	2.0	2.0	0	11,374	0	0.0%
March	81.4	5.0	0.0	0.0	0.0	0.0	5.0	5.0	2,814,767	2,843,746	0	0.0%
April	74.9	20.0	196.5	0.0	0.0	0.0	216.4	216.4	5,490,899	6,741,748	0	0.0%
May	25.9	65.5	309.9	42.9	37.2	273.9	332.4	64.2	2,890,078	3,473,241	0	0.0%
June	2.5	113.1	2.5	95.3	95.3	16.4	20.2	3.8	1,298,961	1,334,150	0	0.0%
July	0.0	146.4	0.0	117.5	117.5	23.4	28.9	5.5	1,381,434	1,431,726	0	0.0%
August	0.0	137.6	0.0	97.3	97.3	32.6	40.3	7.6	1,436,791	1,506,767	0	0.0%
September	6.2	116.6	6.2	54.0	39.6	67.4	68.8	15.8	1,600,160	1,733,429	0	0.0%
October	52.4	57.0	39.9	2.6	0.3	78.3	94.3	18.4	1,711,552	1,877,752	0	0.0%
November	91.3	23.0	17.3	0.0	0.0	0.0	40.3	40.3	1,359,998	1,592,942	0	0.0%
December	93.9	5.4	0.0	0.0	0.0	0.0	5.4	5.4	1,261,305	1,292,323	0	0.0%
Annual	**572**	**693**	**572**	**410**	**387**	**492**	**855**	**386**	**21,245,944**	**23,846,657**	**0**	

Appendix D

Annual Balances for Wet Years

Table D-11: Annual Water Balance for the Treatment Plant (wet year)

Month	Monthly Intake[1]	Average Pumping Vapacity		% of Pump Use (7100 m³/h)
	(m³)	(m³/day)	(m³/h)	(%)
January	0	0	0	0.0%
February	0	0	0	0.0%
March	1,980,900	127,800	5,325	75.0%
April	3,834,000	127,800	5,325	75.0%
May	3,961,800	127,800	5,325	75.0%
June	1,532,485	51,083	2,128	30.0%
July	1,355,815	43,736	1,822	25.7%
August	1,401,145	45,198	1,883	26.5%
September	1,530,727	51,024	2,126	29.9%
October	1,626,638	52,472	2,186	30.8%
November	1,359,998	45,333	1,889	26.6%
December	1,261,305	40,687	1,695	23.9%
Annual	**19,844,814**			

[1] Water flow coming from pumping of the End & Elfie Lake.

Appendix E

Annual Balances for Dry Years

Tables for dry years:

Table E-1: Annual Water Balance for Rose Pit (dry year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	Ground-Water Inflow	Monthly Intake	Monthly Pumped	% of Pump Use (4680 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	32.8	0.5	0.0	0.0	0.0	0.0	0.5	0.5	1,240,000	1,241,644	1,241,644	35.7%
February	24.0	0.8	0.0	0.0	0.0	0.0	0.8	0.8	1,120,000	1,122,417	1,122,417	35.7%
March	29.0	1.8	0.0	0.0	0.0	0.0	1.8	1.8	1,240,000	1,245,668	1,245,668	35.8%
April	11.9	3.2	72.8	0.0	0.0	0.0	76.0	76.0	1,200,000	1,440,793	1,440,793	42.8%
May	9.7	24.6	115.0	42.9	37.2	41.6	96.7	60.8	1,240,000	1,433,582	1,433,582	41.2%
June	1.7	75.9	1.7	77.6	77.6	0.0	0.0	0.0	1,200,000	1,200,000	1,200,000	35.6%
July	0.0	109.9	0.0	109.9	109.9	0.0	0.0	0.0	1,240,000	1,240,000	1,240,000	35.6%
August	0.0	96.3	0.0	96.3	96.3	0.0	0.0	0.0	1,240,000	1,240,000	1,240,000	35.6%
September	4.7	87.5	4.7	54.0	39.6	21.3	38.2	31.2	1,200,000	1,299,415	1,299,415	38.6%
October	32.2	35.1	24.6	2.6	0.3	24.1	57.0	35.3	1,240,000	1,352,305	1,352,305	38.8%
November	43.4	10.9	8.5	0.0	0.0	0.0	19.4	19.4	1,200,000	1,261,581	1,261,581	37.4%
December	37.7	2.2	0.0	0.0	0.0	0.0	2.2	2.2	1,240,000	1,246,825	1,246,825	35.8%
Annual	**227**	**449**	**227**	**383**	**361**	**87**	**292**	**228**	**14,600,000**	**15,324,230**	**15,324,230**	

Appendix E

Annual Balances for Dry Years

Table E-2: Annual Water Balance for Rose North (dry year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use (1480 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	32.8	0.5	0.0	0.0	0.0	0.0	0.5	0.5	0	861	0	0.0%
February	24.0	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	1,266	0	0.0%
March	29.0	1.8	0.0	0.0	0.0	0.0	1.8	1.8	0	2,968	40,916	7.4%
April	11.9	3.2	72.8	0.0	0.0	0.0	76.0	76.0	0	126,094	126,094	11.8%
May	9.7	24.6	115.0	42.9	37.2	66.4	96.7	36.0	0	60,948	60,948	5.5%
June	1.7	75.9	1.7	77.6	77.6	0.0	0.0	0.0	0	0	0	0.0%
July	0.0	109.9	0.0	109.9	109.9	0.0	0.0	0.0	0	0	0	0.0%
August	0.0	96.3	0.0	96.3	96.3	0.0	0.0	0.0	0	0	0	0.0%
September	4.7	87.5	4.7	54.0	39.6	34.1	38.2	18.5	0	31,074	31,074	2.9%
October	32.2	35.1	24.6	2.6	0.3	38.5	57.0	20.9	0	35,377	35,377	3.2%
November	43.4	10.9	8.5	0.0	0.0	0.0	19.4	19.4	0	32,247	0	0.0%
December	37.7	2.2	0.0	0.0	0.0	0.0	2.2	2.2	0	3,574	0	0.0%
Annual	**227**	**449**	**227**	**383**	**361**	**139**	**292**	**176**	**0**	**294,408**	**294,408**	

Appendix E

Annual Balances for Dry Years

Table E-3: Annual Water Balance for Rose South – EB (dry year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use (1750 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	32.8	0.5	0.0	0.0	0.0	0.0	0.5	0.5	0	975	0	0.0%
February	24.0	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	1,434	0	0.0%
March	29.0	1.8	0.0	0.0	0.0	0.0	1.8	1.8	0	3,361	46,338	7.1%
April	11.9	3.2	72.8	0.0	0.0	0.0	76.0	76.0	0	142,805	142,805	11.3%
May	9.7	24.6	115.0	42.9	37.2	75.8	96.7	26.6	0	50,909	50,909	3.9%
June	1.7	75.9	1.7	77.6	77.6	0.0	0.0	0.0	0	0	0	0.0%
July	0.0	109.9	0.0	109.9	109.9	0.0	0.0	0.0	0	0	0	0.0%
August	0.0	96.3	0.0	96.3	96.3	0.0	0.0	0.0	0	0	0	0.0%
September	4.7	87.5	4.7	54.0	39.6	38.9	38.2	13.7	0	26,004	26,004	2.1%
October	32.2	35.1	24.6	2.6	0.3	44.0	57.0	15.4	0	29,546	29,546	2.3%
November	43.4	10.9	8.5	0.0	0.0	0.0	19.4	19.4	0	36,521	0	0.0%
December	37.7	2.2	0.0	0.0	0.0	0.0	2.2	2.2	0	4,047	0	0.0%
Annual	**227**	**449**	**227**	**383**	**361**	**159**	**292**	**156**	**0**	**295,603**	**295,603**	

Appendix E

Annual Balances for Dry Years

Table E-4: Annual Water Balance for Rose South – NB (dry year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use (4410 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	32.8	0.5	0.0	0.0	0.0	0.0	0.5	0.5	0	731	0	0.0%
February	24.0	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	1,075	0	0.0%
March	29.0	1.8	0.0	0.0	0.0	0.0	1.8	1.8	83,310	85,831	118,063	7.2%
April	11.9	3.2	72.8	0.0	0.0	0.0	76.0	76.0	256,745	363,848	363,848	11.5%
May	9.7	24.6	115.0	42.9	37.2	76.1	96.7	26.3	91,495	128,866	128,866	3.9%
June	1.7	75.9	1.7	77.6	77.6	0.0	0.0	0.0	0	0	0	0.0%
July	0.0	109.9	0.0	109.9	109.9	0.0	0.0	0.0	0	0	0	0.0%
August	0.0	96.3	0.0	96.3	96.3	0.0	0.0	0.0	0	0	0	0.0%
September	4.7	87.5	4.7	54.0	39.6	39.1	38.2	13.5	46,696	65,831	65,831	2.1%
October	32.2	35.1	24.6	2.6	0.3	44.2	57.0	15.2	53,104	74,790	74,790	2.3%
November	43.4	10.9	8.5	0.0	0.0	0.0	19.4	19.4	0	27,391	0	0.0%
December	37.7	2.2	0.0	0.0	0.0	0.0	2.2	2.2	0	3,036	0	0.0%
Annual	**227**	**449**	**227**	**383**	**361**	**159**	**292**	**156**	**531,350**	**751,399**	**751,399**	

Appendix E

Annual Balances for Dry Years

Table E-5: Annual Water Balance for Rose South – WB (dry year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use (1400 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	32.8	0.5	0.0	0.0	0.0	0.0	0.5	0.5	0	296	0	0.0%
February	24.0	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	435	0	0.0%
March	29.0	1.8	0.0	0.0	0.0	0.0	1.8	1.8	22,923	23,942	36,972	7.1%
April	11.9	3.2	72.8	0.0	0.0	0.0	76.0	76.0	70,643	113,940	113,940	11.3%
May	9.7	24.6	115.0	42.9	37.2	76.3	96.7	26.1	25,155	40,586	40,586	3.9%
June	1.7	75.9	1.7	77.6	77.6	0.0	0.0	0.0	0	0	0	0.0%
July	0.0	109.9	0.0	109.9	109.9	0.0	0.0	0.0	0	0	0	0.0%
August	0.0	96.3	0.0	96.3	96.3	0.0	0.0	0.0	0	0	0	0.0%
September	4.7	87.5	4.7	54.0	39.6	39.2	38.2	13.4	12,854	20,692	20,692	2.0%
October	32.2	35.1	24.6	2.6	0.3	44.2	57.0	15.2	14,599	23,558	23,558	2.3%
November	43.4	10.9	8.5	0.0	0.0	0.0	19.4	19.4	0	11,073	0	0.0%
December	37.7	2.2	0.0	0.0	0.0	0.0	2.2	2.2	0	1,227	0	0.0%
Annual	**227**	**449**	**227**	**383**	**361**	**160**	**292**	**155**	**146,173**	**235,747**	**235,747**	

Appendix E

Annual Balances for Dry Years

Table E-6: Annual Water Balance for Rose South – SW (dry year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use (936 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	32.8	0.5	0.0	0.0	0.0	0.0	0.5	0.5	0	482	0	0.0%
February	24.0	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	709	0	0.0%
March	29.0	1.8	0.0	0.0	0.0	0.0	1.8	1.8	0	1,663	22,923	6.6%
April	11.9	3.2	72.8	0.0	0.0	0.0	76.0	76.0	0	70,643	70,643	10.5%
May	9.7	24.6	115.0	42.9	37.2	75.8	96.7	26.6	0	25,155	25,155	3.6%
June	1.7	75.9	1.7	77.6	77.6	0.0	0.0	0.0	0	0	0	0.0%
July	0.0	109.9	0.0	109.9	109.9	0.0	0.0	0.0	0	0	0	0.0%
August	0.0	96.3	0.0	96.3	96.3	0.0	0.0	0.0	0	0	0	0.0%
September	4.7	87.5	4.7	54.0	39.6	38.9	38.2	13.7	0	12,854	12,854	1.9%
October	32.2	35.1	24.6	2.6	0.3	44.0	57.0	15.4	0	14,599	14,599	2.1%
November	43.4	10.9	8.5	0.0	0.0	0.0	19.4	19.4	0	18,066	0	0.0%
December	37.7	2.2	0.0	0.0	0.0	0.0	2.2	2.2	0	2,002	0	0.0%
Annual	**227**	**449**	**227**	**383**	**361**	**159**	**292**	**156**	**0**	**146,173**	**146,173**	

Appendix E

Annual Balances for Dry Years

Table E-7: Annual Water Balance for End & Elfie Lake (dry year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use (7100 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	32.8	0.5	0.0	0.0	0.0	0.0	0.5	0.5	1,241,644	1,242,058	0	0.0%
February	24.0	0.8	0.0	0.0	0.0	0.0	0.8	0.8	1,122,417	1,123,028	0	0.0%
March	29.0	1.8	0.0	0.0	0.0	0.0	1.8	1.8	1,404,647	1,406,077	1,980,900	75.0%
April	11.9	3.2	72.8	0.0	0.0	0.0	76.0	76.0	1,930,735	1,991,503	3,781,765	74.0%
May	9.7	24.6	115.0	42.9	37.2	81.5	96.7	20.9	1,623,396	1,648,853	1,648,853	31.2%
June	1.7	75.9	1.7	77.6	77.6	0.0	0.0	0.0	1,200,000	1,200,000	1,200,000	23.5%
July	0.0	109.9	0.0	109.9	109.9	0.0	0.0	0.0	1,240,000	1,240,000	1,240,000	23.5%
August	0.0	96.3	0.0	96.3	96.3	0.0	0.0	0.0	1,240,000	1,240,000	1,240,000	23.5%
September	4.7	87.5	4.7	54.0	39.6	41.8	38.2	10.7	1,396,320	1,408,072	1,408,072	27.5%
October	32.2	35.1	24.6	2.6	0.3	47.3	57.0	12.1	1,462,472	1,477,351	1,477,351	28.0%
November	43.4	10.9	8.5	0.0	0.0	0.0	19.4	19.4	1,261,581	1,277,121	1,277,121	25.0%
December	37.7	2.2	0.0	0.0	0.0	0.0	2.2	2.2	1,246,825	1,248,547	1,248,547	23.6%
Annual	**227**	**449**	**227**	**383**	**361**	**171**	**292**	**144**	**16,370,037**	**16,502,611**	**16,502,611**	

Appendix E

Annual Balances for Dry Years

Table E-8: Annual Water Balance for Mid Lake (dry year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use (1900 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	32.8	0.5	0.0	0.0	0.0	0.0	0.5	0.5	0	1,383	0	0.0%
February	24.0	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	2,034	0	0.0%
March	29.0	1.8	0.0	0.0	0.0	0.0	1.8	1.8	0	4,769	65,741	9.3%
April	11.9	3.2	72.8	0.0	0.0	0.0	76.0	76.0	0	202,600	202,600	14.8%
May	9.7	24.6	115.0	42.9	37.2	82.4	96.7	20.0	0	68,011	68,011	4.8%
June	1.7	75.9	1.7	77.6	77.6	0.0	0.0	0.0	0	0	0	0.0%
July	0.0	109.9	0.0	109.9	109.9	0.0	0.0	0.0	0	0	0	0.0%
August	0.0	96.3	0.0	96.3	96.3	0.0	0.0	0.0	0	0	0	0.0%
September	4.7	87.5	4.7	54.0	39.6	42.3	38.2	10.3	0	32,728	32,728	2.4%
October	32.2	35.1	24.6	2.6	0.3	47.8	57.0	11.6	0	39,640	39,640	2.8%
November	43.4	10.9	8.5	0.0	0.0	0.0	19.4	19.4	0	51,813	0	0.0%
December	37.7	2.2	0.0	0.0	0.0	0.0	2.2	2.2	0	5,742	0	0.0%
Annual	**227**	**449**	**227**	**383**	**361**	**173**	**292**	**142**	**0**	**408,720**	**408,720**	

Appendix E

Annual Balances for Dry Years

Table E-9: Annual Water Balance for Pike Lake Dike (dry year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Monthly Pumped	% of Pump Use (495 m³/h)
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	32.8	0.5	0.0	0.0	0.0	0.0	0.5	0.5	0	285	0	0.0%
February	24.0	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	420	0	0.0%
March	29.0	1.8	0.0	0.0	0.0	0.0	1.8	1.8	0	984	13,570	7.4%
April	11.9	3.2	72.8	0.0	0.0	0.0	76.0	76.0	0	41,820	41,820	11.7%
May	9.7	24.6	115.0	42.9	37.2	77.9	96.7	24.5	0	20,949	20,949	5.7%
June	1.7	75.9	1.7	77.6	77.6	0.0	0.0	0.0	0	0	0	0.0%
July	0.0	109.9	0.0	109.9	109.9	0.0	0.0	0.0	0	0	0	0.0%
August	0.0	96.3	0.0	96.3	96.3	0.0	0.0	0.0	0	0	0	0.0%
September	4.7	87.5	4.7	54.0	39.6	40.0	38.2	12.6	0	9,574	9,574	2.7%
October	32.2	35.1	24.6	2.6	0.3	45.2	57.0	14.2	0	12,252	12,252	3.3%
November	43.4	10.9	8.5	0.0	0.0	0.0	19.4	19.4	0	10,695	0	0.0%
December	37.7	2.2	0.0	0.0	0.0	0.0	2.2	2.2	0	1,185	0	0.0%
Annual	**227**	**449**	**227**	**383**	**361**	**163**	**292**	**152**	**0**	**98,166**	**98,166**	

Appendix E

Annual Balances for Dry Years

Table E-10: Annual Water Balance for Pike Lake South (north of the lake – dry year)

Month	Snow	Rain	Snowmelt	Max. E Lake	Max. ET Ground	Infiltration	Runoff Lake	Runoff Soil	External Pumping Input	Monthly Intake	Water Outlet	% of Pump Use
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m³)	(m³)	(m³)	
January	32.8	0.5	0.0	0.0	0.0	0.0	0.5	0.5	0	2,997	0	0.0%
February	24.0	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0	4,408	0	0.0%
March	29.0	1.8	0.0	0.0	0.0	0.0	1.8	1.8	2,720,511	2,730,845	0	0.0%
April	11.9	3.2	72.8	0.0	0.0	0.0	76.0	76.0	3,365,886	3,804,934	0	0.0%
May	9.7	24.6	115.0	42.9	37.2	82.9	96.7	19.5	1,737,814	1,911,247	0	0.0%
June	1.7	75.9	1.7	77.6	77.6	0.0	0.0	0.0	1,200,000	1,200,000	0	0.0%
July	0.0	109.9	0.0	109.9	109.9	0.0	0.0	0.0	1,240,000	1,240,000	0	0.0%
August	0.0	96.3	0.0	96.3	96.3	0.0	0.0	0.0	1,240,000	1,240,000	0	0.0%
September	4.7	87.5	4.7	54.0	39.6	42.6	38.2	10.0	1,450,374	1,530,381	0	0.0%
October	32.2	35.1	24.6	2.6	0.3	48.1	57.0	11.3	1,529,243	1,630,616	0	0.0%
November	43.4	10.9	8.5	0.0	0.0	0.0	19.4	19.4	1,277,121	1,389,404	0	0.0%
December	37.7	2.2	0.0	0.0	0.0	0.0	2.2	2.2	1,248,547	1,260,991	0	0.0%
Annual	**227**	**449**	**227**	**383**	**361**	**174**	**292**	**141**	**17,009,496**	**17,945,823**	**0**	

Appendix E

Annual Balances for Dry Years

Table E-11: Annual Water Balance for the Treatment Plant (dry year)

Month	Monthly Intake[1]	Average Pumping Capacity		% of Pump Use (7100 m³/h)
	(m³)	(m³/day)	(m³/h)	(%)
January	0	0	0	0.0%
February	0	0	0	0.0%
March	1,980,900	127,800	5,325	75.0%
April	3,781,765	126,059	5,252	74.0%
May	1,648,853	53,189	2,216	31.2%
June	1,200,000	40,000	1,667	23.5%
July	1,240,000	40,000	1,667	23.5%
August	1,240,000	40,000	1,667	23.5%
September	1,408,072	46,936	1,956	27.5%
October	1,477,351	47,656	1,986	28.0%
November	1,277,121	42,571	1,774	25.0%
December	1,248,547	40,276	1,678	23.6%
Annual	**16,502,611**			

[1] Water flow coming from pumping of the End & Elfie Lake.

Appendix F

Drawings

CHAMPION IRON

KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

LIST OF DRAWINGS

DRAWING No.	TITLE	REVISION	DATE	COMMENTS
692696-8000-40DD-0001	GENERAL PLAN VIEW	00	2023/10/20	
692696-8000-40DD-0002	ROSE PIT PLAN VIEW	00	2023/10/20	
692696-8000-40DD-0003	ROSE PIT DIVERSION DITCHES AND TRENCH (1/2) LONGITUDINAL PROFILES AND TYPICAL SECTIONS	00	2023/10/20	
692696-8000-40DD-0004	ROSE PIT DIVERSION DITCHES AND TRENCH (2/2) LONGITUDINAL PROFILES AND TYPICAL SECTIONS	00	2023/10/20	
692696-8000-40DD-0005	ROSE PIT COLLECTION POND - END LAKE EAST DAM LONGITUDINAL PROFILES AND TYPICAL SECTIONS	00	2023/10/20	
692696-8000-40DD-0006	ROSE PIT COLLECTION POND - END LAKE EAST DAM - EMERGENCY SPILLWAY TYPICAL SECTIONS	00	2023/10/20	
692696-8000-40DD-0007	ROSE PIT COLLECTION POND - ELFIE LAKE WEST DAM LONGITUDINAL PROFILES AND TYPICAL SECTIONS	00	2023/10/20	
692696-8000-40DD-0008	MID LAKE DAM LONGITUDINAL PROFILES AND TYPICAL SECTIONS	00	2023/10/20	
692696-8000-40DD-0009	PIKE LAKE DIKE LONGITUDINAL PROFILES AND TYPICAL SECTIONS	00	2023/10/20	
692696-8000-40DD-0010	MID LAKE DAM TYPICAL SECTION - PUMPING STATION	00	2023/10/20	
692696-8000-40DD-0011	PIPING - PLAN VIEW	00	2023/10/20	
692696-8000-40DD-0012	ROSE NORTH OVERBURDEN STOCKPILE DITCHES PLAN VIEW	00	2023/10/20	
692696-8000-40DD-0013	ROSE NORTH OVERBURDEN STOCKPILE COLLECTION POND (1/2) PLAN VIEW	00	2023/10/20	
692696-8000-40DD-0014	ROSE NORTH OVERBURDEN STOCKPILE COLLECTION POND (2/2) LONGITUDINAL PROFILES AND TYPICAL SECTIONS	00	2023/10/20	
692696-8000-40DD-0015	ROSE NORTH OVERBURDEN STOCKPILE DITCHES (1/2) LONGITUDINAL PROFILES AND TYPICAL SECTIONS	00	2023/10/20	
692696-8000-40DD-0016	ROSE NORTH OVERBURDEN STOCKPILE DITCHES (2/2) LONGITUDINAL PROFILES AND TYPICAL SECTIONS	00	2023/10/20	
692696-8000-40DD-0017	ROSE SOUTH WASTE ROCK STOCKPILE DITCHES PLAN VIEW	00	2023/10/20	
692696-8000-40DD-0018	ROSE SOUTH WASTE ROCK STOCKPILE NORTH BASIN (1/2) LONGITUDINAL PROFILES AND TYPICAL SECTIONS	00	2023/10/20	
692696-8000-40DD-0019	ROSE SOUTH WASTE ROCK STOCKPILE NORTH BASIN (2/2) LONGITUDINAL PROFILES AND TYPICAL SECTIONS	00	2023/10/20	
692696-8000-40DD-0020	ROSE SOUTH WASTE ROCK STOCKPILE DITCHES (1/2) LONGITUDINAL PROFILES AND TYPICAL SECTIONS	00	2023/10/20	
692696-8000-40DD-0021	ROSE SOUTH WASTE ROCK STOCKPILE DITCHES (1/2) LONGITUDINAL PROFILES AND TYPICAL SECTIONS	00	2023/10/20	
		00	2023/10/20	

NOT FOR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2023/10/20	ISSUED WITH INFRASTRUCTURE DESIGN REPORT NO. 692696-8000-4GER-0001

ISSUE REGISTER — ISSUE REGISTER — REVISION REGISTER — REVISION REGISTER — REFERENCE DRAWINGS

No | REVISION DESCRIPTION | DATE (Y/M/D) | * | ** — INITIALS: * DESIGNED ** APPROVED

PROFESSIONAL SEAL

Licensed Professional Engineer — 07899 — Marie-Hélène Paquette — Year Valid 2024 — 2024-01-17 — pegnl — Newfoundland and Labrador

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED: P. PAGE	PROJECT DISCIPLINE ENGINEER
DRAWN: M. SYKES	PROJECT ENGINEERING MANAGER: M.H. PAQUETTE
CHECKED: M.H. PAQUETTE	CLIENT: M. GROLEAU
DATE: 2023/10/20	
SCALE: N.T.S.	

CLIENT: CHAMPION IRON

PROJECT: KAMI MINING PROJECT — ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: LIST OF DRAWINGS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0000	00

A1-HDR-FRAME-EN (SI)

LAST SAVE: 2023/12/18 – 7:28am
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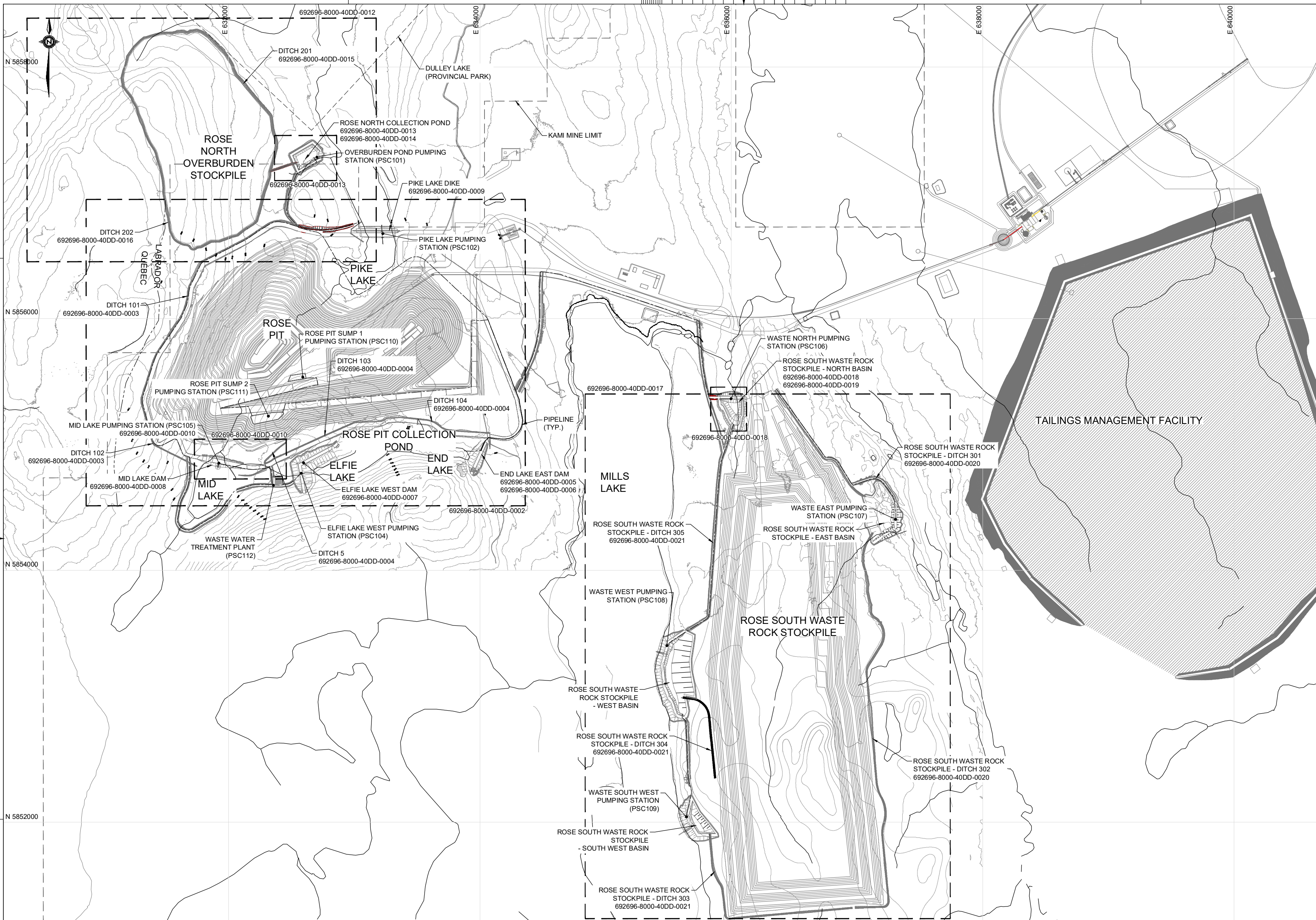

NOTES

1. THE CO-ORDINATES, DIMENSIONS AND ELEVATIONS ARE IN METERS. ELEVATIONS ARE TIED TO MEAN SEA LEVEL. CO-ORDINATES ARE BASED ON UTM NAD83 ZONE 19 METRIC GRID PROJECTION.
2. CONTOURS WERE DERIVED FROM LIDAR SURVEY FROM B.B.A SEP. 2022.
3. PIT LAYOUT FROM B.B.A SEP. 2023

NOT FOR CONSTRUCTION

0 100 200 300m
100 SCALE= 1:5000

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2023/10/20	ISSUED WITH INFRASTRUCTURE DESIGN REPORT NO. 692696-8000-4GER-0001

ISSUE REGISTER — ISSUE REGISTER — REVISION REGISTER — REVISION REGISTER — REFERENCE DRAWINGS

PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED S. NACHET	PROJECT DISCIPLINE ENGINEER
DRAWN M. SYKES	PROJECT ENGINEERING MANAGER M.H. PAQUETTE
CHECKED M.H. PAQUETTE	CLIENT M. GROLEAU
DATE 2023-10-20	
SCALE 1:12,000	

CLIENT: CHAMPION IRON

PROJECT: KAMI MINING PROJECT — ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: GENERAL LAYOUT

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0001	00

A1-HDR-FRAME-EN (SI)

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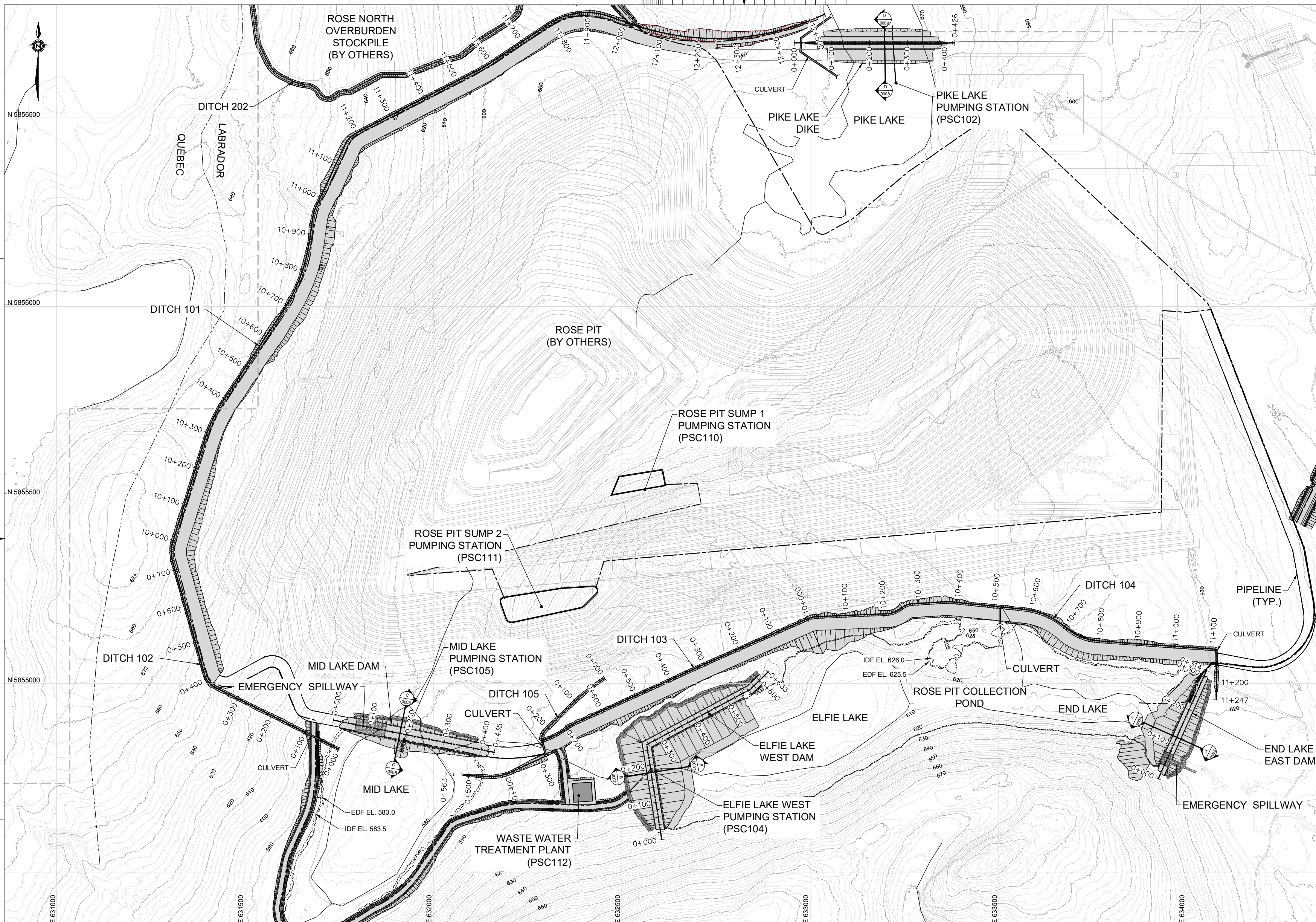

NOTES

1. THE CO-ORDINATES, DIMENSIONS AND ELEVATIONS ARE IN METERS. ELEVATIONS ARE TIED TO MEAN SEA LEVEL. CO-ORDINATES ARE BASED ON UTM NAD83 ZONE 19 METRIC GRID PROJECTION.
2. CONTOURS WERE DERIVED FROM LIDAR SURVEY FROM B.B.A SEP. 2022.
3. PIT LAYOUT FROM B.B.A SEP. 2023

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2023/10/20	ISSUED WITH INFRASTRUCTURE DESIGN REPORT NO. 692696-8000-4GER-0001

ISSUE REGISTER

REVISION REGISTER

REFERENCE DRAWINGS

PROFESSIONAL SEAL

AtkinsRéalis

CLIENT: CHAMPION IRON

PREPARATION		APPROVAL	
DESIGNED	P. PASQUIS / P. PAGÉ	PROJECT DISCIPLINE ENGINEER	
DRAWN	M. SYKES	PROJECT ENGINEERING MANAGER	M.H. PAQUETTE
CHECKED	M.H. PAQUETTE	CLIENT	M. GROLEAU
DATE	2023/10/20		
SCALE	1:5000		

PROJECT: KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: ROSE PIT PLAN VIEW

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0002	00

A1-HDR-FRAME-EN (SI)

LAST SAVE: 2023/12/18 - 7:35am
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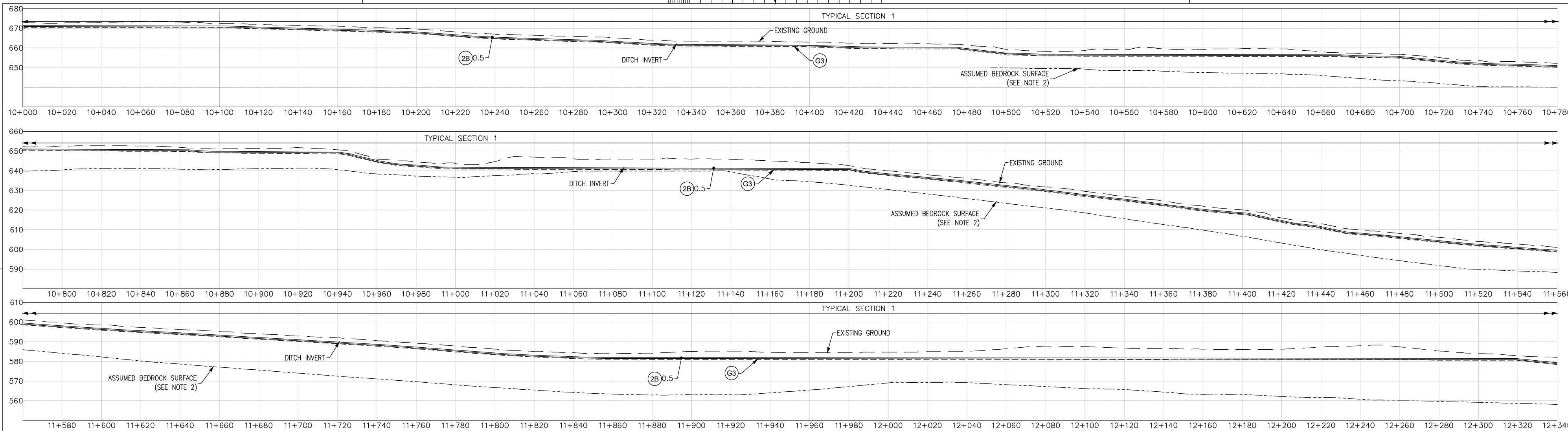
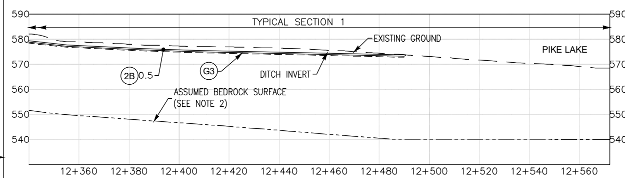
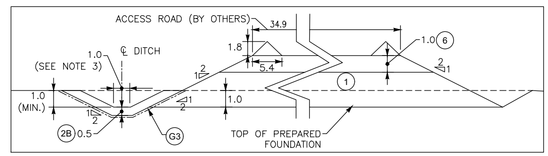
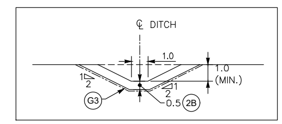




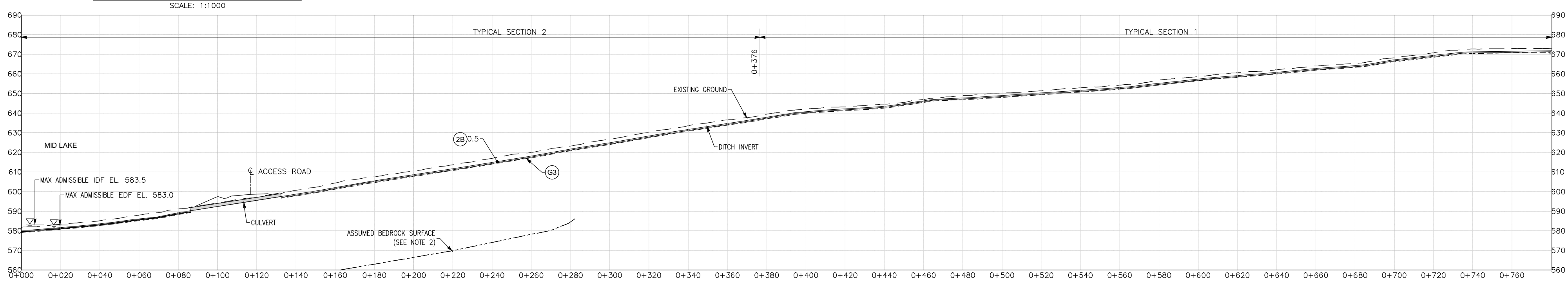
PROFILE ALONG DITCH 101 CENTERLINE (692696-8000-40DD-0002)
SCALE: 1:1000



TYPICAL SECTION 1 (692696-8000-40DD-0002)
SCALE: 1:150



TYPICAL SECTION 2 (692696-8000-40DD-0002)
SCALE: 1:150



PROFILE ALONG DITCH 102 CENTERLINE (692696-8000-40DD-0002)
SCALE: 1:1000

NOT FOR CONSTRUCTION

NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METERS.
2. BEDROCK SURFACE ASSUMED BASED ON AN INTERPOLATION WITH BOREHOLES LOCATED IN THE AREA.
3. WIDTH 2 m BETWEEN STATIONS 11+200 TO 11+600

MATERIALS

- (1) NPAG ROCKFILL 0 – 1000mm
- (2B) RIPRAP 200–300mm
- (5) COMPACTED TILL
- (6) ROAD SURFACE – SAND AND GRAVEL
- (G3) GEOTEXTILE (TEXEL 912 – 250 g/m²)

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
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PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED P. PAGE	PROJECT DISCIPLINE ENGINEER
DRAWN M. SYKES	PROJECT ENGINEERING MANAGER M.H. PAQUETTE
CHECKED M.H. PAQUETTE	CLIENT M. GROLEAU
DATE 2023/10/20	
SCALE INDICATED	

CLIENT: CHAMPION IRON

PROJECT: KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: ROSE PIT DIVERSION DITCHES AND TRENCH (1/2) LONGITUDINAL PROFILES AND TYPICAL SECTIONS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0003	00

A1-HDR-FRAME-EN (SI)

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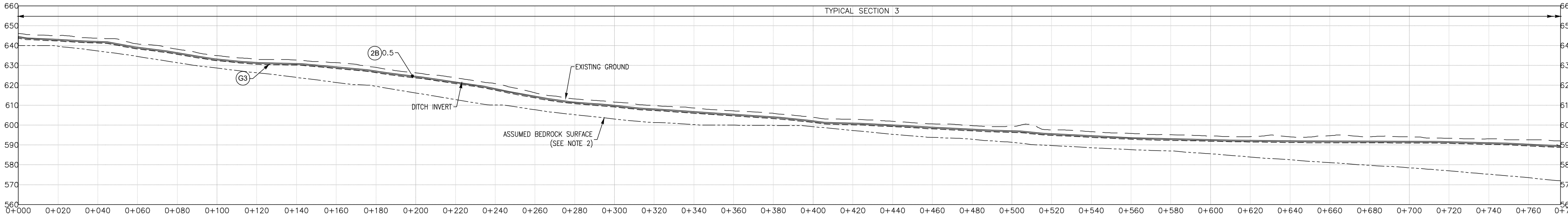
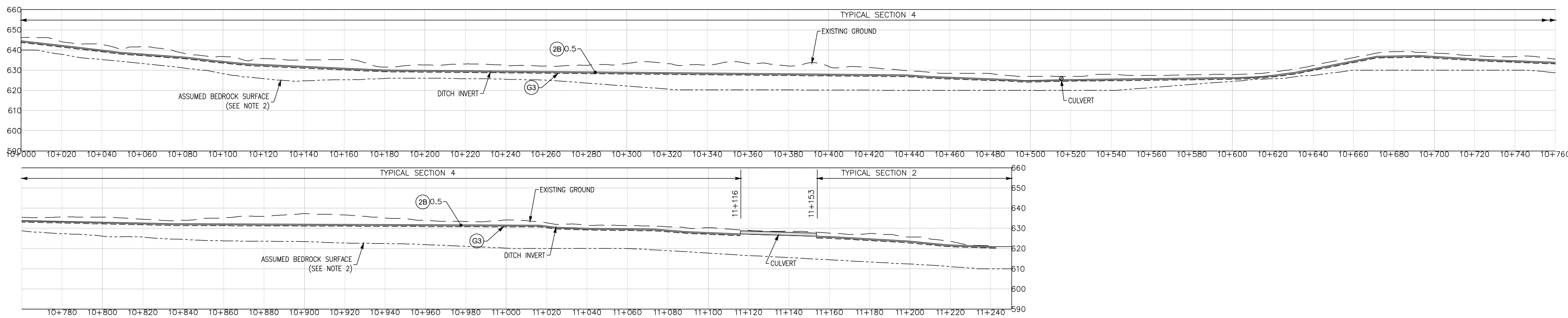
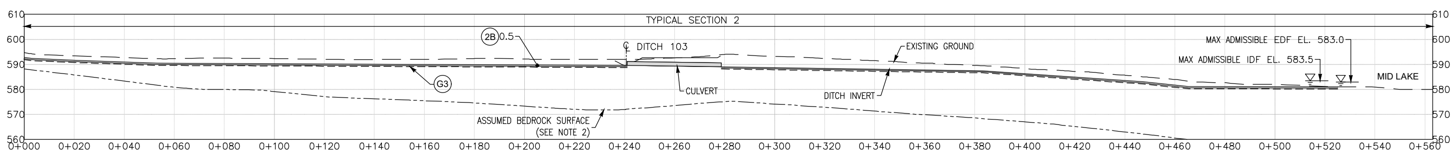


PROFILE ALONG DITCH 103 CENTERLINE (692696-8000-40DD-0002)
SCALE: 1:1000

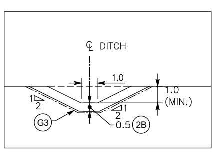


PROFILE ALONG DITCH 104 CENTERLINE (692696-8000-40DD-0002)
SCALE: 1:1000

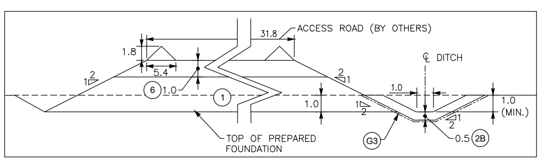


PROFILE ALONG DITCH 105 CENTERLINE (692696-8000-40DD-0002)
SCALE: 1:1000

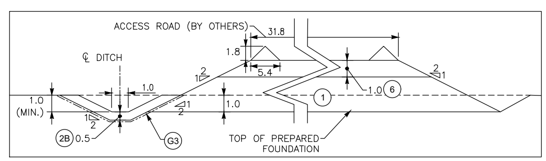
NOT FOR CONSTRUCTION



TYPICAL SECTION 2
SCALE: 1:150



TYPICAL SECTION 3
SCALE: 1:150



TYPICAL SECTION 4
SCALE: 1:150

NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METERS.
2. BEDROCK SURFACE ASSUMED BASED ON AN INTERPOLATION WITH BOREHOLES LOCATED IN THE AREA.

MATERIALS

- (1) NPAG ROCKFILL 0 – 1000mm
- (2B) RIPRAP 200–300mm
- (5) COMPACTED TILL
- (6) ROAD SURFACE – SAND AND GRAVEL
- (G3) GEOTEXTILE (TEXEL 912 – 250 g/m²)

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
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PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED: P. PAGE	PROJECT DISCIPLINE ENGINEER
DRAWN: M. SYKES	PROJECT ENGINEERING MANAGER: M.H. PAQUETTE
CHECKED: M.H. PAQUETTE	CLIENT: M. GROLEAU
DATE: 2023/10/20	
SCALE: INDICATED	

CLIENT: CHAMPION IRON

PROJECT: KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: ROSE PIT DIVERSION DITCHES AND TRENCH (2/2) LONGITUDINAL PROFILES AND TYPICAL SECTIONS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0004	00

A1-HDR-FRAME-EN (SI)

LAST SAVE: 2023/11/27 – 9:36am
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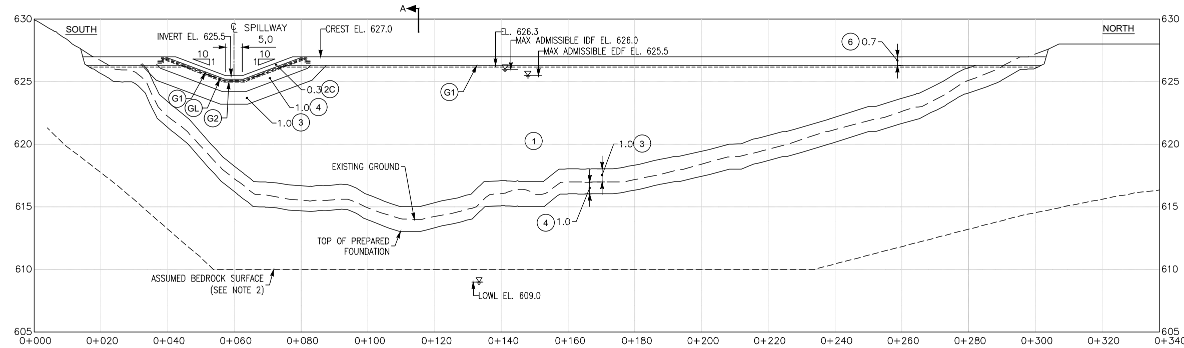
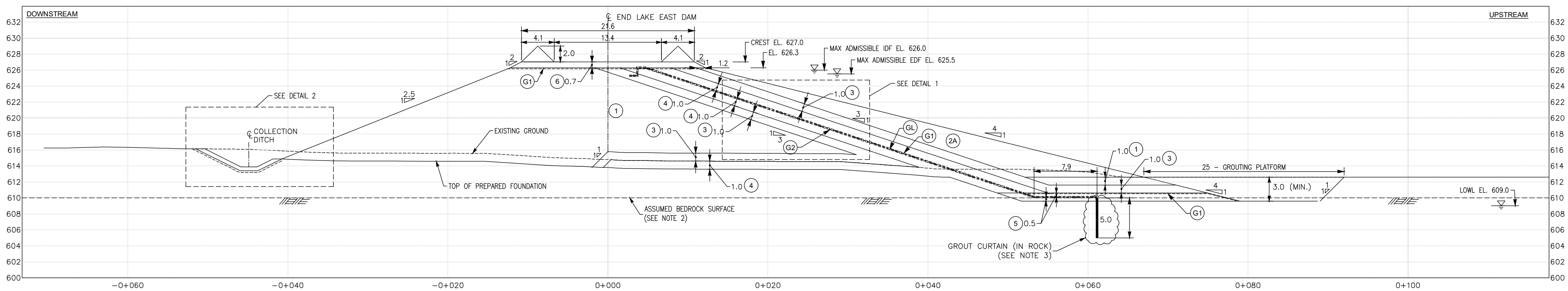
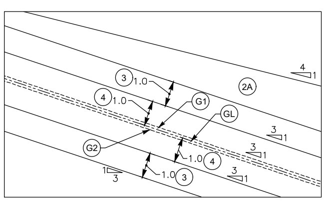
0 1 2 3 4 5 6 7 8 9 10 CENTIMETERS



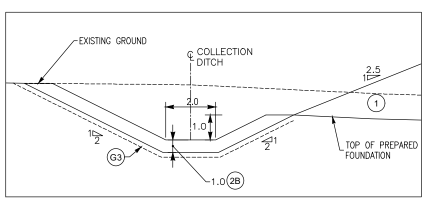
PROFILE ALONG DAM CENTERLINE (692696-8000-40DD-0002)
HORIZONTAL SCALE: 1:750
VERTICAL SCALE: 1:200



SECTION A-A (692696-8000-40DD-0002)
SCALE: 1:250



DETAIL 1
SCALE: 1:100



DETAIL 2
SCALE: 1:100

MATERIALS

1. NPAG ROCKFILL 0 – 1000mm
2A. RIPRAP 400 – 600mm
2B. RIPRAP 200 – 300mm
3. TRANSITION – SAND AND GRAVEL
4. SAND BEDDING
5. COMPACTED TILL
6. ROAD SURFACE – SAND AND GRAVEL
G1. GEOTEXTILE (TEXEL 918 – 407 g/m²)
G2. GEOSYNTHETIC CLAY LINER (GCL)
G3. GEOTEXTILE (TEXEL 912 – 250 g/m²)
GL. HDPE LINER TYPE MICRO-SPIKE

NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METERS.
2. BEDROCK SURFACE ASSUMED BASED ON AN INTERPOLATION WITH BOREHOLES LOCATED MORE THAN 200 m FROM THE DAM. NO BOREHOLE INFORMATION IS AVAILABLE IN THE ALIGNMENT OF THE DAM.
3. FOLLOWING DISCUSSIONS WITH MFQ, IT WAS DECIDED TO SEAL THE ENTIRE FOUNDATION IN SOIL WITH JET GROUT CURTAIN AND IN BEDROCK WITH GROUT CURTAIN. HOWEVER, AN INVESTIGATION CAMPAIGN SHALL BE DONE FOR THE NEXT STAGE OF ENGINEERING TO ASSESS THE PROPERTIES OF THE FOUNDATION.

IDF: INFLOW DESIGN FLOOD
EDF: ENVIRONMENTAL DESIGN FLOOD
LOWL: LOW OPERATING WATER LEVEL

NOT FOR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
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INDICATED

INITIALS: * DESIGNED ** APPROVED

PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED: P. PASQUIS	PROJECT DISCIPLINE ENGINEER
DRAWN: M. SYKES	PROJECT ENGINEERING MANAGER: M.H. PAQUETTE
CHECKED: M.H. PAQUETTE	CLIENT: M. GROLEAU
DATE: 2023/10/20	
SCALE: INDICATED	

CLIENT: CHAMPION IRON

PROJECT: KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: ROSE PIT COLLECTION POND
END LAKE EAST DAM
LONGITUDINAL PROFILES AND TYPICAL SECTIONS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0005	00

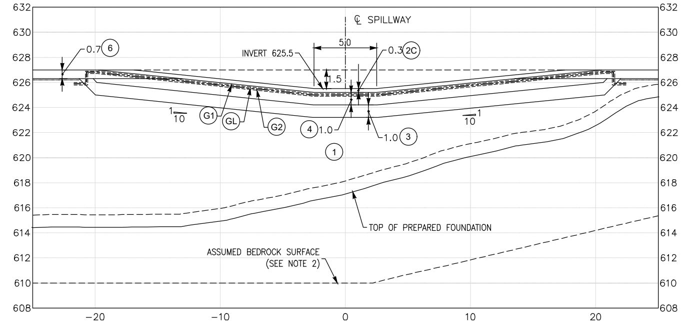
A1-HDR-FRAME-EN (SI)

LAST SAVE: 2023/12/18 – 7:37am
PATH: T:\692696 Kami Mine Conceptual Study\40_DD_DESSINS\CAD\8000\692696-8000-4000-0005_00.dwg

0 1 2 3 4 5 6 7 8 9 10 CENTIMETERS

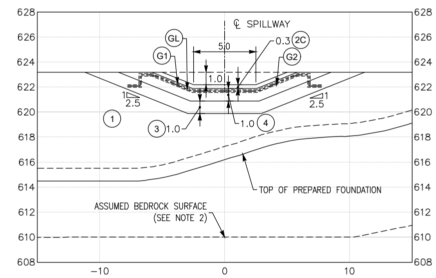
PLAN - EMERGENCY SPILLWAY

SCALE: 1:500



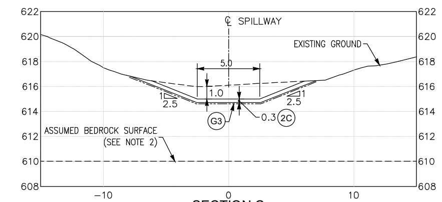
SECTION A

SCALE: 1:200



SECTION B

SCALE: 1:200



SECTION C

SCALE: 1:200

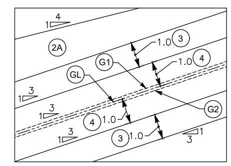
MATERIALS

1. NPAG ROCKFILL 0 – 1000mm
2A. RIPRAP 400 – 600mm
2C. RIPRAP 100 – 200mm – GABION MATTRESS
3. TRANSITION – SAND AND GRAVEL
4. SAND BEDDING
5. COMPACTED TILL
6. ROAD SURFACE – SAND AND GRAVEL
G1. GEOTEXTILE (TEXEL 918 – 407 g/m²)
G2. GEOSYNTHETIC CLAY LINER (GCL)
G3. GEOTEXTILE (TEXEL 912 – 250 g/m²)
GL. HDPE LINER TYPE MICRO-SPIKE

NOTES:

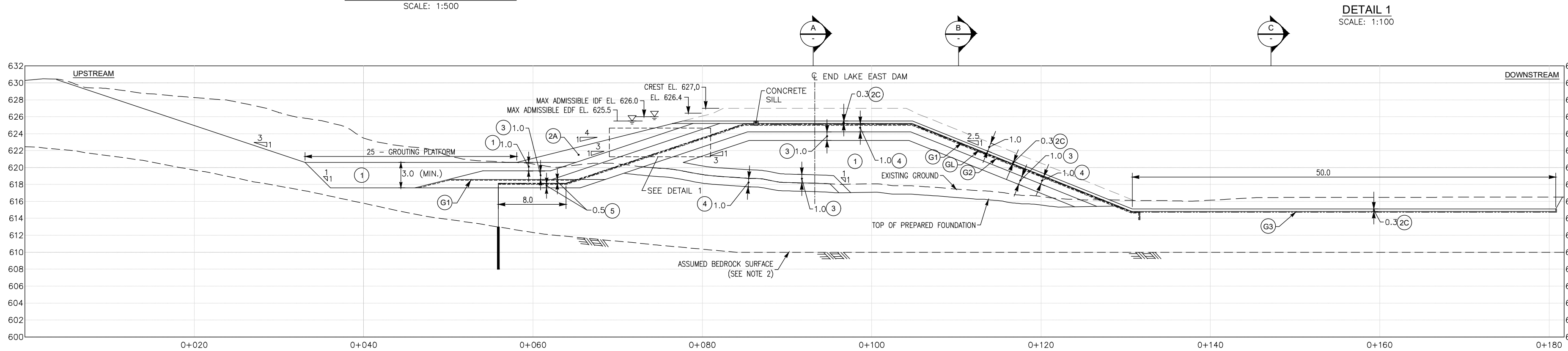
1. ALL DIMENSIONS AND ELEVATIONS ARE IN METERS.
2. BEDROCK SURFACE ASSUMED BASED ON AN INTERPOLATION WITH BOREHOLES LOCATED MORE THAN 200 m FROM THE DAM. NO BOREHOLE INFORMATION IS AVAILABLE IN THE ALIGNMENT OF THE DAM.

IDF: INFLOW DESIGN FLOOD
EDF: ENVIRONMENTAL DESIGN FLOOD
LOWL: LOW OPERATING WATER LEVEL



DETAIL 1

SCALE: 1:100



EMERGENCY SPILLWAY - CENTERLINE PROFILE

SCALE: 1:250

NOT FOR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2023/10/20	ISSUED WITH INFRASTRUCTURE DESIGN REPORT NO. 692696-8000-4GER-0001

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PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED: P. PASQUIS / P. PAGE	PROJECT DISCIPLINE ENGINEER
DRAWN: M. SYKES	PROJECT ENGINEERING MANAGER: M.H. PAQUETTE
CHECKED: M.H. PAQUETTE	CLIENT: M. GROLEAU
DATE: 2023/10/20	
SCALE: INDICATED	

CLIENT: CHAMPION IRON

PROJECT: KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: ROSE PIT COLLECTION POND
END LAKE EAST DAM
EMERGENCY SPILLWAY
PLAN, PROFILE AND SECTIONS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0006	00

A1-HDR-FRAME-EN (S)

LAST SAVE: 2023/12/18 – 7:40pm
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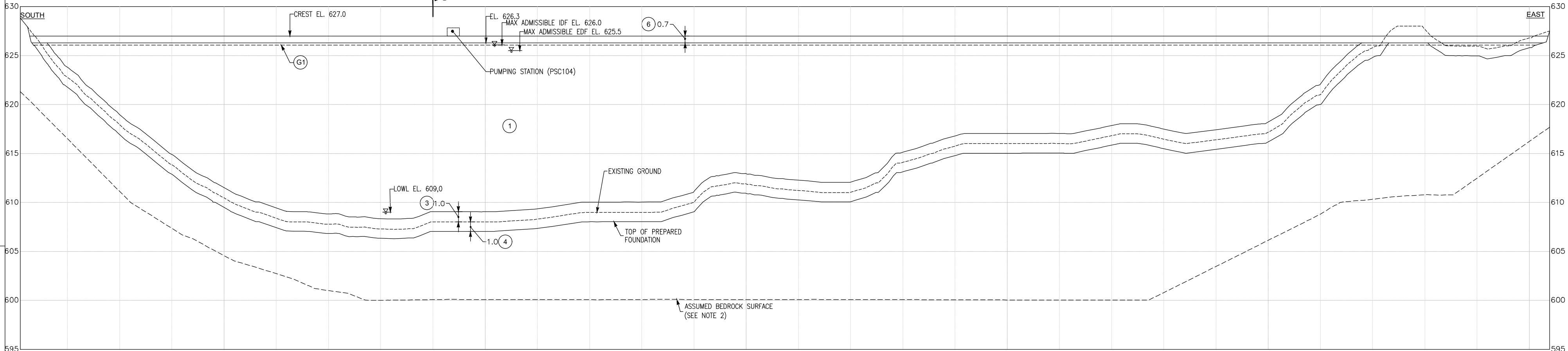
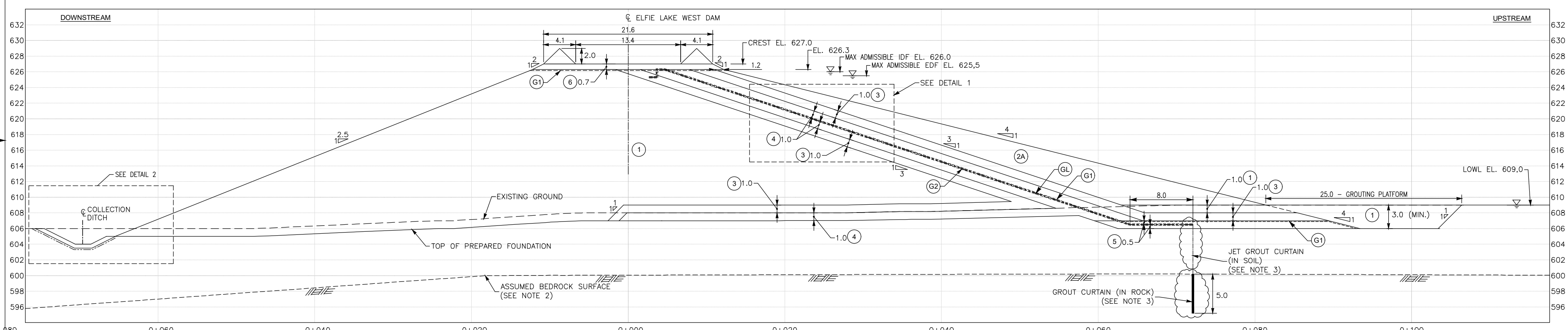
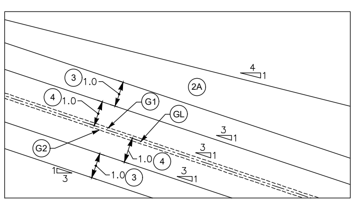


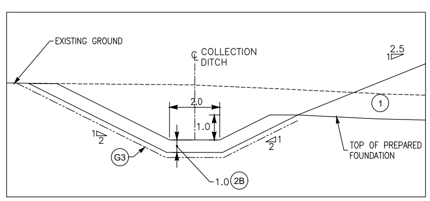
PROFILE ALONG DAM CENTERLINE (692696-8000-40DD-0001)
HORIZONTAL SCALE: 1:750
VERTICAL SCALE: 1:200



SECTION B-B (692696-8000-40DD-0002)
SCALE: 1:250



DETAIL 1
SCALE: 1:100



DETAIL 2
SCALE: 1:100

NOT FOR CONSTRUCTION

MATERIALS

1	NPAG ROCKFILL 0 – 1000mm
2A	RIPRAP 400 – 600mm
2B	RIPRAP 200 – 300mm
3	TRANSITION – SAND AND GRAVEL
4	SAND BEDDING
5	COMPACTED TILL
6	ROAD SURFACE – SAND AND GRAVEL
G1	GEOTEXTILE (TEXEL 918 – 407 g/m²)
G2	GEOSYNTHETIC CLAY LINER (GCL)
G3	GEOTEXTILE (TEXEL 912 – 250 g/m²)
GL	HDPE LINER TYPE MICRO-SPIKE

NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METERS.
2. BEDROCK SURFACE ASSUMED BASED ON AN INTERPOLATION WITH BOREHOLES LOCATED MORE THAN 200 m FROM THE DAM. NO BOREHOLE INFORMATION IS AVAILABLE IN THE ALIGNMENT OF THE DAM.
3. FOLLOWING DISCUSSIONS WITH MFQ, IT WAS DECIDED TO SEAL THE ENTIRE FOUNDATION IN SOIL WITH JET GROUT CURTAIN AND IN BEDROCK WITH GROUT CURTAIN. HOWEVER, AN INVESTIGATION CAMPAIGN SHALL BE DONE FOR THE NEXT STAGE OF ENGINEERING TO ASSESS THE PROPERTIES OF THE FOUNDATION.

IDF: INFLOW DESIGN FLOOD
EDF: ENVIRONMENTAL DESIGN FLOOD
LOWL: LOW OPERATING WATER LEVEL

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
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PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED: P. PASQUIS	PROJECT DISCIPLINE ENGINEER
DRAWN: M. SYKES	PROJECT ENGINEERING MANAGER: M.H. PAQUETTE
CHECKED: M.H. PAQUETTE	CLIENT: M. GROLEAU
DATE: 2023/10/20	
SCALE: INDICATED	

CLIENT: CHAMPION IRON

PROJECT: KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: ROSE PIT COLLECTION POND
ELFIE LAKE WEST DAM
LONGITUDINAL PROFILES AND TYPICAL SECTIONS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0007	00

A1-HDR-FRAME-EN (SI)

LAST SAVE: 2023/12/18 – 7:42pm
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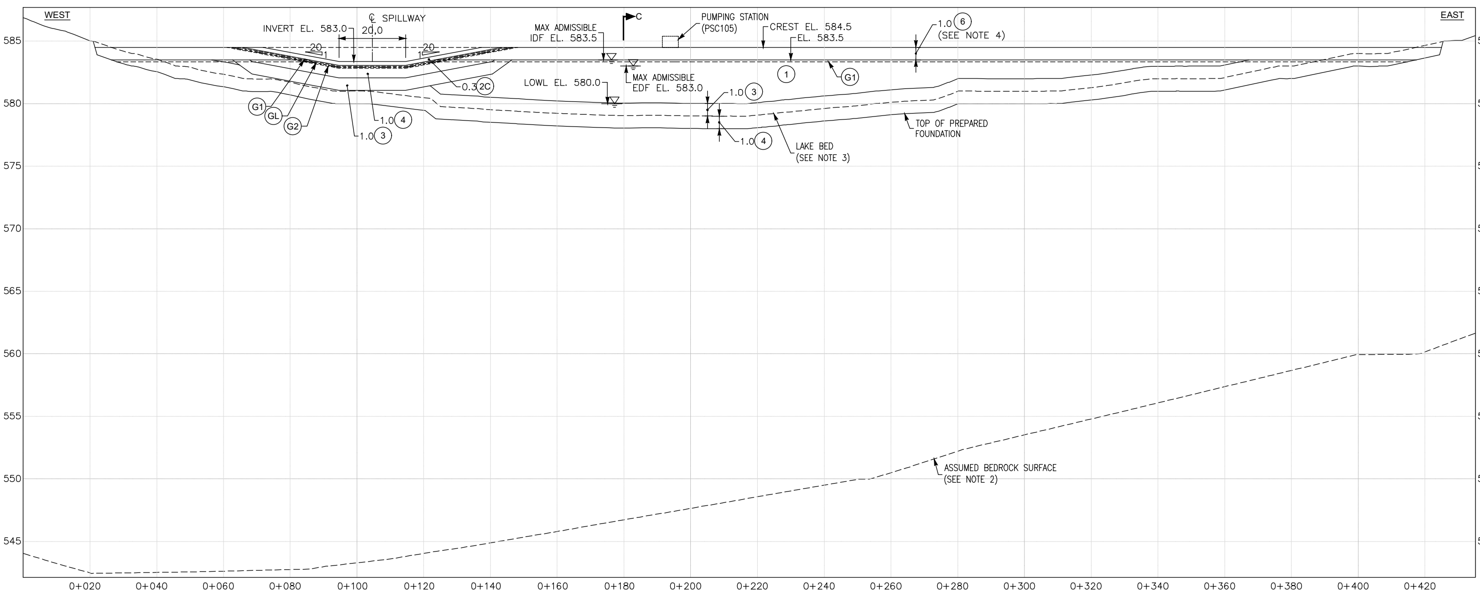
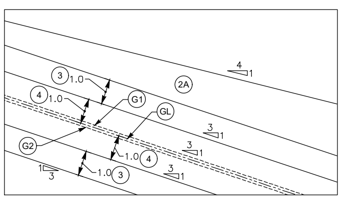
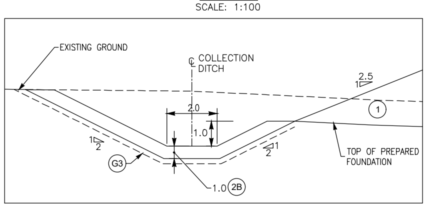


PROFILE ALONG DAM CENTERLINE (692696-8000-40DD-0002)
HORIZONTAL SCALE: 1:750
VERTICAL SCALE: 1:200

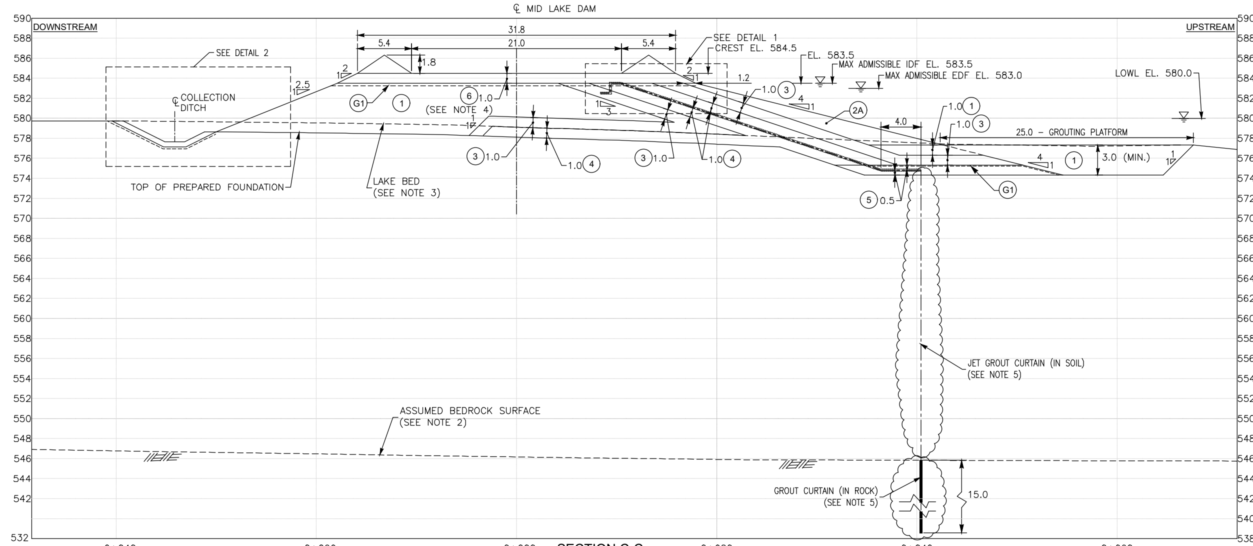
NOT FOR CONSTRUCTION



DETAIL 1
SCALE: 1:100



DETAIL 2
SCALE: 1:100



SECTION C-C
SCALE: 1:250 (692696-8000-40DD-0002)

MATERIALS

1. NPAG ROCKFILL 0 – 1000mm
2A. RIPRAP 400 – 600mm
2B. RIPRAP 200 – 300mm
3. TRANSITION – SAND AND GRAVEL
4. SAND BEDDING
5. COMPACTED TILL
6. ROAD SURFACE (NOTE 4)
G1. GEOTEXTILE (TEXEL 918 – 407 g/m²)
G2. GEOSYNTHETIC CLAY LINER (GCL)
G3. GEOTEXTILE (TEXEL 912 – 250 g/m²)
GL. HDPE LINER TYPE MICRO-SPIKE

NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METERS.
2. BEDROCK SURFACE ASSUMED BASED ON AN INTERPOLATION WITH BOREHOLES LOCATED MORE THAN 200 m FROM THE DAM. NO BOREHOLE INFORMATION IS AVAILABLE IN THE ALIGNMENT OF THE DAM.
3. ASSUMED LAKE BED BASED ON 2012 BATHYMETRY.
4. ROAD STRUCTURE DESIGNED BY OTHERS.
5. FOLLOWING DISCUSSIONS WITH MFQ, IT WAS DECIDED TO SEAL THE ENTIRE FOUNDATION IN SOIL WITH JET GROUT CURTAIN AND IN BEDROCK WITH GROUT CURTAIN. HOWEVER, AN INVESTIGATION CAMPAIGN SHALL BE DONE FOR THE NEXT STAGE OF ENGINEERING TO ASSESS THE PROPERTIES OF THE FOUNDATION.

IDF: INFLOW DESIGN FLOOD
EDF: ENVIRONMENTAL DESIGN FLOODLNOLNORMAL
LOWL: LOW OPERATING WATER LEVEL

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2023/10/20	ISSUED WITH INFRASTRUCTURE DESIGN REPORT NO. 692696-8000-4GER-0001

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PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED: P. PASQUIS	PROJECT DISCIPLINE ENGINEER
DRAWN: M. SYKES	PROJECT ENGINEERING MANAGER: M.H. PAQUETTE
CHECKED: M.H. PAQUETTE	CLIENT: M. GROLEAU
DATE: 2023/10/20	
SCALE: INDICATED	

CLIENT: CHAMPION IRON

PROJECT: KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: MID LAKE DAM
LONGITUDINAL PROFILES AND TYPICAL SECTIONS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0008	00

A1-HDR-FRAME-EN (SI)

LAST SAVE: 2023/12/19 – 10:07am
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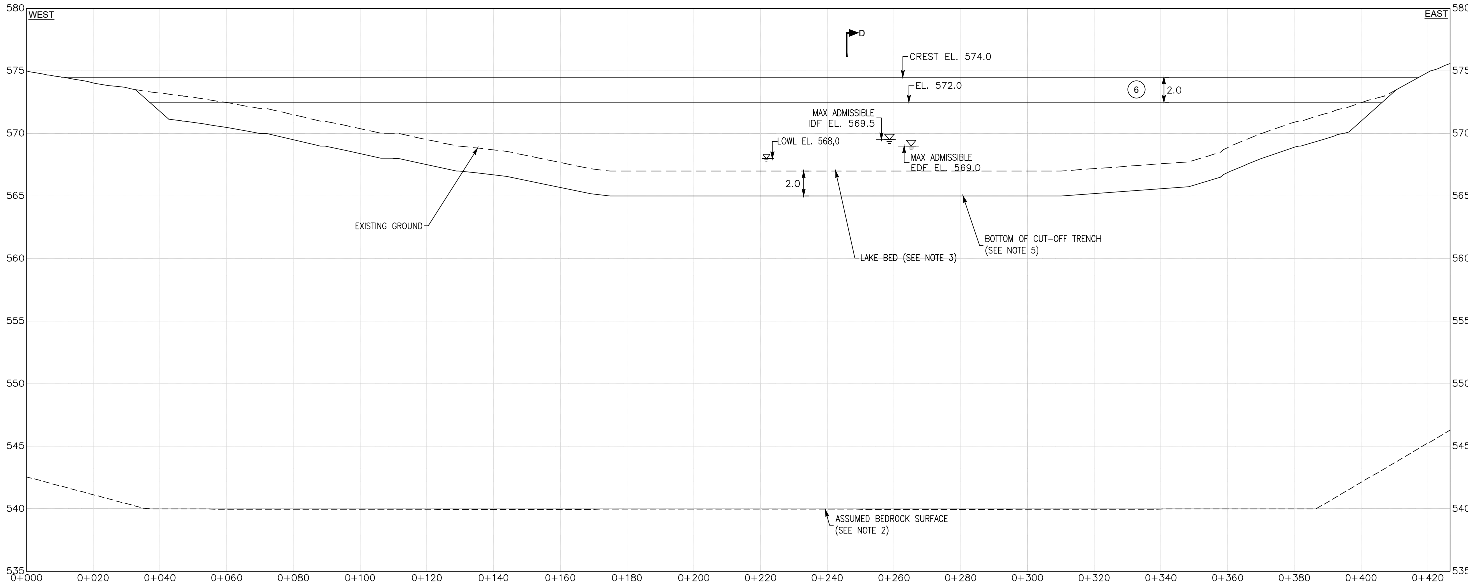
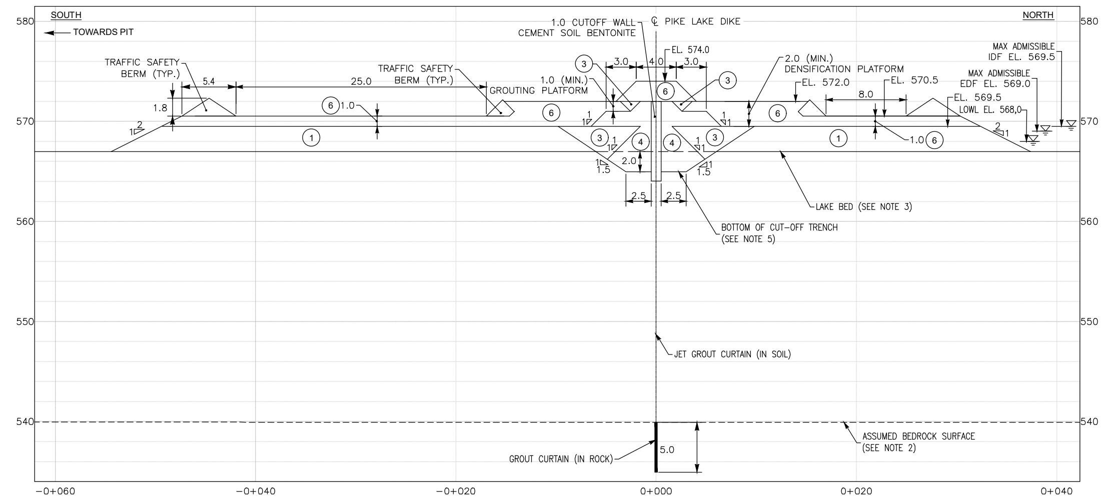


PROFILE ALONG DIKE CENTERLINE (692696-8000-40DD-0002)
HORIZONTAL SCALE: 1:750
VERTICAL SCALE: 1:200



SECTION D-D (692696-8000-40DD-0002)
SCALE: 1:250

NOT FOR CONSTRUCTION

MATERIALS

1. NPAG ROCKFILL 0 – 1000mm
3. TRANSITION – SAND AND GRAVEL
4. SAND
6. ROAD SURFACE – SAND AND GRAVEL

NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METERS.
2. BEDROCK SURFACE ASSUMED BASED ON AN INTERPOLATION WITH BOREHOLES LOCATED MORE THAN 200 m FROM THE DAM. NO BOREHOLE INFORMATION IS AVAILABLE IN THE ALIGNMENT OF THE DAM.
3. ASSUMED LAKE BED BASED ON 2012 BATHYMETRY.
4. FOLLOWING DISCUSSIONS WITH MFQ, IT WAS DECIDED TO SEAL THE ENTIRE FOUNDATION IN SOIL WITH JET GROUT CURTAIN AND IN BEDROCK WITH GROUT CURTAIN. HOWEVER, AN INVESTIGATION CAMPAIGN SHALL BE DONE FOR THE NEXT STAGE OF ENGINEERING TO ASSESS THE PROPERTIES OF THE FOUNDATION.
5. THE CUT-OFF TRENCH SHALL BE EXCAVATED INTO A DENSE FOUNDATION.

IDF: INFLOW DESIGN FLOOD
EDF: ENVIRONMENTAL DESIGN FLOODLNOLNORMAL
LOWL: LOW OPERATING WATER LEVEL

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
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PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED: P. PASQUIS	PROJECT DISCIPLINE ENGINEER
DRAWN: M. SYKES	PROJECT ENGINEERING MANAGER: M. H. PAQUETTE
CHECKED: M. H. PAQUETTE	CLIENT: M. GROLEAU
DATE: 2023/10/20	
SCALE: INDICATED	

CLIENT: CHAMPION IRON

PROJECT: KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: PIKE LAKE DIKE
LONGITUDINAL PROFILE AND TYPICAL SECTION

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0009	00

A1-HDR-FRAME-EN (SI)

LAST SAVE: 2023/11/27 – 9:45am
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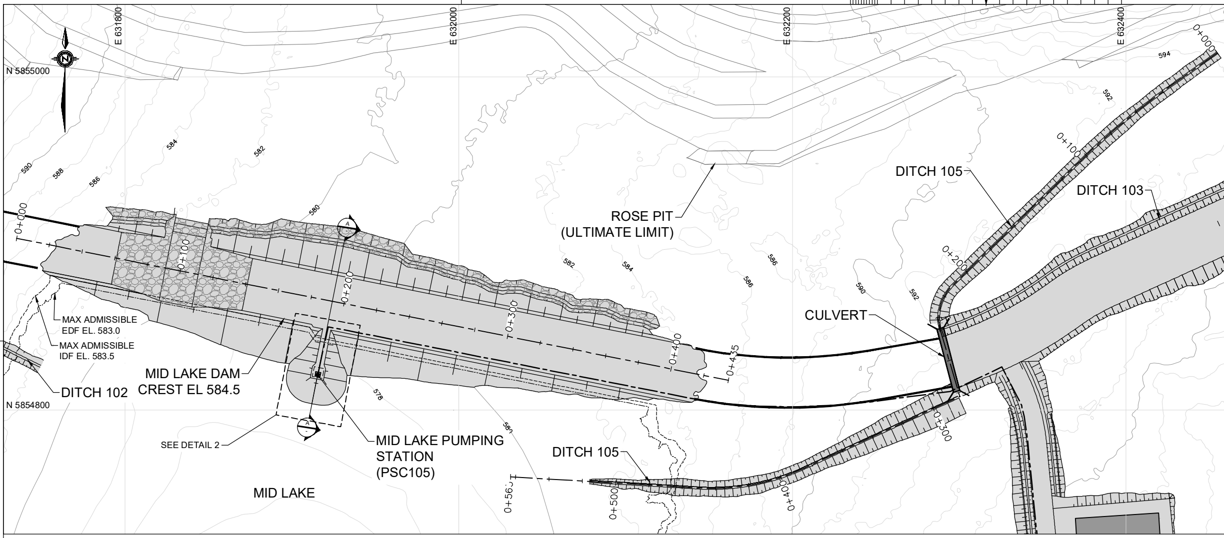
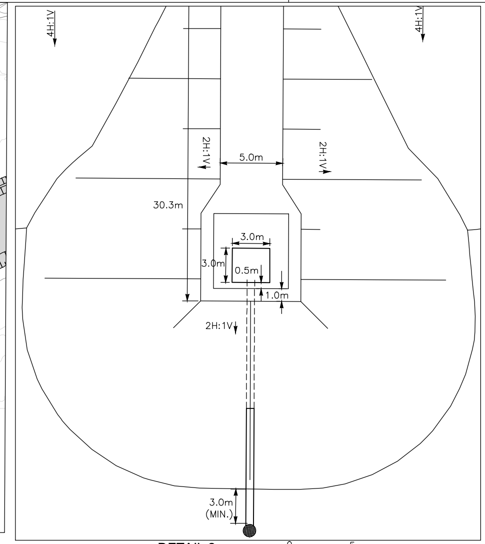


PLAN
MIDLAKE
SCALE: 1:1000

SCALE= 1:1500



DETAIL 2
SCALE: 1:200

SCALE= 1:200

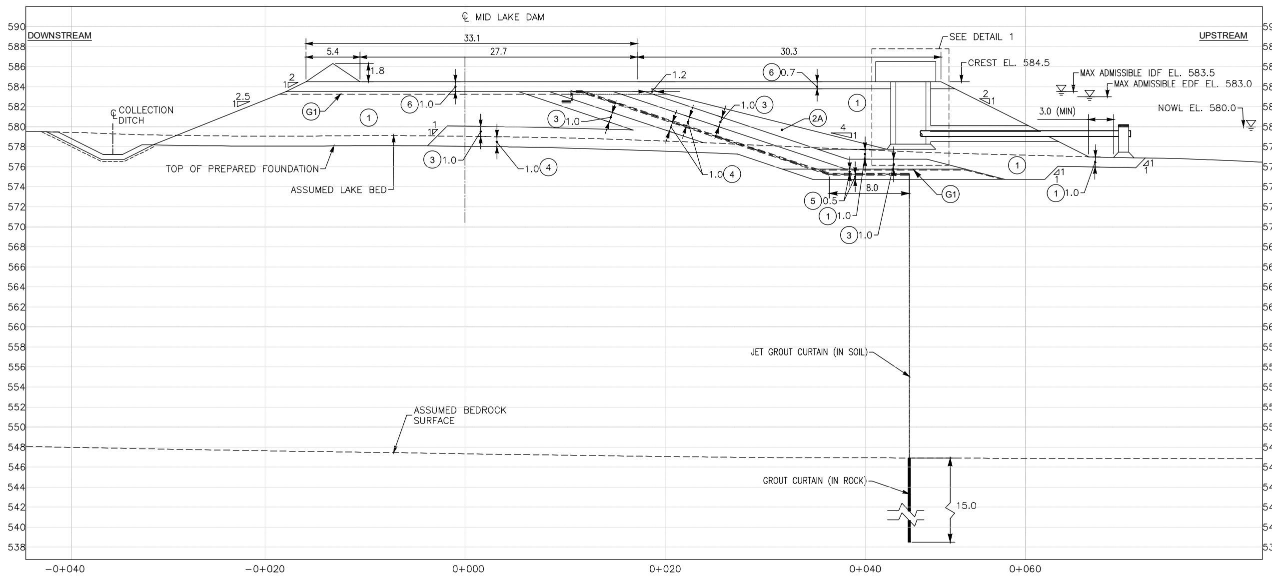
NOTES:

1. THE CO-ORDINATES, DIMENSIONS AND ELEVATIONS ARE IN METERS. ELEVATIONS ARE TIED TO MEAN SEA LEVEL. CO-ORDINATES ARE BASED ON UTM NAD83 ZONE 19 METRIC GRID PROJECTION.
2. CONTOURS WERE DERIVED FROM LIDAR SURVEY FROM B.B.A SEP. 2022.
3. PIT LAYOUT FROM B.B.A SEP. 2023
4. BEDROCK SURFACE ASSUMED BASED ON AN INTERPOLATION WITH BOREHOLES LOCATED MORE THAN 200 M FROM THE DAM. NO BOREHOLE INFORMATION IS AVAILABLE IN THE ALIGNMENT OF THE DAM.
5. ASSUMED LAKE BED BASED OF 2012 BATHYMETRY SURVEY
6. ROAD STRUCTURE DESIGNED BY OTHERS.

IDF: INFLOW DESIGN FLOOD
EDF: ENVIRONMENTAL DESIGN FLOOD
LOWL: LOW OPERATING WATER LEVEL

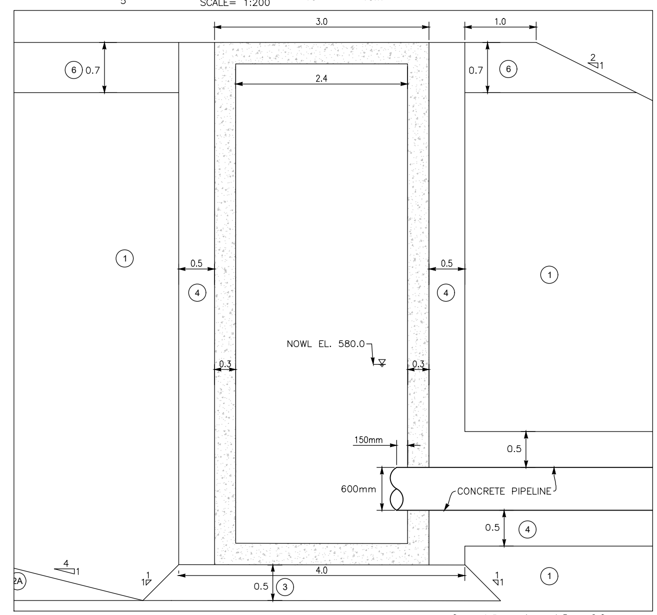
MATERIALS

- (1) NPAG ROCKFILL 0 – 1000mm
- (2A) RIPRAP 400 – 600mm
- (2B) RIPRAP 200–300mm
- (3) TRANSITION – SAND AND GRAVEL
- (4) SAND BEDDING
- (5) COMPACTED TILL
- (6) ROAD SURFACE – SAND AND GRAVEL
- (G1) GEOTEXTILE (TEXEL 918 – 407 g/m²)
- (G2) GEOSYNTHETIC CLAY LINER (GCL)
- (G3) GEOTEXTILE (TEXEL 912 – 250 g/m²)
- (GL) HDPE LINER TYPE MICRO-SPIKE



SECTION A-A
SCALE: 1:250

SCALE= 1:250



NOT FOR CONSTRUCTION

DETAIL 1
SCALE: 1:35

SCALE= 1:35

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2023/10/20	ISSUED WITH INFRASTRUCTURE DESIGN REPORT NO. 692696-8000-4GER-0001

ISSUE REGISTER

ISSUE REGISTER

REVISION REGISTER

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REFERENCE DRAWINGS

PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED P. PAGE	PROJECT DISCIPLINE ENGINEER
DRAWN M. SYKES	PROJECT ENGINEERING MANAGER M.H. PAQUETTE
CHECKED M.H. PAQUETTE	CLIENT M. GROLEAU
DATE 2023/10/20	
SCALE AS SHOWN	

CLIENT
CHAMPION IRON

PROJECT
KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE
MID LAKE DAM
PUMP STATION
PLAN VIEW, SECTION AND DETAILS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0010	00

A1-HDR-FRAME-EN (S)

LAST SAVE: 2023/11/27 – 9:48am
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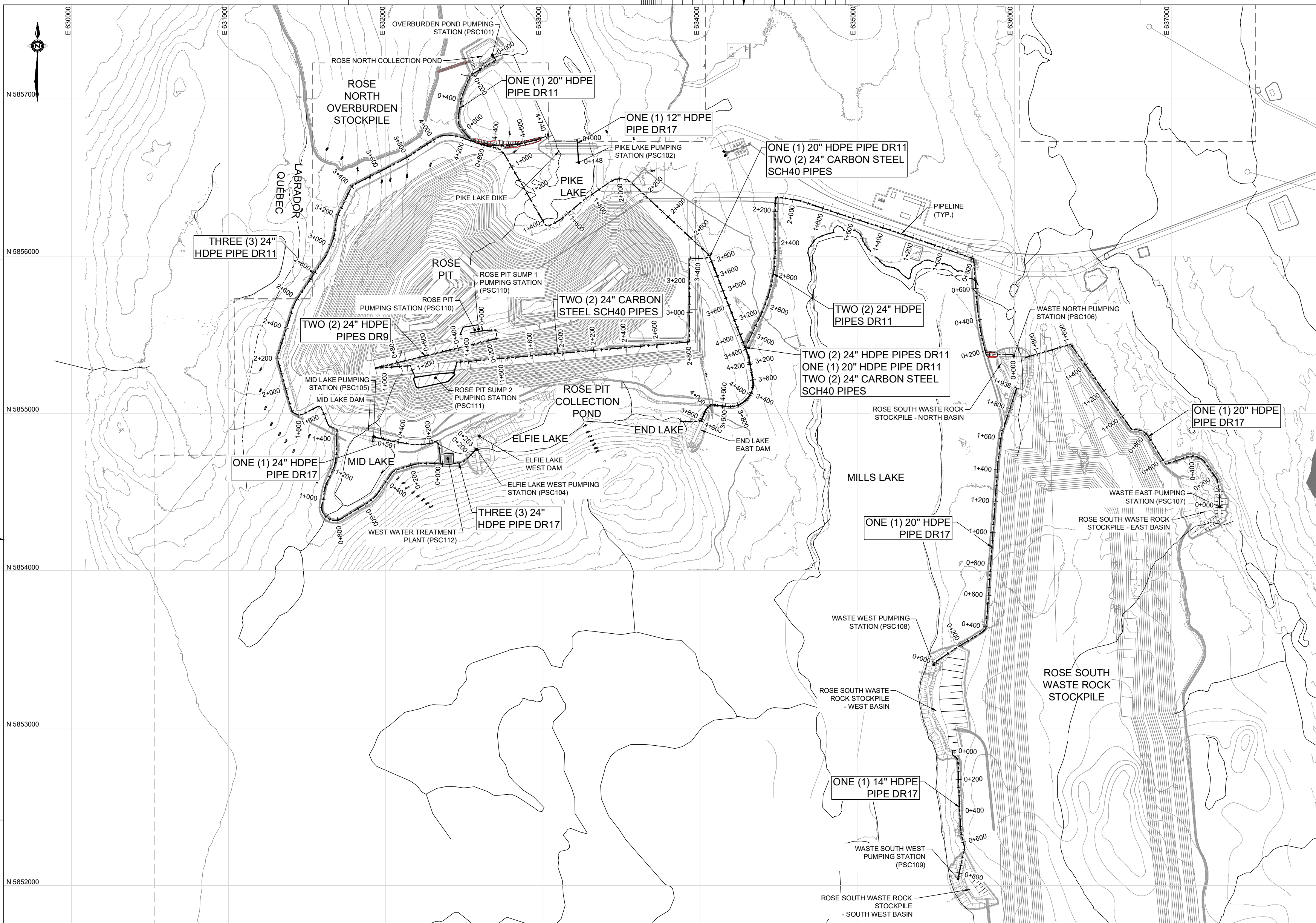

NOTES

1. THE CO-ORDINATES, DIMENSIONS AND ELEVATIONS ARE IN METERS. ELEVATIONS ARE TIED TO MEAN SEA LEVEL. CO-ORDINATES ARE BASED ON UTM NAD83 ZONE 19 METRIC GRID PROJECTION.
2. CONTOURS WERE DERIVED FROM LIDAR SURVEY FROM B.B.A SEP. 2022.
3. PIT LAYOUT FROM B.B.A SEP. 2023

NOT FOR CONSTRUCTION

0 100 200 300m
100
SCALE= 1:5000

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2023/10/20	ISSUED WITH INFRASTRUCTURE DESIGN REPORT NO. 692696-8000-4GER-0001

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INITIALS: * DESIGNED ** APPROVED

PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED S. NACHET	PROJECT DISCIPLINE ENGINEER
DRAWN M. SYKES	PROJECT ENGINEERING MANAGER M.H. PAQUETTE
CHECKED M.H. PAQUETTE	CLIENT M. GROLEAU
DATE 2023/10/20	
SCALE 1:12,000	

CLIENT
CHAMPION IRON

PROJECT
KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE
PIPLINE PLAN VIEW

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0011	00

A1-HDR-FRAME-EN (SI)

LAST SAVE: 2023/12/18 - 7:44am
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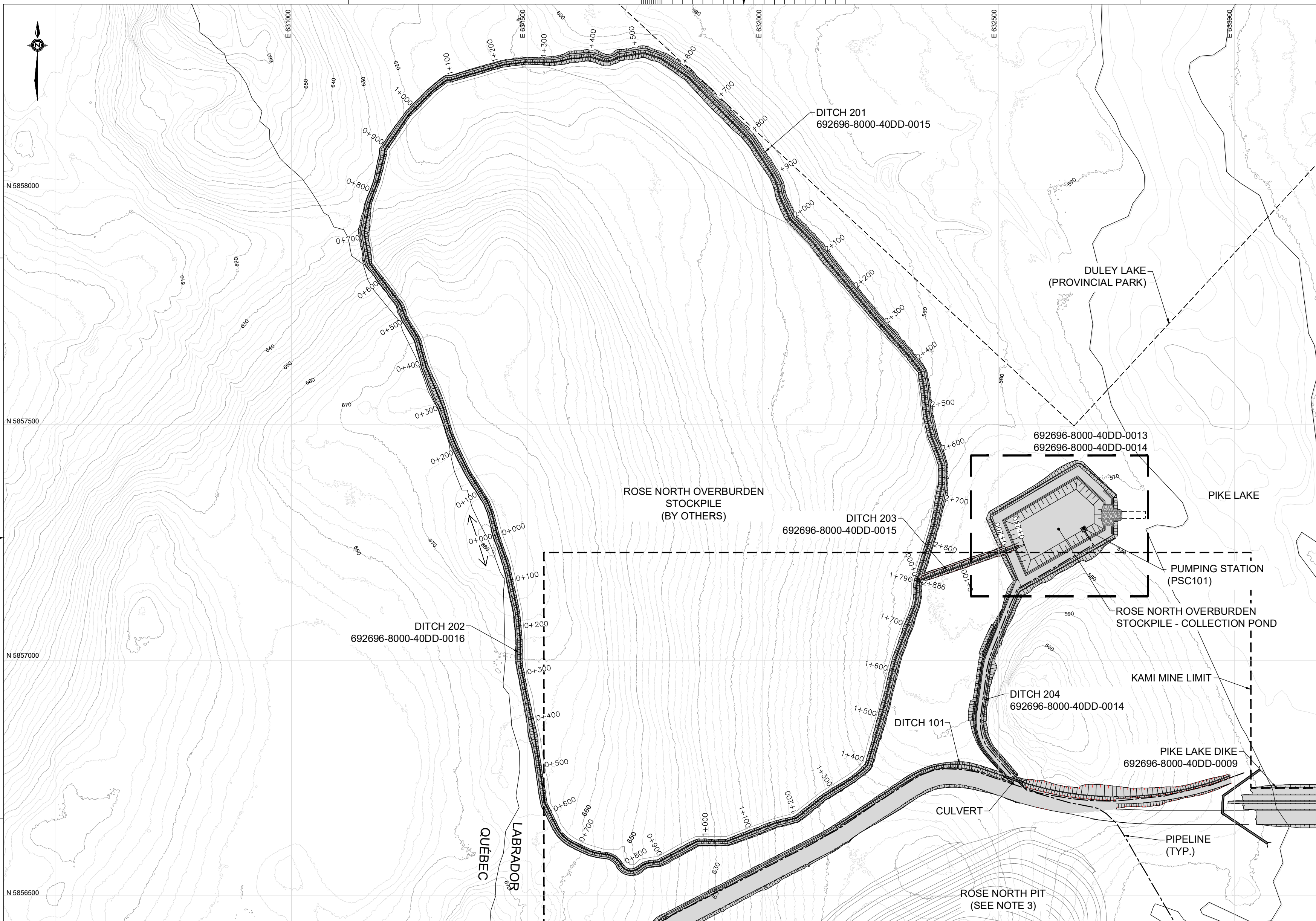

NOTES

1. THE CO-ORDINATES, DIMENSIONS AND ELEVATIONS ARE IN METERS. ELEVATIONS ARE TIED TO MEAN SEA LEVEL. CO-ORDINATES ARE BASED ON UTM NAD83 ZONE 19 METRIC GRID PROJECTION.
2. CONTOURS WERE DERIVED FROM LIDAR SURVEY FROM B.B.A SEP. 2022.
3. PIT LAYOUT FROM B.B.A SEP. 2023

NOT FOR CONSTRUCTION

0 50 100 200m

SCALE= 1:4000

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
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PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED P. PAGE	PROJECT DISCIPLINE ENGINEER
DRAWN M. SYKES	PROJECT ENGINEERING MANAGER M.H. PAQUETTE
CHECKED M.H. PAQUETTE	CLIENT M. GROLEAU
DATE 2023/10/20	
SCALE 1:4000	

CLIENT: CHAMPION IRON

PROJECT: KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: ROSE NORTH OVERBURDEN STOCKPILE DITCHES PLAN VIEW

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0012	00

A1-HDR-FRAME-EN (S)

LAST SAVE: 2023/12/18 - 7:47am
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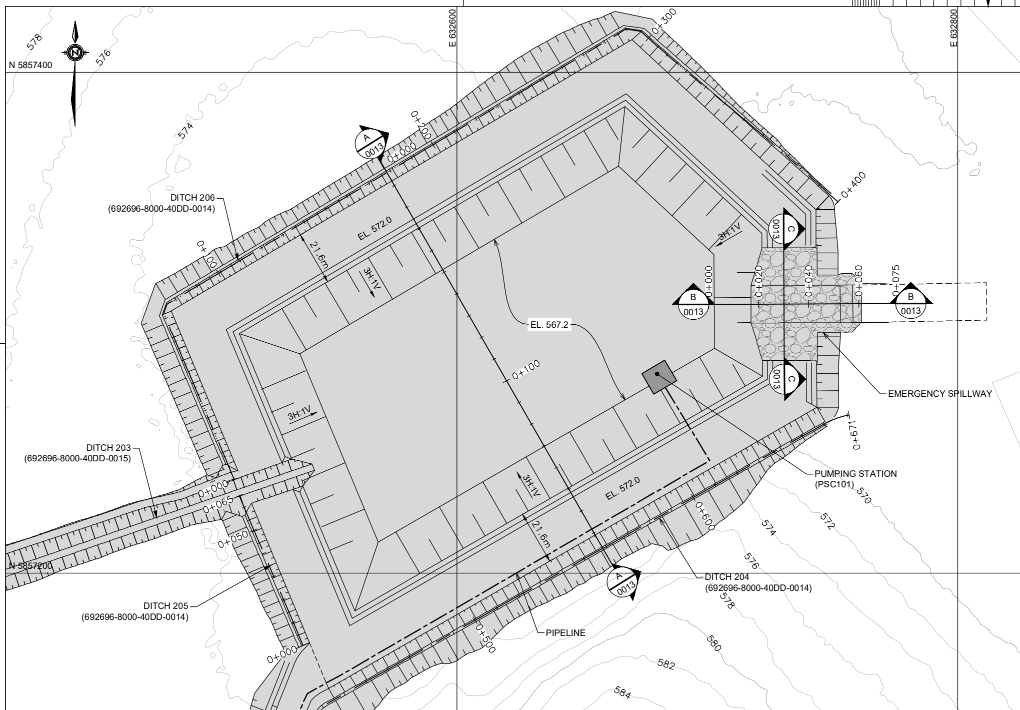


PLAN - ROSE NORTH COLLECTION POND

SCALE: 1:1000

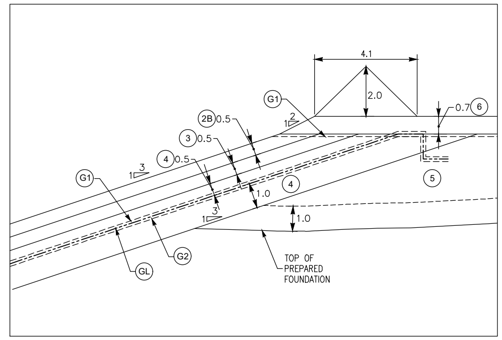
NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METERS.
2. BEDROCK SURFACE ASSUMED BASED ON AN INTERPOLATION WITH BOREHOLES LOCATED IN THE AREA.
3. ROAD STRUCTURE DESIGNED BY OTHERS.

IDF: INFLOW DESIGN FLOOD
EDF: ENVIRONMENTAL DESIGN FLOOD
LOWL: LOW OPERATING WATER LEVEL

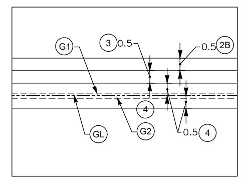
MATERIALS

- (2B) RIPRAP 200 – 300mm
- (2C) RIPRAP 100 – 200mm
- (3) TRANSITION – SAND AND GRAVEL
- (4) SAND BEDDING
- (5) COMPACTED TILL
- (6) ROAD SURFACE – SAND AND GRAVEL
- (G1) GEOTEXTILE (TEXEL 918 – 407 g/m²)
- (G2) GEOSYNTHETIC CLAY LINER (GCL)
- (G3) GEOTEXTILE (TEXEL 912 – 250 g/m²)
- (GL) HDPE LINER TYPE MICRO-SPIKE



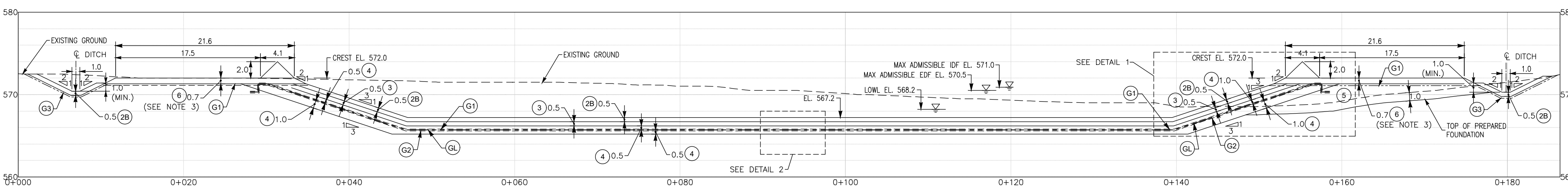
DETAIL 1

SCALE: 1:100



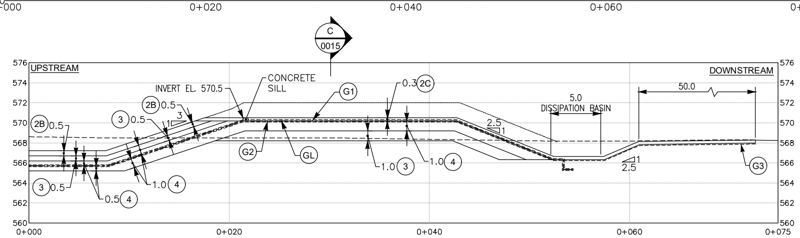
DETAIL 2

SCALE: 1:100



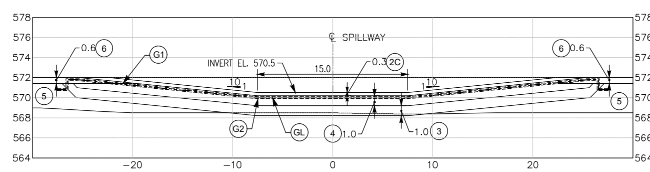
SECTION A

SCALE: 1:250



SECTION B

SCALE: 1:250



SECTION C

SCALE: 1:250

NOT FOR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2023/10/20	ISSUED WITH INFRASTRUCTURE DESIGN REPORT NO. 692696-8000-4GER-0001

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PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED: P. PAGÉ	PROJECT DISCIPLINE ENGINEER
DRAWN: M. SYKES	PROJECT ENGINEERING MANAGER: M.H. PAQUETTE
CHECKED: M.H. PAQUETTE	CLIENT: M. GROLEAU
DATE: 2023/10/20	
SCALE: INDICATED	

CLIENT: CHAMPION IRON

PROJECT: KAMI MINING PROJECT — ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: ROSE NORTH OVERBURDEN STOCKPILE COLLECTION POND (1/2) PLAN, SECTION AND DETAILS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0013	00

A1-HDR-FRAME-EN (SI)

LAST SAVE: 2023/12/18 – 7:53am
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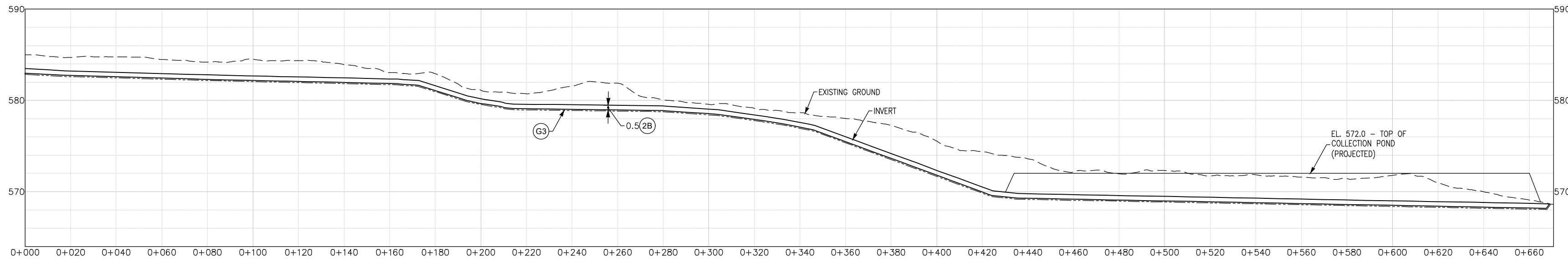
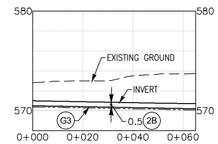
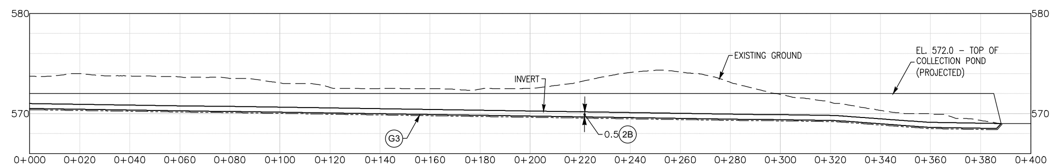


PROFILE ALONG DITCH 204 CENTERLINE (692696–8000–40DD–0013)
VERTICAL SCALE: 1:250
HORIZONTAL SCALE: 1:1000



PROFILE ALONG DITCH 205 CENTERLINE (692696–8000–40DD–0013)
VERTICAL SCALE: 1:250
HORIZONTAL SCALE: 1:1000



PROFILE ALONG DITCH 206 CENTERLINE (692696–8000–40DD–0013)
VERTICAL SCALE: 1:250
HORIZONTAL SCALE: 1:1000

NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METERS.
2. BEDROCK SURFACE ASSUMED BASED ON AN INTERPOLATION WITH BOREHOLES LOCATED IN THE AREA.
3. ROAD STRUCTURE DESIGNED BY OTHERS.

MATERIALS

(2B) RIPRAP 200 – 300mm

(G3) GEOTEXTILE (TEXEL 912 – 250 g/m²)

NOT FOR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2023/10/20	ISSUED WITH INFRASTRUCTURE DESIGN REPORT NO. 692696-8000-4GER-0001

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE

ISSUE REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	

REFERENCE DRAWINGS

PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED P. PAGÉ	PROJECT DISCIPLINE ENGINEER
DRAWN M. SYKES	PROJECT ENGINEERING MANAGER M.H. PAQUETTE
CHECKED M.H. PAQUETTE	CLIENT M. GROLEAU
DATE 2023/10/20	
SCALE INDICATED	

CLIENT
CHAMPION IRON

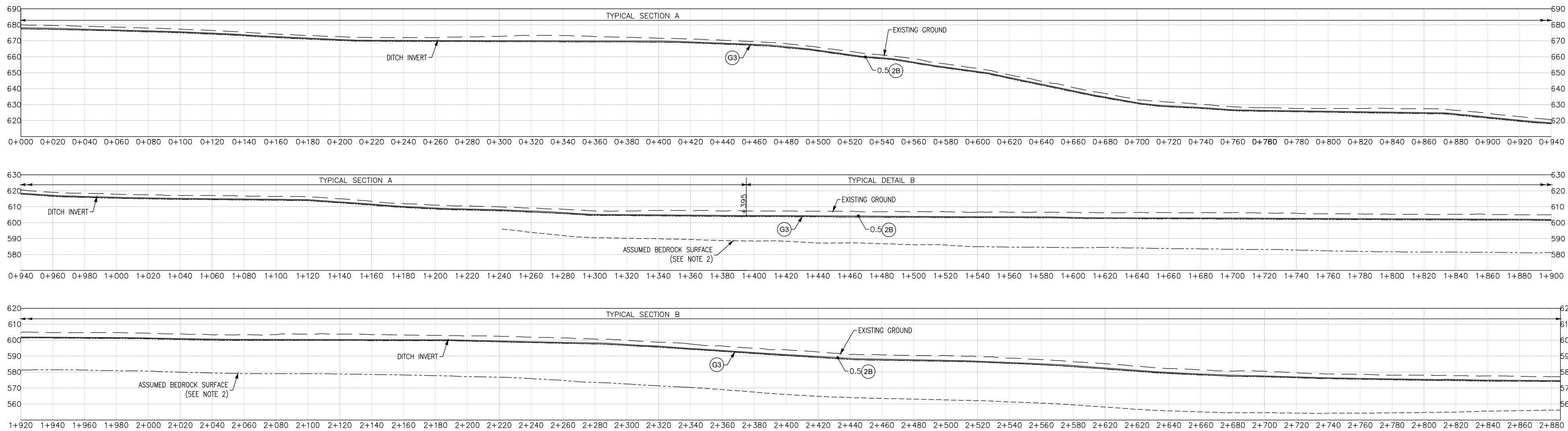
PROJECT
KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE
ROSE NORTH OVERBURDEN STOCKPILE
COLLECTION POND (2/2)
LONGITUDINAL PROFILES

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0014	00

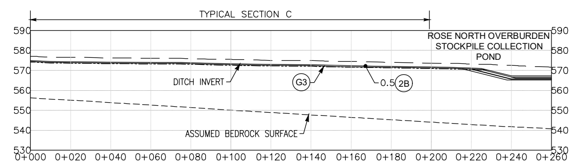
A1-HDR-FRAME-EN (SI)

LAST SAVE: 2023/12/18 – 7:55am
PATH: T:\692696 Kami Mine Conceptual Study\40_DD_DESSINS\CAD\8000\692696-8000-4000-0014_00.dwg



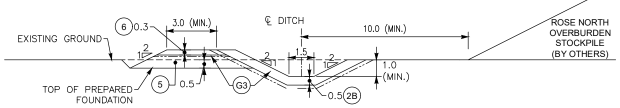
PROFILE ALONG DITCH 201 CENTERLINE
(692696-8000-40DD-0012)

SCALE: 1:1250



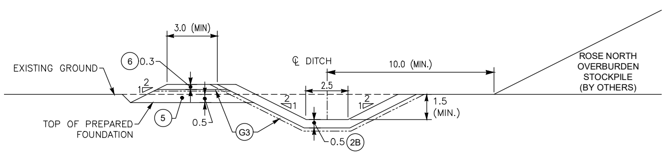
PROFILE ALONG DITCH 203 CENTERLINE
(692696-8000-40DD-0012)

SCALE: 1:1250



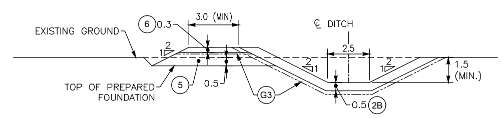
TYPICAL SECTION A
(0+000 TO 1+395)

SCALE: 1:150



TYPICAL SECTION B
(1+395 TO 2+886)

SCALE: 1:150



TYPICAL SECTION C

SCALE: 1:150

NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METERS.
2. BEDROCK SURFACE ASSUMED BASED ON AN INTERPOLATION WITH BOREHOLES LOCATED IN THE AREA.
3. EXCAVATED MATERIAL TO BE PLACED DOWNSTREAM OF THE DITCH. CAN BE USED AS SERVICE ROAD

MATERIALS

- (2B) RIPRAP 200–300mm
- (5) COMPACTED TILL
- (6) ROAD SURFACE – SAND AND GRAVEL
- (G3) GEOTEXTILE (TEXEL 912 – 250 g/m²)

NOT FOR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2023/10/20	ISSUED WITH INFRASTRUCTURE DESIGN REPORT NO. 692696-8000-4GER-0001

ISSUE REGISTER — ISSUE REGISTER — REVISION REGISTER — REVISION REGISTER — REFERENCE DRAWINGS

PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED P. PAGE	PROJECT DISCIPLINE ENGINEER
DRAWN M. SYKES	PROJECT ENGINEERING MANAGER M.H. PAQUETTE
CHECKED M.H. PAQUETTE	CLIENT M. GROLEAU
DATE 2023/10/20	
SCALE INDICATED	

CLIENT: CHAMPION IRON

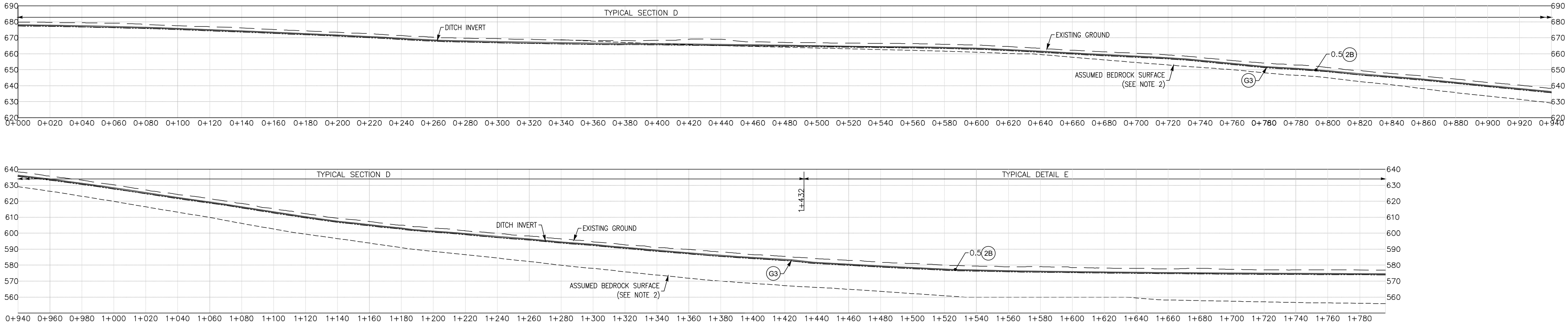
PROJECT: KAMI MINING PROJECT — ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: ROSE NORTH OVERBURDEN STOCKPILE DITCHES (1/2) — LONGITUDINAL PROFILES AND TYPICAL SECTIONS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0015	00

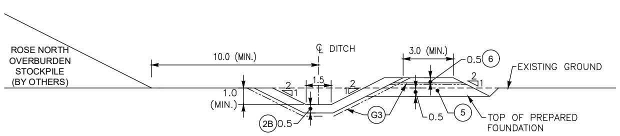
A1-HDR-FRAME-EN (SI)

LAST SAVE: 2023/12/18 – 7:58am
PATH: T:\692696 Kami Mine Conceptual Study\40_DD_DESSINS\CAD\8000\692696-8000-4000-0015_00.dwg



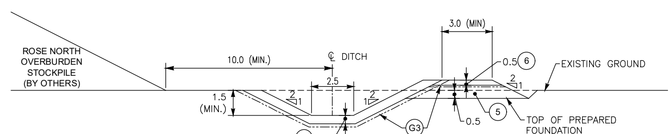
PROFILE ALONG DITCH 202 CENTERLINE (692696-8000-40DD-0012)

SCALE: 1:1250



TYPICAL SECTION D
(0+000 TO 1+432)

SCALE: 1:150



TYPICAL SECTION E
(1+432 TO 1+796)

SCALE: 1:150

NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METERS.
2. BEDROCK SURFACE ASSUMED BASED ON AN INTERPOLATION WITH BOREHOLES LOCATED IN THE AREA.
3. EXCAVATED MATERIAL TO BE PLACED DOWNSTREAM OF THE DITCH. CAN BE USED AS SERVICE ROAD

MATERIALS

- (2B) RIPRAP 200–300mm
- (5) COMPACTED TILL
- (6) ROAD SURFACE – SAND AND GRAVEL
- (G3) GEOTEXTILE (TEXEL 912 – 250 g/m²)

NOT FOR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2023/10/20	ISSUED WITH INFRASTRUCTURE DESIGN REPORT NO. 692696-8000-4GER-0001

ISSUE REGISTER

REVISION REGISTER (No / REVISION DESCRIPTION / DATE (Y/M/D) / * / ** — INITIALS: * DESIGNED ** APPROVED)

REFERENCE DRAWINGS

PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED: P. PAGE	PROJECT DISCIPLINE ENGINEER
DRAWN: M. SYKES	PROJECT ENGINEERING MANAGER: M.H. PAQUETTE
CHECKED: M.H. PAQUETTE	CLIENT: M. GROLEAU
DATE: 2023/10/20	
SCALE: INDICATED	

CLIENT: CHAMPION IRON

PROJECT: KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: ROSE NORTH OVERBURDEN STOCKPILE DITCHES (2/2)
LONGITUDINAL PROFILES AND TYPICAL SECTIONS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0016	00

A1-HDR-FRAME-EN (SI)

LAST SAVE: 2023/11/27 – 10:00am
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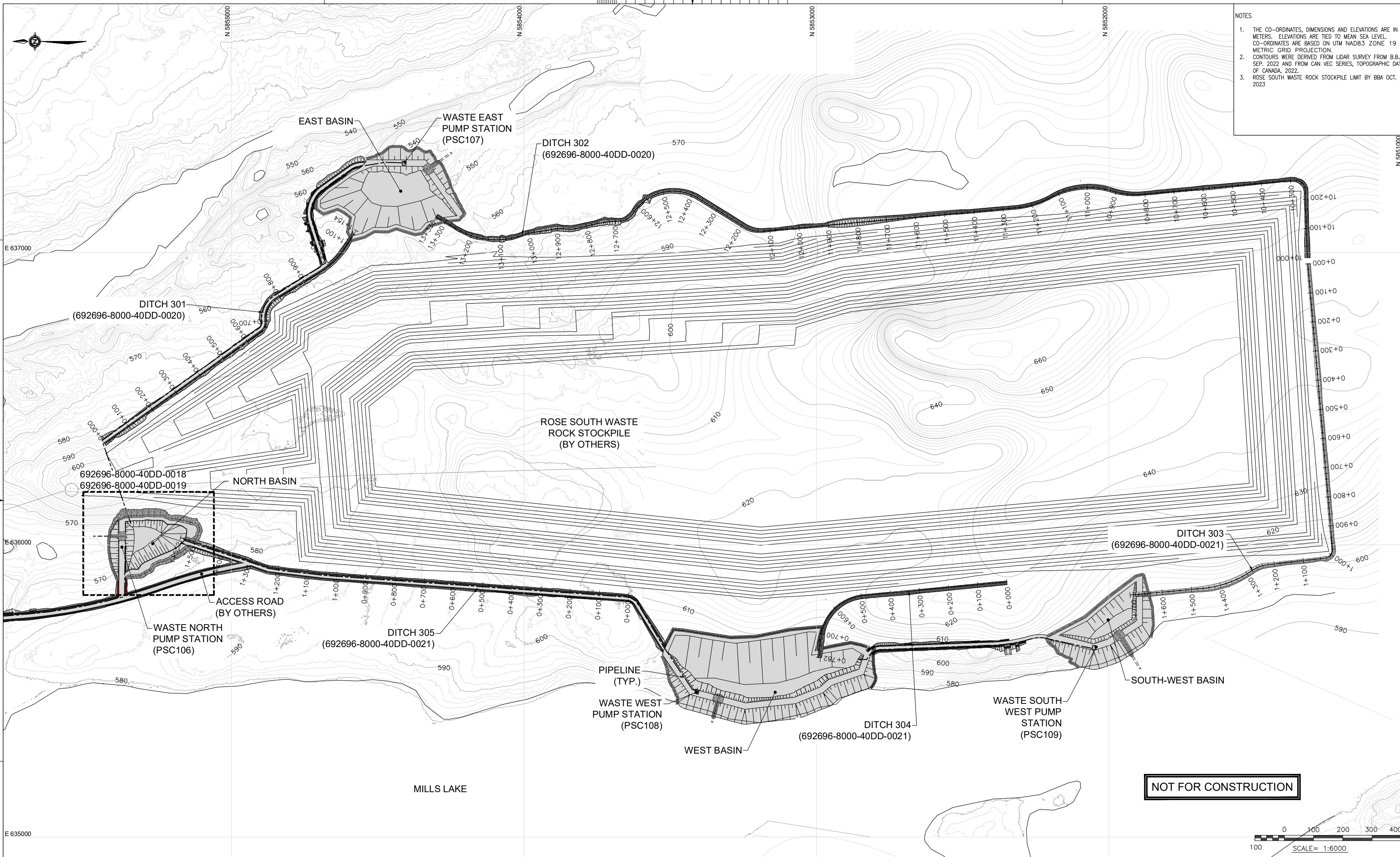

NOTES

1. THE CO-ORDINATES, DIMENSIONS AND ELEVATIONS ARE IN METERS. ELEVATIONS ARE TIED TO MEAN SEA LEVEL. CO-ORDINATES ARE BASED ON UTM NAD83 ZONE 19 METRIC GRID PROJECTION.
2. CONTOURS WERE DERIVED FROM LIDAR SURVEY FROM B.B.A SEP. 2022 AND FROM CAN VEC SERIES, TOPOGRAPHIC DATA OF CANADA, 2022.
3. ROSE SOUTH WASTE ROCK STOCKPILE LIMIT BY BBA OCT. 2023

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2023/10/20	ISSUED WITH INFRASTRUCTURE DESIGN REPORT NO. 692696-8000-4GER-0001

ISSUE REGISTER — ISSUE REGISTER — REVISION REGISTER — REVISION REGISTER — REFERENCE DRAWINGS

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PREPARATION	APPROVAL
DESIGNED P. PAGE	PROJECT DISCIPLINE ENGINEER
DRAWN M. SYKES	PROJECT ENGINEERING MANAGER M.H. PAQUETTE
CHECKED M.H. PAQUETTE	CLIENT M. GROLEAU
DATE 2023/10/20	
SCALE 1:6000	

CLIENT: CHAMPION IRON

PROJECT: KAMI MINING PROJECT — ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: ROSE SOUTH WASTE ROCK STOCKPILE DITCHES PLAN VIEW

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0017	00

A1-HDR-FRAME-EN (S)

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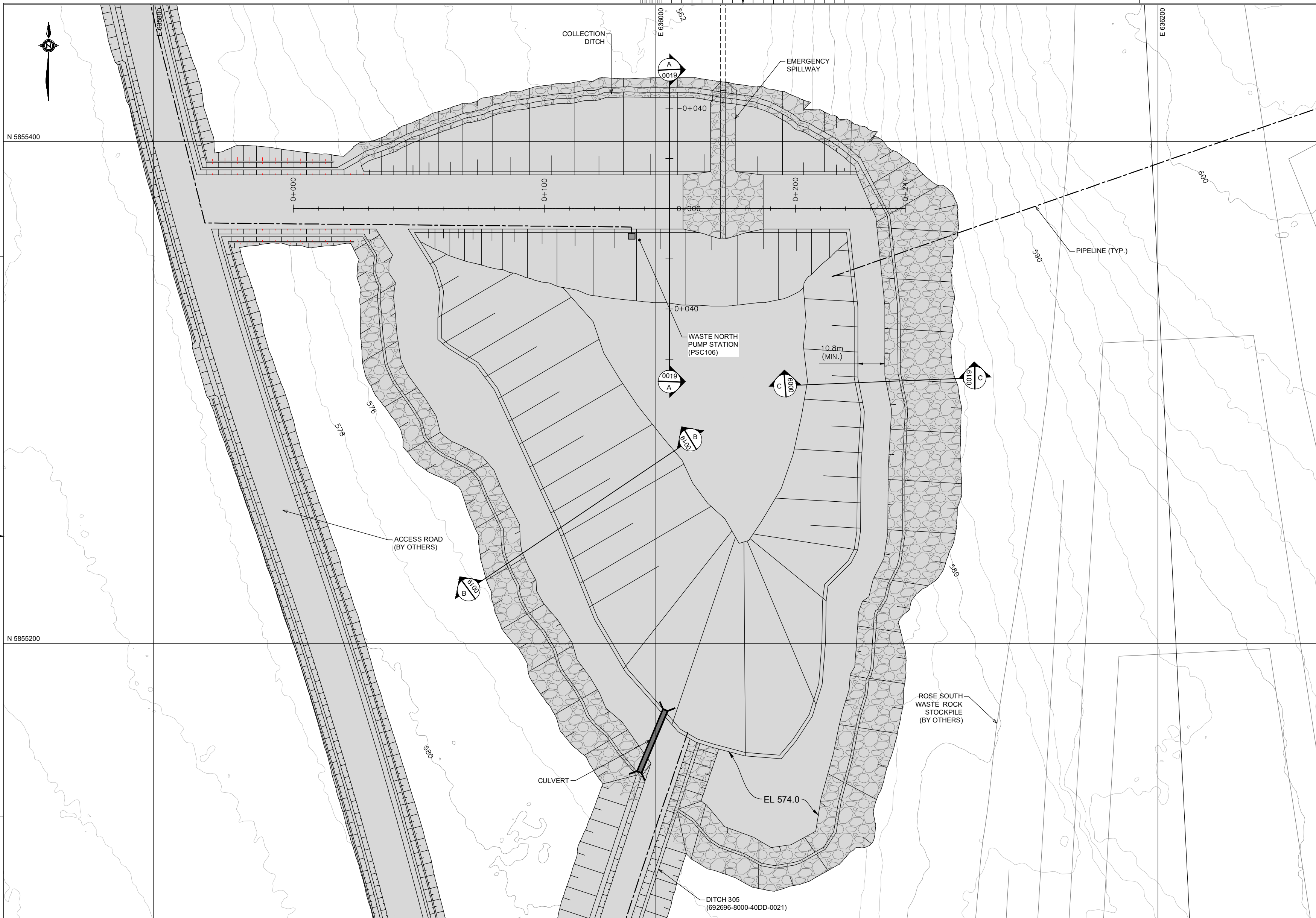

NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METERS.
2. BEDROCK SURFACE ASSUMED BASED ON AN INTERPOLATION WITH BOREHOLES LOCATED MORE THAN 200 m FROM THE DAM. NO BOREHOLE INFORMATION IS AVAILABLE IN THE ALIGNMENT OF THE DAM.

NOT FOR CONSTRUCTION

0 10 20 30 40 50m

SCALE= 1:750

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2023/10/20	ISSUED WITH INFRASTRUCTURE DESIGN REPORT NO. 692696-8000-4GER-0001

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DESIGNED P. PAGE	PROJECT DISCIPLINE ENGINEER
DRAWN M. SYKES	PROJECT ENGINEERING MANAGER M.H. PAQUETTE
CHECKED M.H. PAQUETTE	CLIENT M. GROLEAU
DATE 2023/10/20	
SCALE 1:750	

CLIENT CHAMPION IRON

PROJECT KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE ROSE SOUTH WASTE ROCK STOCKPILE NORTH BASIN (1/2) PLAN VIEW

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0018	00

A1-HDR-FRAME-EN (S)

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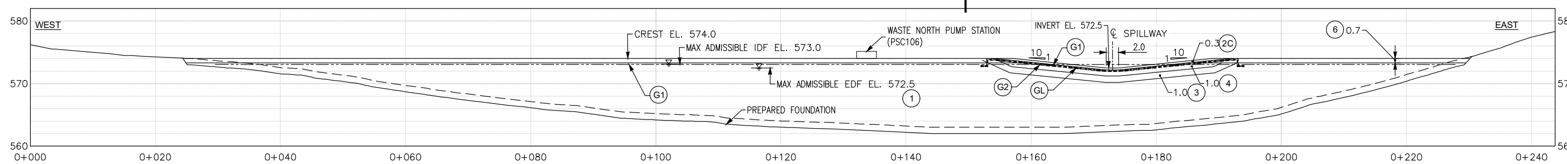

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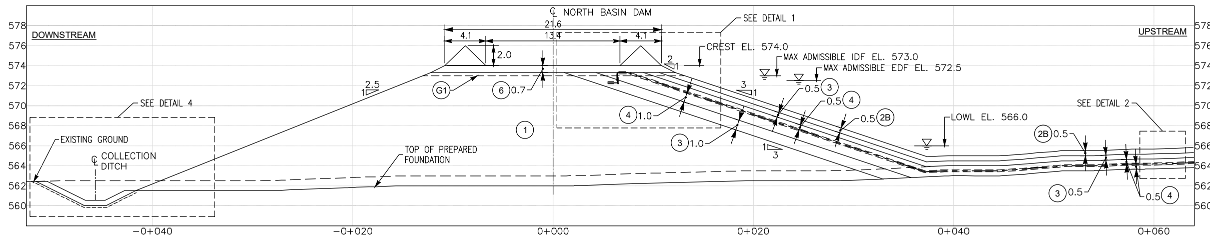

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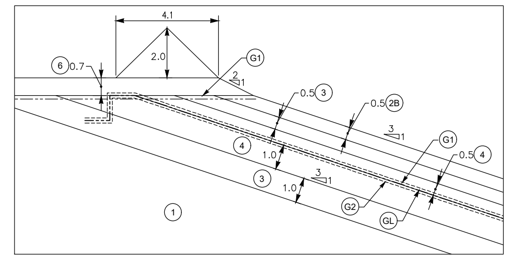

DETAIL 1

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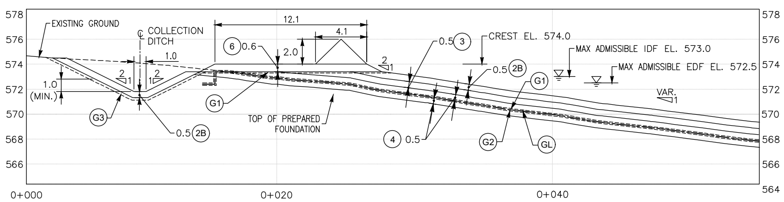

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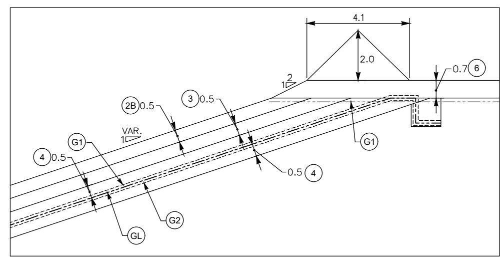

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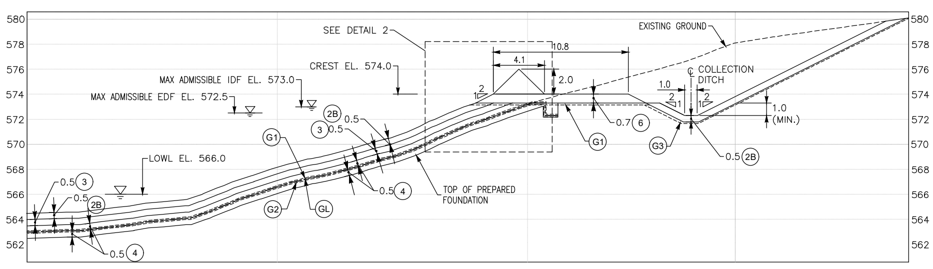

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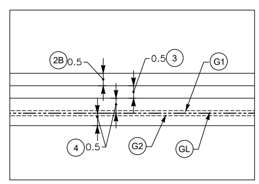

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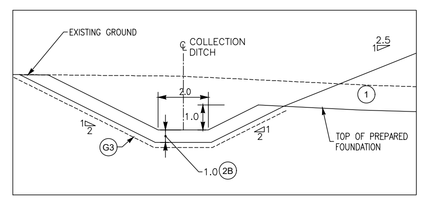
SCALE: 1:100



DETAIL 4

SCALE: 1:100

NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METERS.
2. BEDROCK SURFACE ASSUMED BASED ON AN INTERPOLATION WITH BOREHOLES LOCATED MORE THAN 200 M FROM THE DAM. NO BOREHOLE INFORMATION IS AVAILABLE IN THE ALIGNMENT OF THE DAM.

IDF: INFLOW DESIGN FLOOD
EDF: ENVIRONMENTAL DESIGN FLOOD
LOWL: LOW OPERATING WATER LEVEL

MATERIALS

- (1) NPAG ROCKFILL 0 – 1000mm
- (2A) RIPRAP 400 – 600mm
- (2B) RIPRAP 200 – 300mm
- (2C) RIPRAP 100 – 200mm
- (3) TRANSITION – SAND AND GRAVEL
- (4) SAND BEDDING
- (5) COMPACTED TILL
- (6) ROAD SURFACE – SAND AND GRAVEL
- (G1) GEOTEXTILE (TEXEL 918 – 407 g/m²)
- (G2) GEOSYNTHETIC CLAY LINER (GCL)
- (G3) GEOTEXTILE (TEXEL 912 – 250 g/m²)
- (GL) HDPE LINER TYPE MICRO-SPIKE

NOT FOR CONSTRUCTION

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2023/10/20	ISSUED WITH INFRASTRUCTURE DESIGN REPORT NO. 692696-8000-4GER-0001

REVISION REGISTER: No | REVISION DESCRIPTION | DATE (Y/M/D) | * | ** — INITIALS: * DESIGNED ** APPROVED

REFERENCE DRAWINGS

PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED P. PAGE	PROJECT DISCIPLINE ENGINEER
DRAWN M. SYKES	PROJECT ENGINEERING MANAGER M.H. PAQUETTE
CHECKED M.H. PAQUETTE	CLIENT M. GROLEAU
DATE 2023/10/20	
SCALE INDICATED	

CLIENT: CHAMPION IRON

PROJECT: KAMI MINING PROJECT — ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: ROSE SOUTH WASTE ROCK STOCKPILE NORTH BASIN (2/2) PLAN VIEW

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0019	00

A1-HDR-FRAME-EN (SI)

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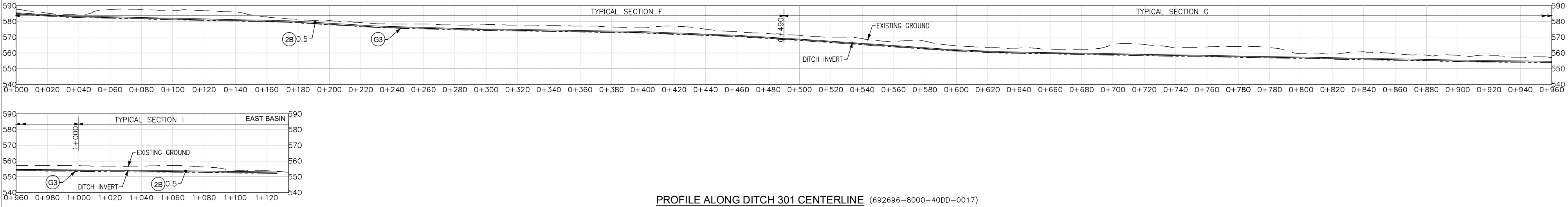
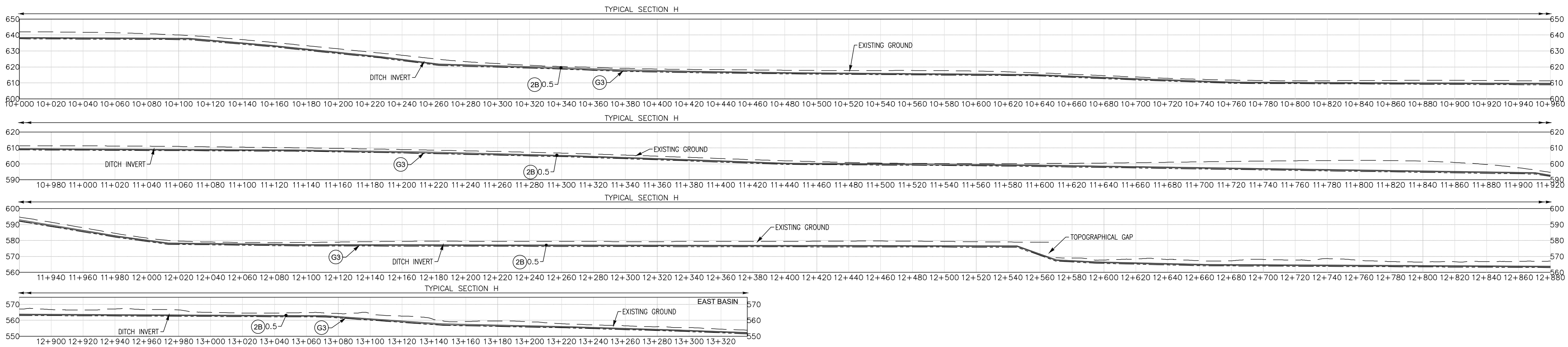


PROFILE ALONG DITCH 301 CENTERLINE (692696-8000-40DD-0017)
SCALE: 1:1250



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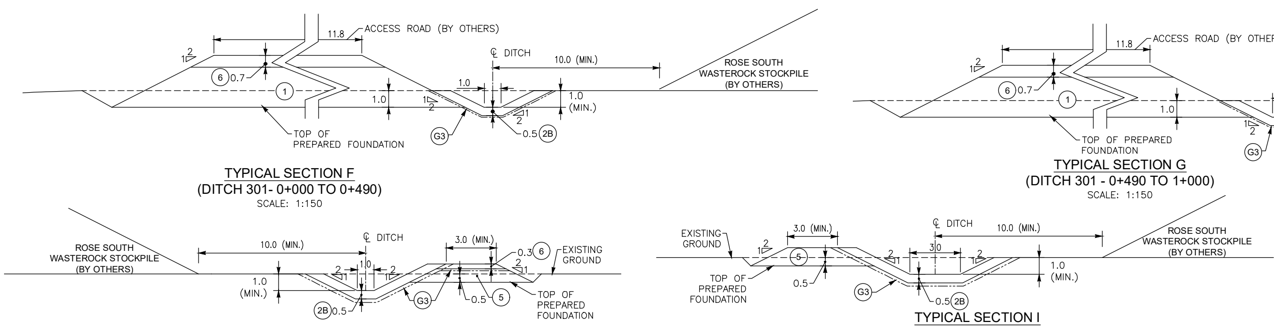

TYPICAL SECTION F
(DITCH 301- 0+000 TO 0+490)
SCALE: 1:150

TYPICAL SECTION G
(DITCH 301 - 0+490 TO 1+000)
SCALE: 1:150

TYPICAL SECTION H
SCALE: 1:150

TYPICAL SECTION I
(DITCH 301 - 1+000 TO 1+127)
SCALE: 1:150

NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METERS.
2. BEDROCK SURFACE ASSUMED BASED ON AN INTERPOLATION WITH BOREHOLES LOCATED IN THE AREA
3. EXCAVATED MATERIAL TO BE PLACED DOWNSTREAM OF THE DITCH.

MATERIALS

- (1) NPAG ROCKFILL 0 – 1000mm
- (2B) RIPRAP 200–300mm
- (5) COMPACTED TILL
- (6) ROAD SURFACE – SAND AND GRAVEL
- (G3) GEOTEXTILE (TEXEL 912 – 250 g/m²)

NOT FOR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2023/10/20	ISSUED WITH INFRASTRUCTURE DESIGN REPORT NO. 692696-8000-4GER-0001

ISSUE REGISTER | ISSUE REGISTER | REVISION REGISTER | REVISION REGISTER | REFERENCE DRAWINGS

PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED P. PAGE	PROJECT DISCIPLINE ENGINEER
DRAWN M. SYKES	PROJECT ENGINEERING MANAGER M.H. PAQUETTE
CHECKED M.H. PAQUETTE	CLIENT M. GROLEAU
DATE 2023/10/20	
SCALE INDICATED	

CLIENT: CHAMPION IRON

PROJECT: KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: ROSE SOUTH WASTE ROCK STOCKPILE NORTH BASIN (1/2) LONGITUDINAL PROFILES AND TYPICAL SECTION

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0020	00

A1-HDR-FRAME-EN (SI)

LAST SAVE: 2023/11/27 – 10:09am
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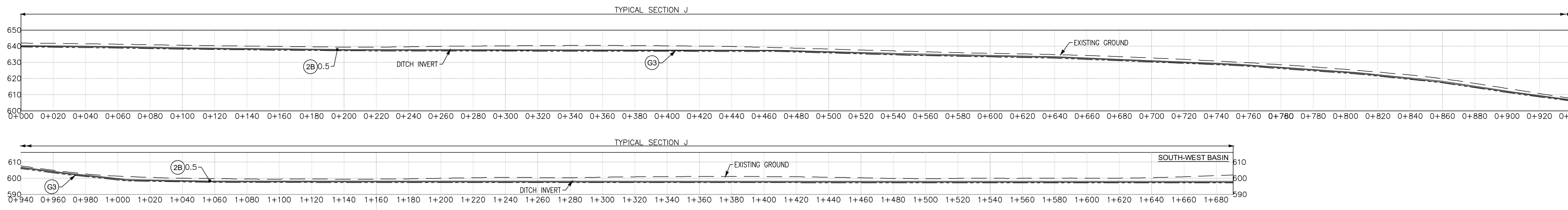
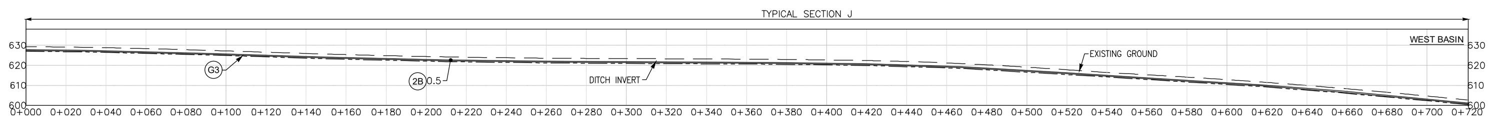


PROFILE ALONG DITCH 303 CENTERLINE (692696-8000-40DD-0017)
SCALE: 1:1250



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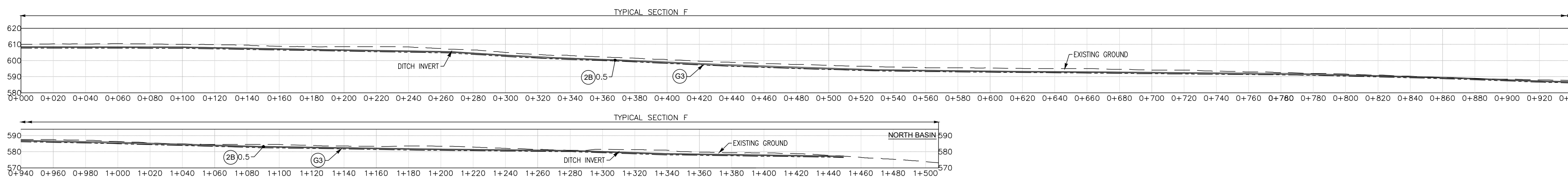
SCALE: 1:1250



PROFILE ALONG DITCH 305 CENTERLINE (692696-8000-40DD-0017)
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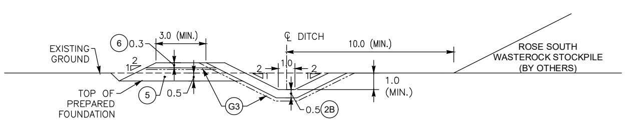
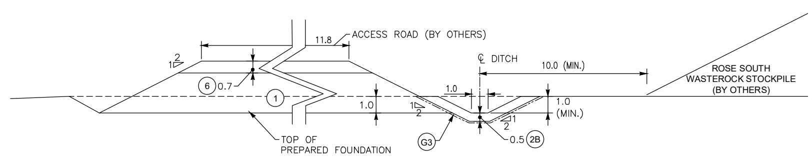


TYPICAL SECTION J
SCALE: 1:150



TYPICAL SECTION F
SCALE: 1:150

NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METERS.
2. BEDROCK SURFACE ASSUMED BASED ON AN INTERPOLATION WITH BOREHOLES LOCATED IN THE AREA
3. EXCAVATED MATERIAL TO BE PLACED DOWNSTREAM OF THE DITCH.

MATERIALS

- (1) NPAG ROCKFILL 0 – 1000mm
- (2B) RIPRAP 200–300mm
- (5) COMPACTED TILL
- (6) ROAD SURFACE – SAND AND GRAVEL
- (G3) GEOTEXTILE (TEXEL 912 – 250 g/m²)

NOT FOR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2023/10/20	ISSUED WITH INFRASTRUCTURE DESIGN REPORT NO. 692696-8000-4GER-0001

ISSUE REGISTER | ISSUE REGISTER | REVISION REGISTER | REVISION REGISTER | REFERENCE DRAWINGS

PROFESSIONAL SEAL

AtkinsRéalis

PREPARATION	APPROVAL
DESIGNED P. PAGE	PROJECT DISCIPLINE ENGINEER
DRAWN M. SYKES	PROJECT ENGINEERING MANAGER M.H. PAQUETTE
CHECKED M.H. PAQUETTE	CLIENT M. GROLEAU
DATE 2023/10/20	
SCALE INDICATED	

CLIENT: CHAMPION IRON

PROJECT: KAMI MINING PROJECT
ROSE PIT HYDROGEOLOGICAL AND WATER BALANCE STUDY

TITLE: ROSE SOUTH WASTE ROCK STOCKPILE NORTH BASIN (2/2) LONGITUDINAL PROFILES AND TYPICAL SECTION

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
692696	8000	40 DD	0021	00

A1-HDR-FRAME-EN (SI)

LAST SAVE: 2023/11/27 – 10:13am
PATH: T:\692696 Kami Mine Conceptual Study\40_DD_DESSINS\CAD\8000\692696-8000-4000-0021_00.dwg

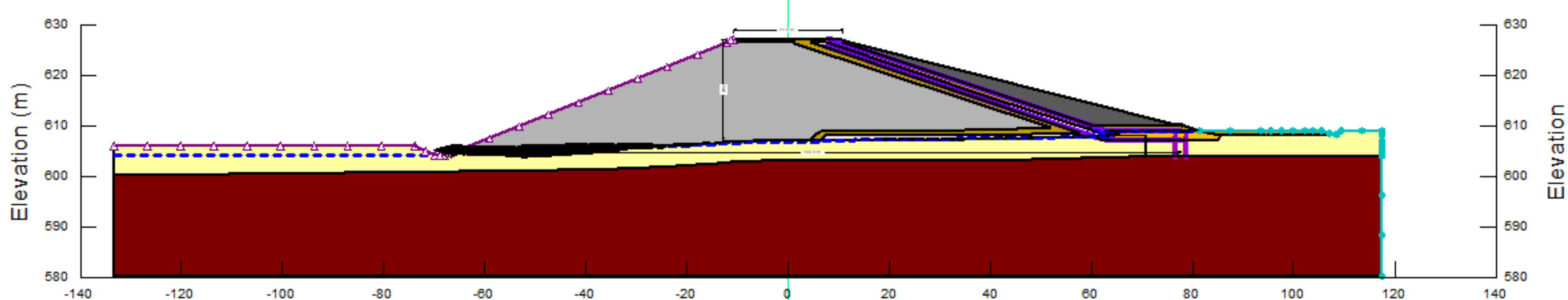
Appendix G

Dams/Dike Seepage and Stability Analyses

SNC • LAVALIN

Color	Name	Hydraulic Material Model	Vol. WC. Function	K-Function	Sat Kx (m/sec)	Ky/Kx' Ratio
	Bedrock (Fractured)	Saturated Only			5e-08	1
	Compacted Till	Saturated Only			1e-06	1
	GCL	Saturated Only			1e-09	1
	Grouting	Saturated Only			1e-09	1
	Overburden - Loose to compact Till	Saturated Only			1e-06	1
	Rip-rap (400-600mm)	Saturated Only			0,01	1
	Rockfill (1) (sat/unsat)	Saturated / Unsaturated	Gravel VWC function (WC=0,3)	Gravel K function (manual)		1
	Sand	Saturated / Unsaturated	Sand VWC function (WC=0,3)	Sand K function (WC=0,3)		1
	Sand and Gravel	Saturated / Unsaturated	Sand VWC function (WC=0,3)	Sand and Gravel K function (WC=0,3)		1

ELFIE LAKE WEST DAM

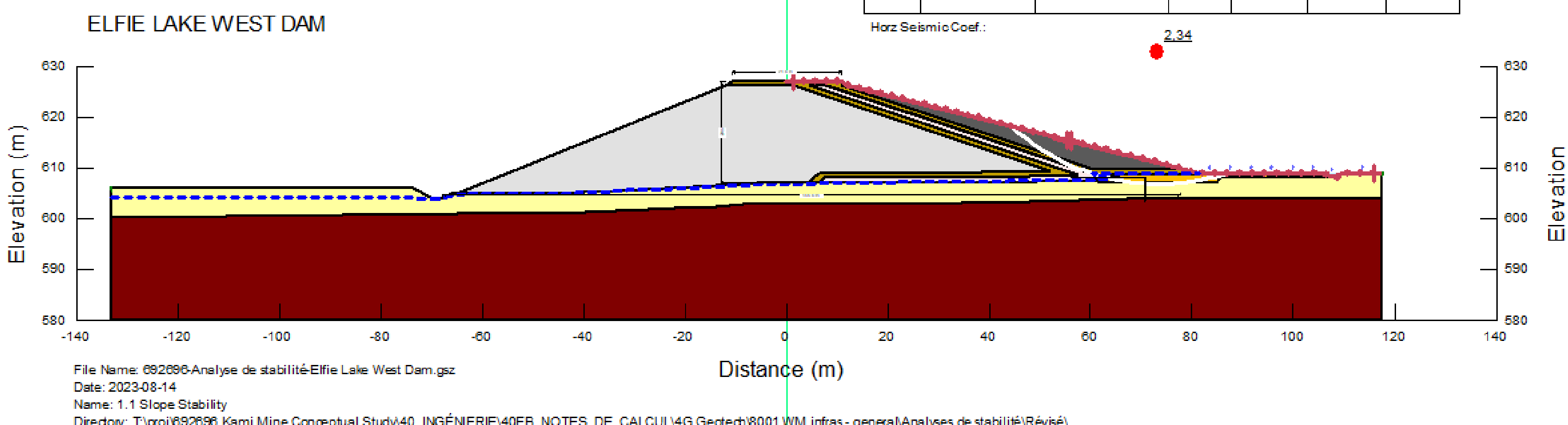


File Name: 692696-Analyse de stabilité-Elfie Lake West Dam.gsz
Date: 2023-06-26
Name: 1. Pond at 609 m - No groundwater recharge
Directory: T:\proj\692696 Kami Mine Conceptual Study\40_INGÉNIERIE\40EB_NOTES_DE_CALCUL\4G Geotech\8001 WM infras - general\Analyses de stabilité\Révisé\

Analysis: Seepage

(Empty Pond)

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Mohr-Coulomb	26		150	30
	Compacted Till	Mohr-Coulomb	18		0	31
	GCL	Mohr-Coulomb	0,1		0	20
	GCL*	Mohr-Coulomb	0,1		0	12
	Geotextile	Mohr-Coulomb	0,1		0	30,5
	Geotextile*	Mohr-Coulomb	0,1		0	25
	HDPE Liner	Mohr-Coulomb	0,1		0	29,5
	HDPE Liner*	Mohr-Coulomb	0,1		0	12
	Overburden - Loose to compact Till	Mohr-Coulomb	18		0	31
	Rip-rap (400-600mm)	Mohr-Coulomb	22		0	38
	Rockfill (Leps 1970, Lower Bound)	Shear/Normal Fn.	22	Leps (Lower bound)		
	Sand	Mohr-Coulomb	19		0	30
	Sand and Gravel	Mohr-Coulomb	22		0	35

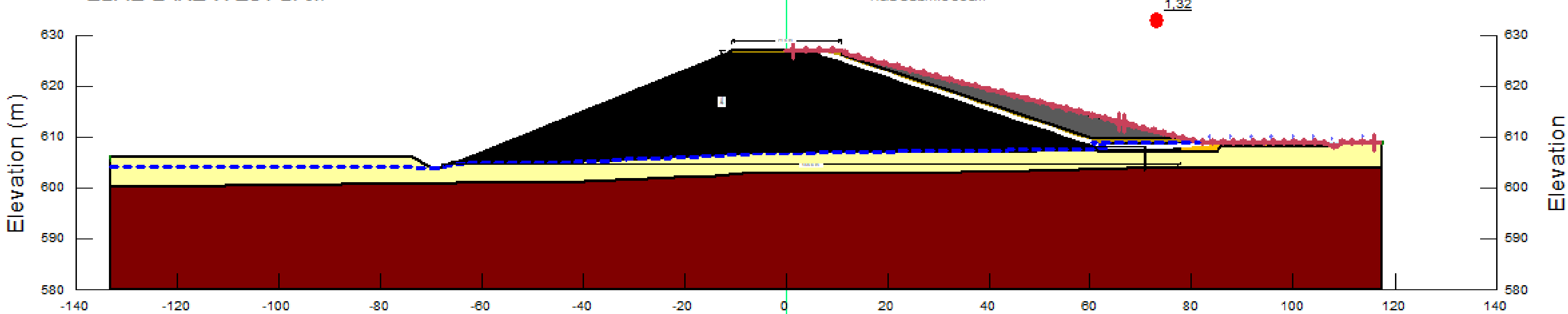


Analysis: Static – Short Term - Upstream

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Mohr-Coulomb	26	150	30
	Compacted Till	Mohr-Coulomb	18	0	31
	Geotextile	Mohr-Coulomb	0,1	0	30,5
	Geotextile*	Mohr-Coulomb	0,1	0	25
	HDPE Liner	Mohr-Coulomb	0,1	0	29,5
	HDPE Liner*	Mohr-Coulomb	0,1	0	12
	Impenetrable	Bedrock (Impenetrable)			
	Overburden - Loose to compact Till	Mohr-Coulomb	18	0	31
	Rip-rap (400-600mm)	Mohr-Coulomb	22	0	38
	Sand and Gravel	Mohr-Coulomb	22	0	35

Horz Seismic Coef.:

ELFIE LAKE WEST DAM



File Name: 692696-Analyse de stabilité-Elfie Lake West Dam.gsz
Date: 2023-08-14
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Directory: T:\proj\692696 Kami Mine Conceptual Study\40_INGÉNIERIE\40EB_NOTES_DE_CALCUL\4G Geotech\8001 WM infras - general\Analyses de stabilité\Révisé\

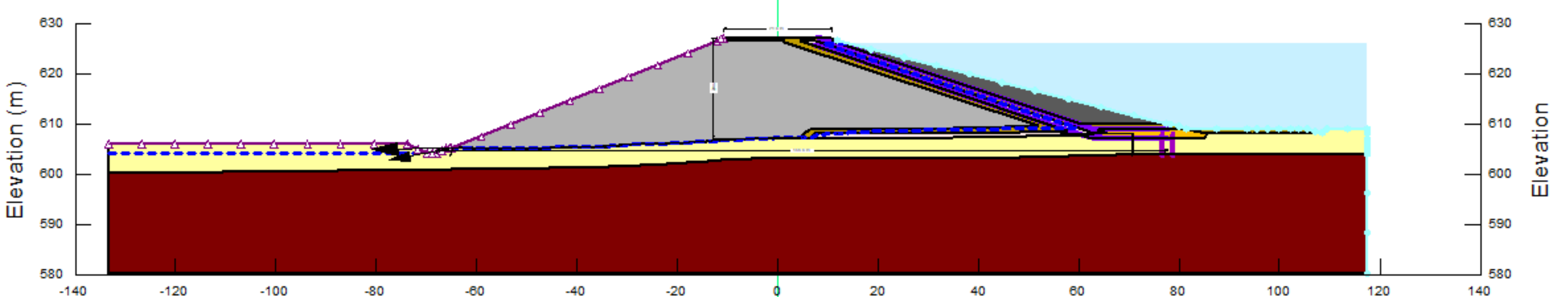
Analysis: Static – Short Term - Upstream

(Geotextile stability)

SNC·LAVALIN

Color	Name	Hydraulic Material Model	Vol. WC. Function	K-Function	Sat Kx (m/sec)	Ky'/Kx' Ratio
	Bedrock (Fractured)	Saturated Only			5e-08	1
	Compacted Till	Saturated Only			1e-06	1
	GCL	Saturated Only			1e-09	1
	Grouting	Saturated Only			1e-09	1
	Overburden - Loose to compact Till	Saturated Only			1e-06	1
	Rip-rap (400-600mm)	Saturated Only			0,01	1
	Rockfill (1) (sat/unsat)	Saturated / Unsaturated	Gravel VWC function (WC=0,3)	Gravel K function (manual)		1
	Sand	Saturated / Unsaturated	Sand VWC function (WC=0,3)	Sand K function (WC=0, 3)		1
	Sand and Gravel	Saturated / Unsaturated	Sand VWC function (WC=0,3)	Sand and Gravel K function (WC=0, 3)		1

ELFIE LAKE WEST DAM

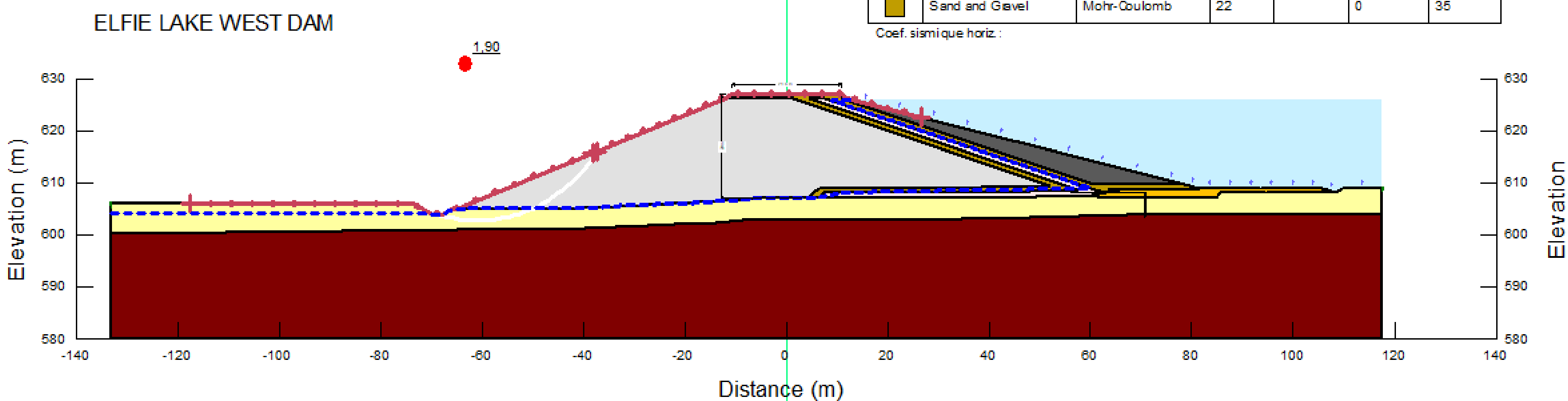


File Name: 692696-Analyse de stabilité-Elfie Lake West Dam.gsz
Date: 2023-06-26
Name: 2. Pond at 626 m - No groundwater recharge
Directoy: T:\proj\692696 Kami Mine Conceptual Study\40_INGÉNIERIE\40EB_NOTES_DE_CALCUL\4G Geotech\8001 WM infras - general\Analyses de stabilité\Révisé\

Analysis: Seepage

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock (Fractured)	Mohr-Coulomb	26		150	30
	Compacted Till	Mohr-Coulomb	18		0	31
	Overburden - Loose to compact Till	Mohr-Coulomb	18		0	31
	Rip-rap (400-600 mm)	Mohr-Coulomb	22		0	38
	Rockfill (Leps 1970, Lower Bound)	Shear/Normal Fn.	22	Leps (Lower bound)		
	Sand	Mohr-Coulomb	19		0	30
	Sand and Gravel	Mohr-Coulomb	22		0	35

Coef. sismique horiz. :



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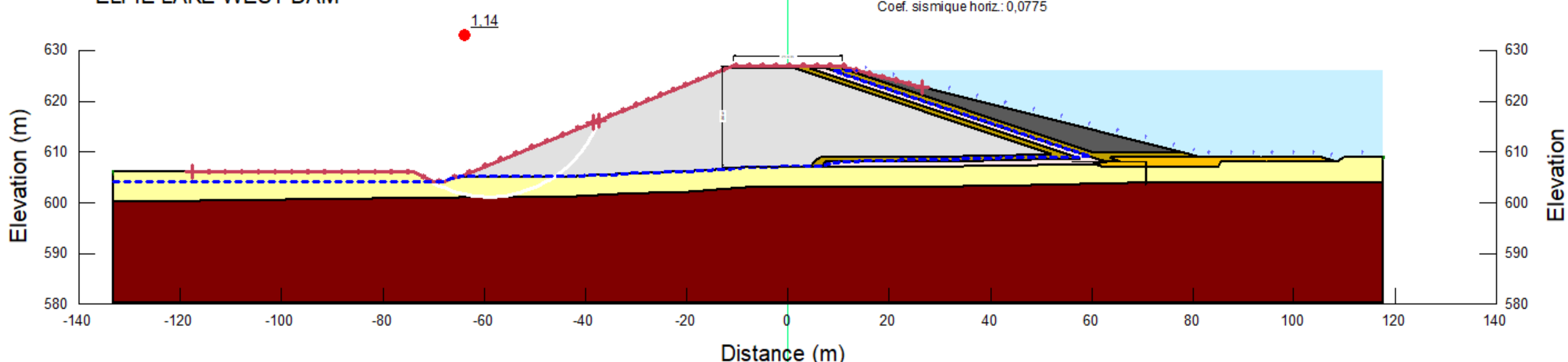
Date: 2023-07-25
Name: 2.1a Slope Stability (2)
Directory: T:\proj\692696 Kami Mine Conceptual Study\40_INGÉNIERIE\40EB_NOTES_DE_CALCUL\4G Geotech\8001 WM infras - general\Analyses de stabilité\Révisé\

Analysis: Static – Long Term

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Mohr-Coulomb	26		150	30
	Compacted Till (80%)	Mohr-Coulomb	18		0	24,8
	Overburden - Loose to compact Till (80%)	Mohr-Coulomb	18		0	24,8
	Rip-rap (400-600mm) (80%)	Mohr-Coulomb	22		0	30,4
	Rockfill (Leps 1970, Lower Bound) (80%)	Shear/Normal Fn.	22	Leps (Lower bound) (80%)		
	Sand (80%)	Mohr-Coulomb	19		0	24
	Sand and Gravel (80%)	Mohr-Coulomb	22		0	28

Coef. sismique horiz.: 0,0775

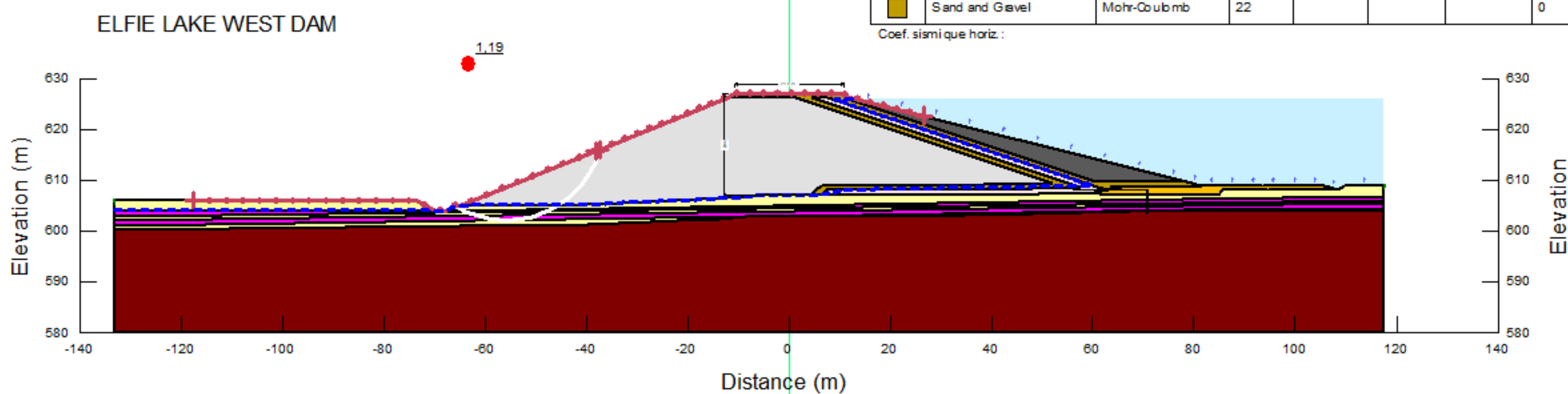


File Name: 692696-Analyse de stabilité-Elfie Lake West Dam.gsz
Date: 2023-12-19
Name: 2.3A Slope Stability - Pseudo-Static (2)
Directory: T:\proj\692696 Kami Mine Conceptual Study\40_INGÉNIERIE\40EB_NOTES_DE_CALCUL\4G Geotech\8001 WM infras - general\Analyses de stabilité\Révisé\Récurrence-moitié-2475-10000\

Analysis: Pseudo-static

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock (Fractured)	Mohr-Coulomb	26				150	30
	Compacted Till	Mohr-Coulomb	18				0	31
	Overburden - Loose to compact Till	Mohr-Coulomb	18				0	31
	Overburden - Loose to compact Till (résiduel)	SHANSEP	18		10	0,05		
	Rip-rap (400-600 mm)	Mohr-Coulomb	22				0	38
	Rockfill (Leps 1970, Lower Bound)	Shear/Normal Fn.	22	Leps (Lower bound)				
	Sand	Mohr-Coulomb	19				0	30
	Sand and Gravel	Mohr-Coulomb	22				0	35

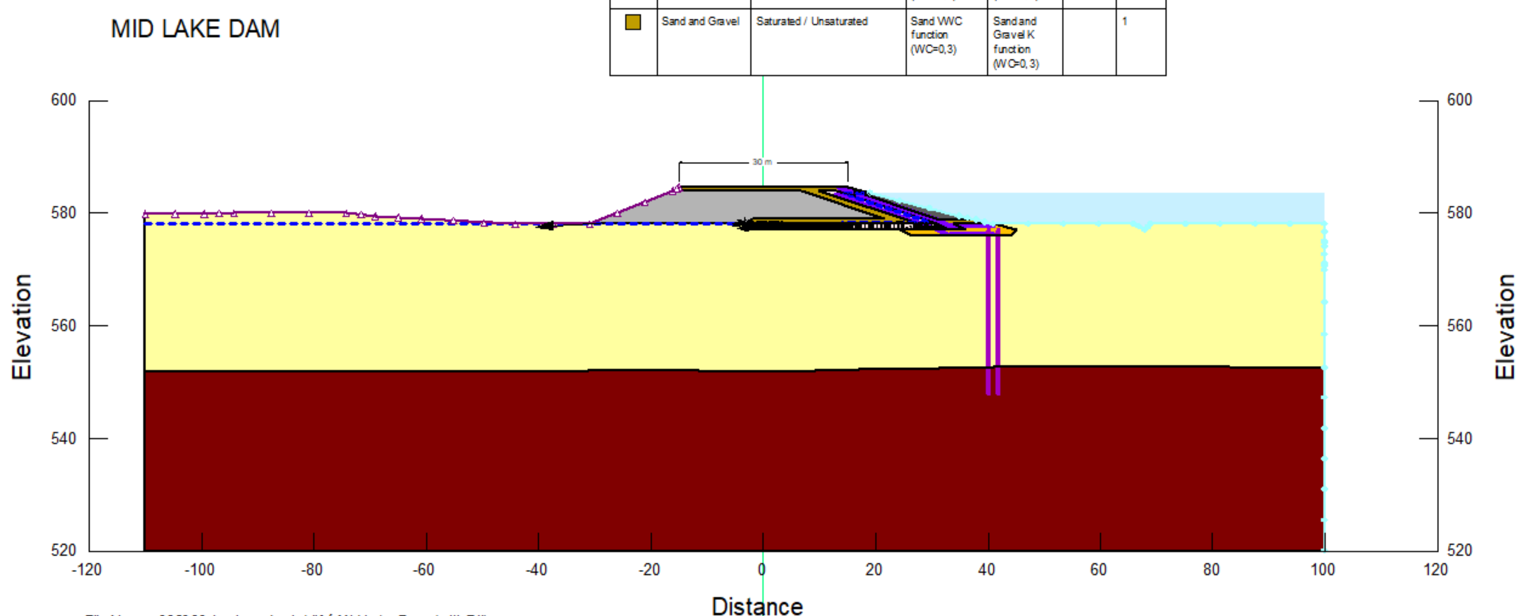
Coef. sismique horiz. :



File Name: 692696-Analyse de stabilité-Elfie Lake West Dam.gsz
Date: 2023-08-07
Name: 2.2A Slope Stability - Post-Seismic (2)
Directory: T:\proj\692696 Kami Mine Conceptual Study\40_INGÉNIERIE\40EB_NOTES_DE_CALCUL\4G Geotech\8001 WM infras - general\Analyses de stabilité\Révisé\

Analysis: Post-seismic

Color	Name	Hydraulic Material Model	Vol. WC. Function	K-Function	Sat Kx (m/sec)	Ky'/Kx' Ratio
	Bedrock	Saturated Only			5e-08	1
	Compacted Till	Saturated Only			1e-06	1
	GCL	Saturated Only			1e-09	1
	Grouting	Saturated Only			1e-09	1
	Overburden - Loose to compact Till	Saturated Only			1e-06	1
	Rip-rap (400-600mm)	Saturated Only			0.01	1
	Rockfill (1) (sat/unsat)	Saturated / Unsaturated	Gravel VWC function (WC=0,3)	Gravel K function (manual)		1
	Sand	Saturated / Unsaturated	Sand VWC function (WC=0,3)	Sand K function (WC=0, 3)		1
	Sand and Gravel	Saturated / Unsaturated	Sand VWC function (WC=0,3)	Sand and Gravel K function (WC=0, 3)		1



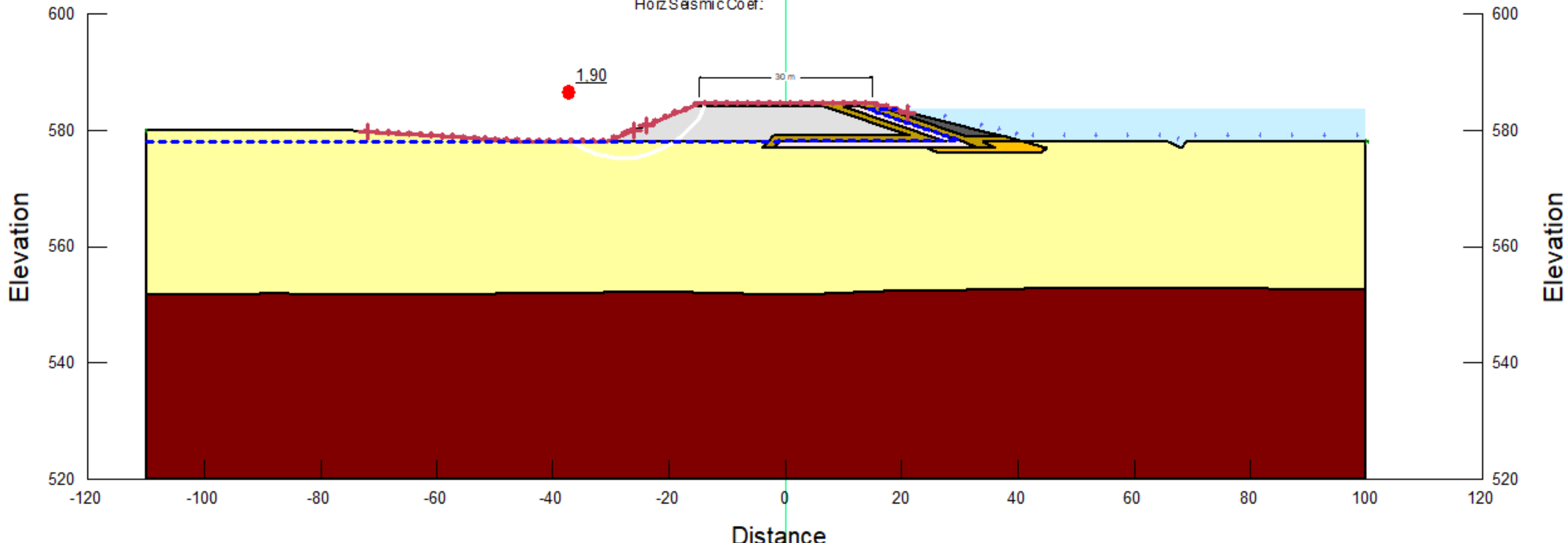
File Name: 692696-Analyse de stabilité-Mid Lake Dam (with Pit).gsz
Date: 2023-09-07
Name: 1. Pond at 583,5 m - No groundwater recharge (2)
Directory: T:\proj\692696 Kami Mine Conceptual Study\40_INGÉNIERIE\40EB_NOTES_DE_CALCUL\4G Geotech\8001 WM infras - general\Analyses de stabilité\Révisé\

Analysis: Seepage

MID LAKE DAM

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Mohr-Coulomb	26		150	30
	Compacted Till	Mohr-Coulomb	18		0	31
	Overburden - Loose to compact Till	Mohr-Coulomb	18		0	31
	Rip-rap (400-600mm)	Mohr-Coulomb	22		0	38
	Rockfill (Leps 1970, Lower Bound)	Shear/Normal Fn.	22	Leps (Lower bound)		
	Sand	Mohr-Coulomb	19		0	30
	Sand and Gravel	Mohr-Coulomb	22		0	35

Horz Seismic Coef:



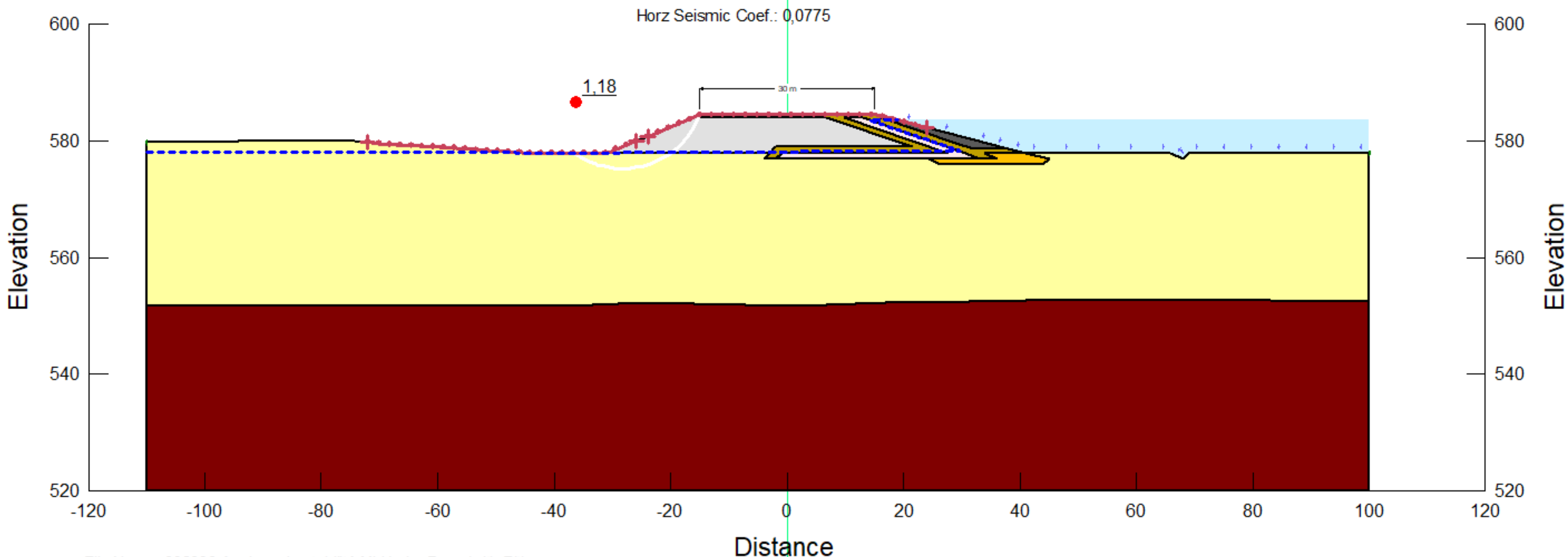
File Name: 692696-Analyse de stabilité-Mid Lake Dam (with Pit).gsz
Date: 2023-09-07
Name: 1.1a Slope Stability (2)
Directory: T:\proj\692696 Kami Mine Conceptual Study\40_INGÉNIERIE\40EB_NOTES_DE_CALCUL\4G Geotech\8001 WM infras - general\Analyses de stabilité\Révisé\

Analysis: Static – Long Term

MID LAKE DAM

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Mohr-Coulomb	26		150	30
	Compacted Till (80%)	Mohr-Coulomb	18		0	24,8
	Overburden - Loose to compact Till (80%)	Mohr-Coulomb	18		0	24,8
	Rip-rap (400-600mm) (80%)	Mohr-Coulomb	22		0	30,4
	Rockfill (Leps 1970, Lower Bound) (80%)	Shear/Normal Fn.	22	Leps (Lower bound) (80%)		
	Sand (80%)	Mohr-Coulomb	19		0	24
	Sand and Gravel (80%)	Mohr-Coulomb	22		0	28

Horz Seismic Coef.: 0,0775



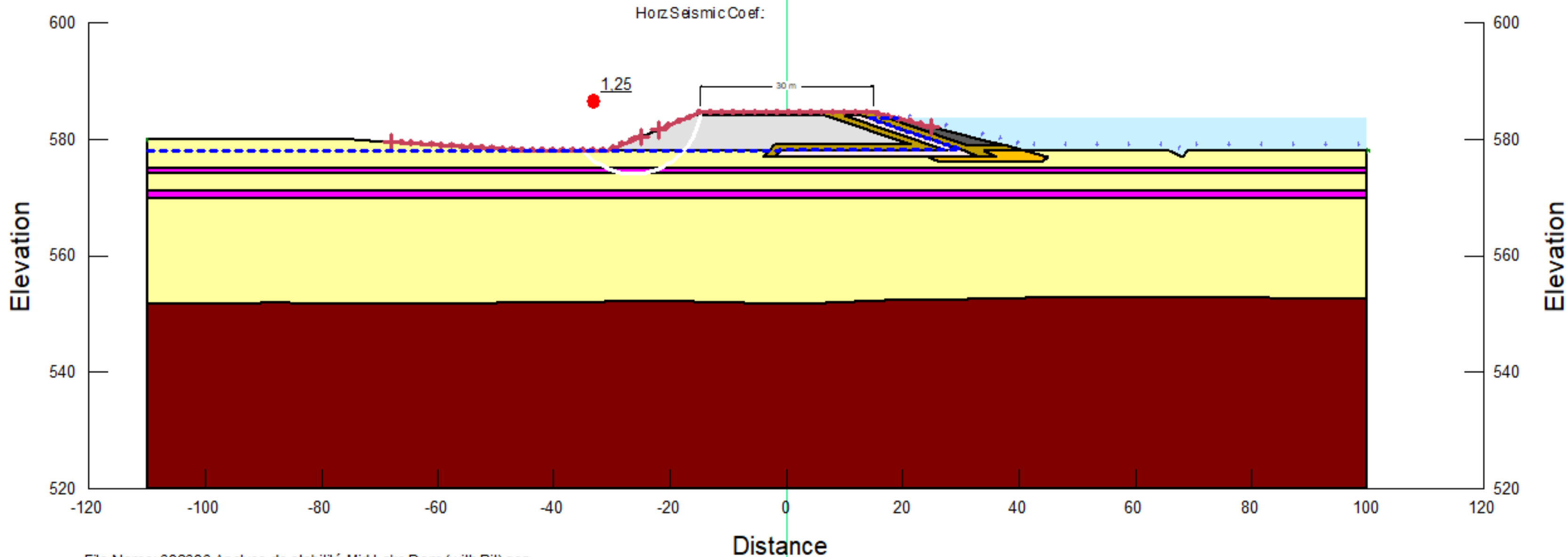
File Name: 692696-Analyse de stabilité-Mid Lake Dam (with Pit).gsz
Date: 2023-12-18
Name: 1.3 Slope Stability - Pseudo-Static (2)
Directory: T:\proj\692696 Kami Mine Conceptual Study\40_INGÉNIERIE\40EB_NOTES_DE_CALCUL\4G Geotech\8001 WM infras - general\Analyses de stabilité\Révisé\Récurrence-moitié-2475-10000\

Analysis: Pseudo-static

MID LAKE DAM

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Mohr-Coulomb	26				150	30
	Compacted Till	Mohr-Coulomb	18				0	31
	Overburden - Loose to compact Till	Mohr-Coulomb	18				0	31
	Overburden - Loose to compact Till (résidue)	SHANSEP	18		10	0,05		
	Rip-rap (400-600mm)	Mohr-Coulomb	22				0	38
	Rockfill (Leps 1970, Lower Bound)	Shear/Normal Fn.	22	Leps (Lower bound)				
	Sand	Mohr-Coulomb	19				0	30
	Sand and Gravel	Mohr-Coulomb	22				0	35

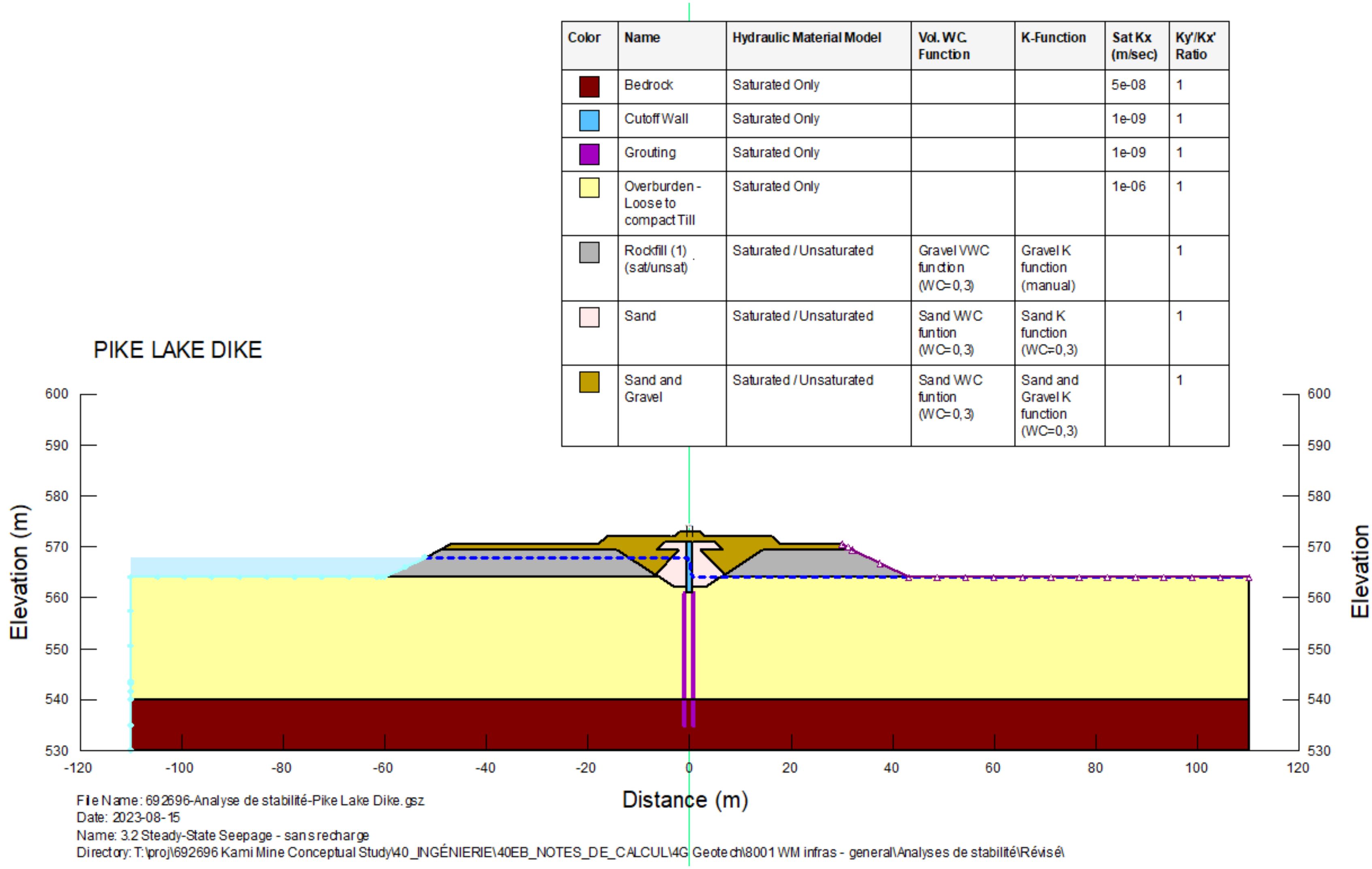
Horz Seismic Coef.:



File Name: 692696-Analyse de stabilité-Mid Lake Dam (with Pit).gsz
Date: 2023-09-07
Name: 1.2 Slope Stability - Post-Seismic (2)
Directory: T:\proj\692696 Kami Mine Conceptual Study\40_INGÉNIERIE\40EB_NOTES_DE_CALCUL\4G Geotech\8001 WM infras - general\Analyses de stabilité\Révisé\

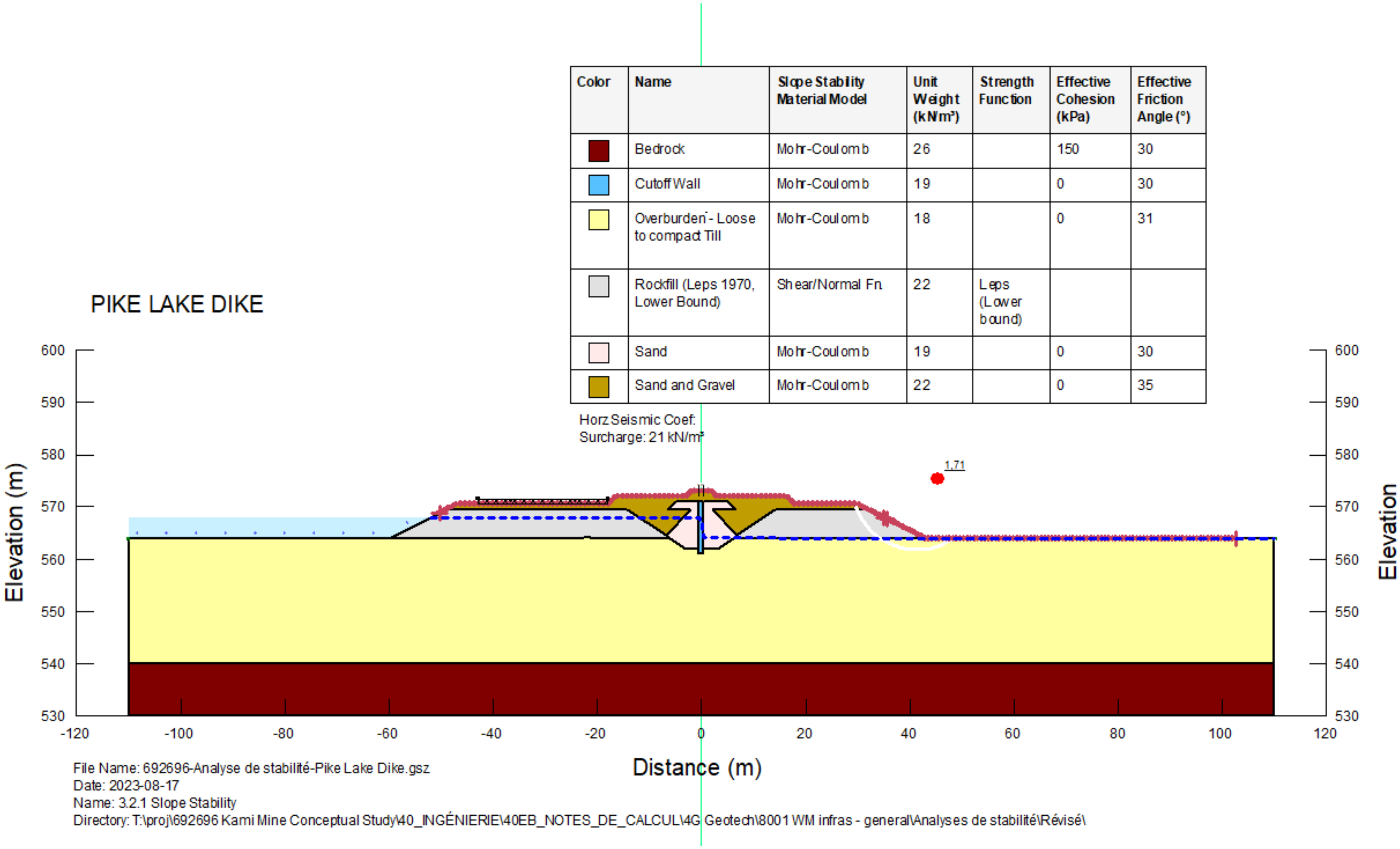
Analysis: Post-seismic

SNC • LAVALIN



Color	Name	Hydraulic Material Model	Vol. WC. Function	K-Function	Sat Kx (m/sec)	Ky'/Kx' Ratio
	Bedrock	Saturated Only			5e-08	1
	Cutoff Wall	Saturated Only			1e-09	1
	Grouting	Saturated Only			1e-09	1
	Overburden - Loose to compact Till	Saturated Only			1e-06	1
	Rockfill (1) (sat/unsat)	Saturated / Unsaturated	Gravel VWC function (WC=0,3)	Gravel K function (manual)		1
	Sand	Saturated / Unsaturated	Sand WVC funtion (WC=0,3)	Sand K function (WC=0,3)		1
	Sand and Gravel	Saturated / Unsaturated	Sand WVC funtion (WC=0,3)	Sand and Gravel K function (WC=0,3)		1

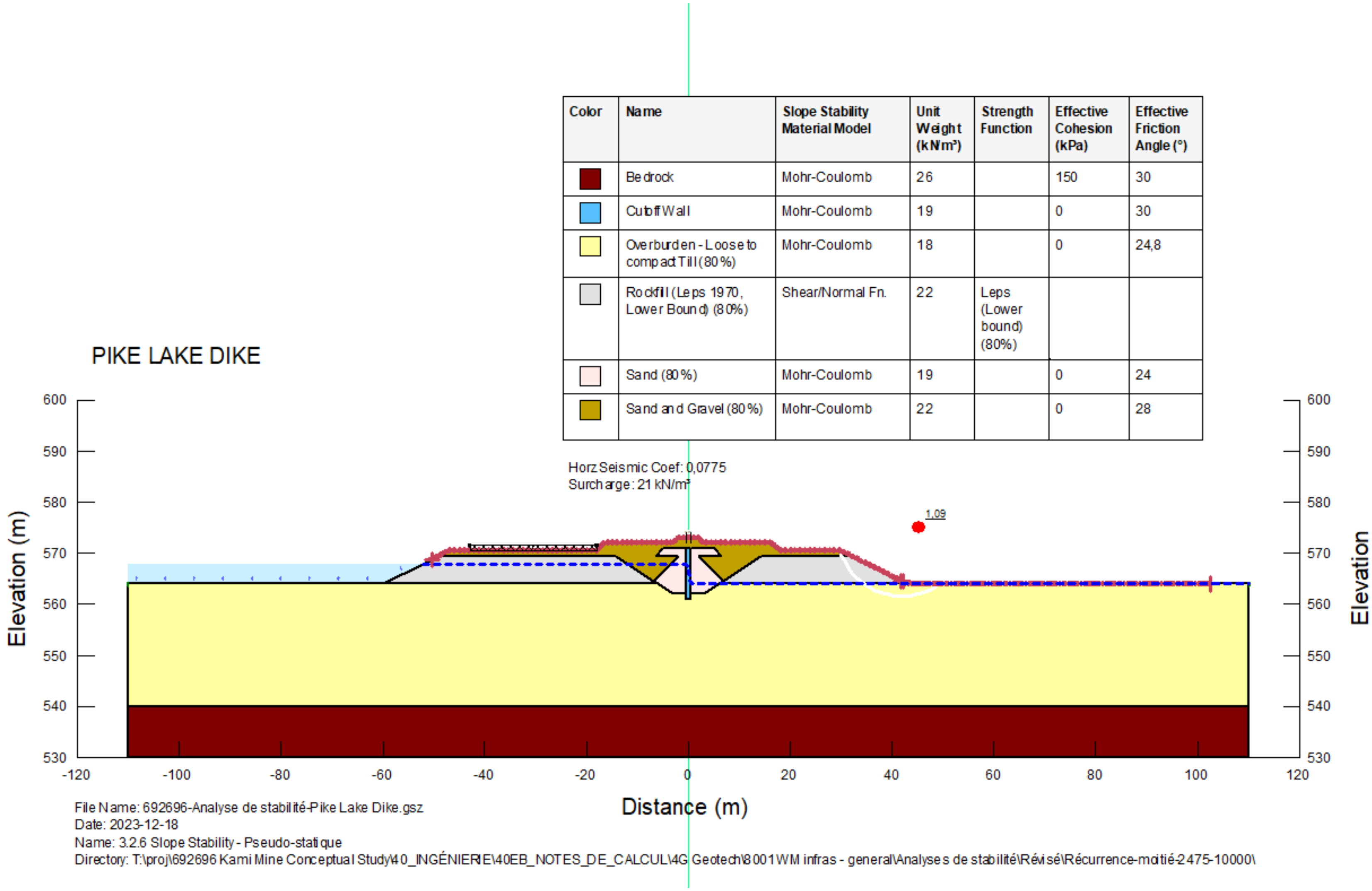
Analysis: Seepage



Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Mohr-Coulomb	26		150	30
	Cutoff Wall	Mohr-Coulomb	19		0	30
	Overburden - Loose to compact Till	Mohr-Coulomb	18		0	31
	Rockfill (Leps 1970, Lower Bound)	Shear/Normal Fn.	22	Leps (Lower bound)		
	Sand	Mohr-Coulomb	19		0	30
	Sand and Gravel	Mohr-Coulomb	22		0	35

Analysis: Static – Long Term

SNC • LAVALIN



Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Mohr-Coulomb	26		150	30
	Cutoff Wall	Mohr-Coulomb	19		0	30
	Overburden - Loose to compact Till (80%)	Mohr-Coulomb	18		0	24,8
	Rockfill (Leps 1970, Lower Bound) (80%)	Shear/Normal Fn.	22	Leps (Lower bound) (80%)		
	Sand (80%)	Mohr-Coulomb	19		0	24
	Sand and Gravel (80%)	Mohr-Coulomb	22		0	28

File Name: 692696-Analyse de stabilité-Pike Lake Dike.gsz
Date: 2023-12-18
Name: 3.2.6 Slope Stability - Pseudo-statique
Directory: T:\proj\692696 Kami Mine Conceptual Study\40_INGÉNIERIE\40EB_NOTES_DE_CALCUL\4G Geotech\8001WM infras - general\Analyses de stabilité\Révisé\Récurrence-moitié-2475-10000\

Analysis: Pseudo-static

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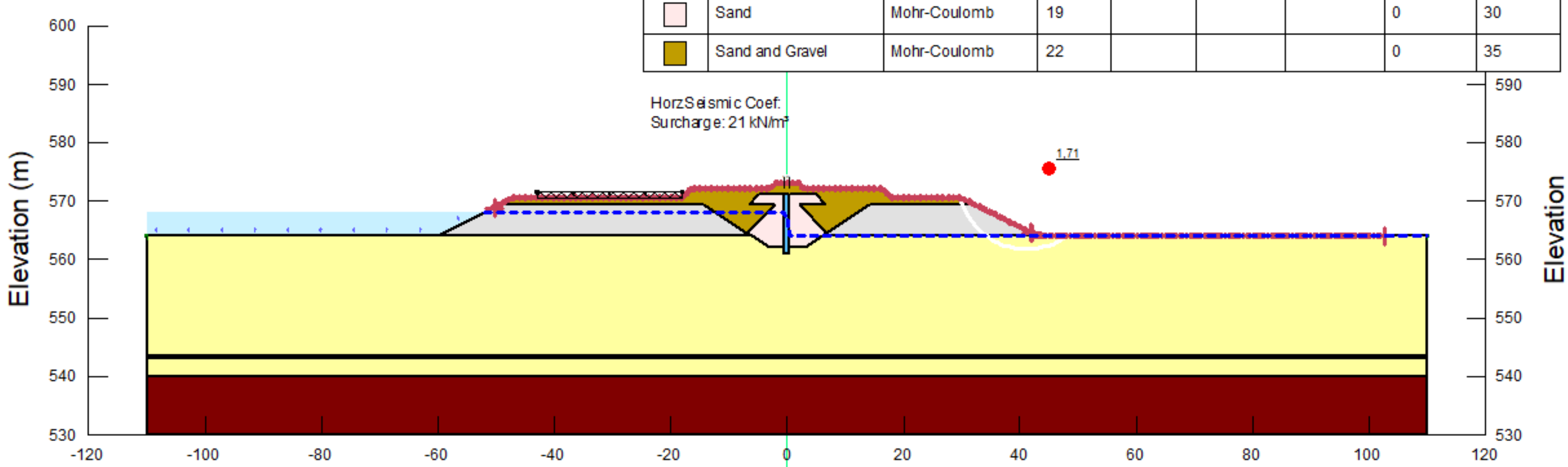
Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Mohr-Coulomb	26				150	30
	Cutoff Wall	Mohr-Coulomb	19				0	30
	Overburden - Loose to compact Till	Mohr-Coulomb	18				0	31
	Overburden - Loose to compact Till (résiduel)	SHANSEP	18		10	0,05		
	Rockfill (Leps 1970, Lower Bound)	Shear/Normal Fn.	22	Leps (Lower bound)				
	Sand	Mohr-Coulomb	19				0	30
	Sand and Gravel	Mohr-Coulomb	22				0	35

PIKE LAKE DIKE



File Name: 692696-Analyse de stabilité-Pike Lake Dike.gsz
Date: 2023-08-17
Name: 3.2.4 Slope Stability - Post-sismique
Directory: T:\proj\692696 Kami Mine Conceptual Study\40_INGÉNIERIE\40EB_NOTES_DE_CALCUL\4G Geotech\8001 WM infras - general\Analyses de stabilité\Révisé\

Analysis: Post-seismic

Appendix H

Pit Seepage Analysis

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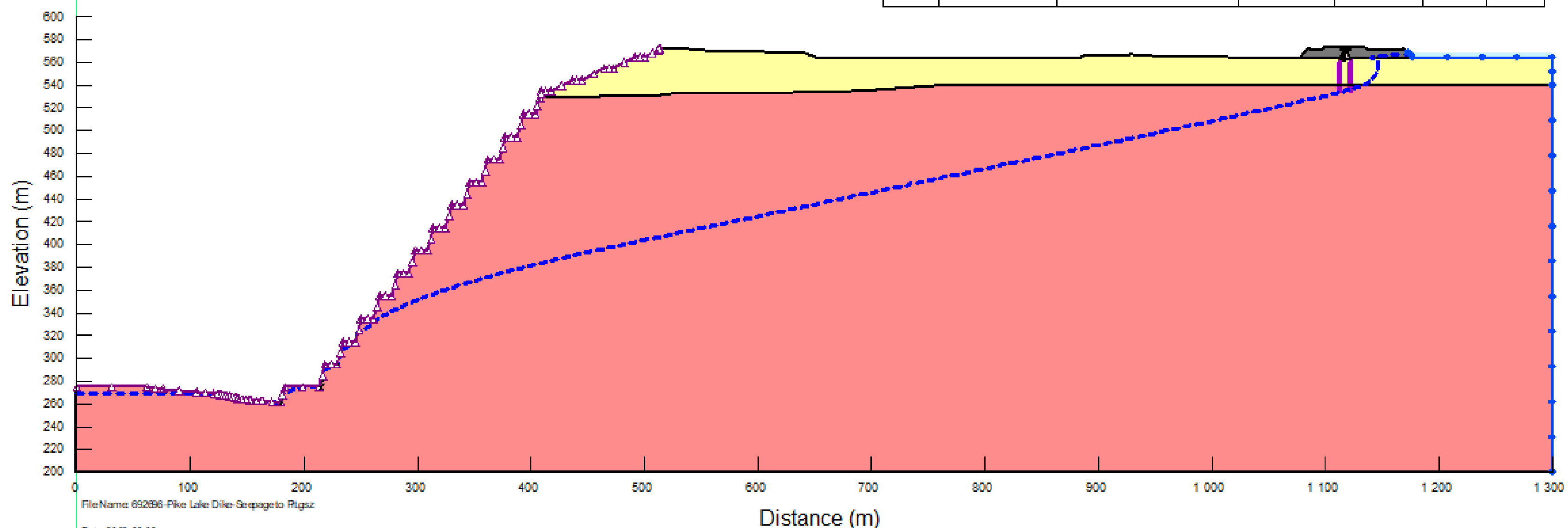
TOTAL SEEPAGE: 62 m^3/day

PIKE LAKE DIKE

Color	Name	Hydraulic Material Model	Vol. WC. Function	K-Function	Sat Kx (m/sec)	Ky'/Kx' Ratio
(pink)	Bedrock (Faults)	Saturated Only			1e-05	1
(purple)	Grouting	Saturated Only			1e-09	1
(yellow)	Overburden - Loose to compact Till	Saturated Only			1e-06	1
(grey)	Rockfill (1) (sat/unsat)	Saturated / Unsaturated	Gravel VWC function (WC=0,3)	Gravel k function (WC=0,3)		1
(light pink)	Sand	Saturated / Unsaturated	Sand VWC funtion (WC=0,3)	Sand K function (WC=0,3)		1



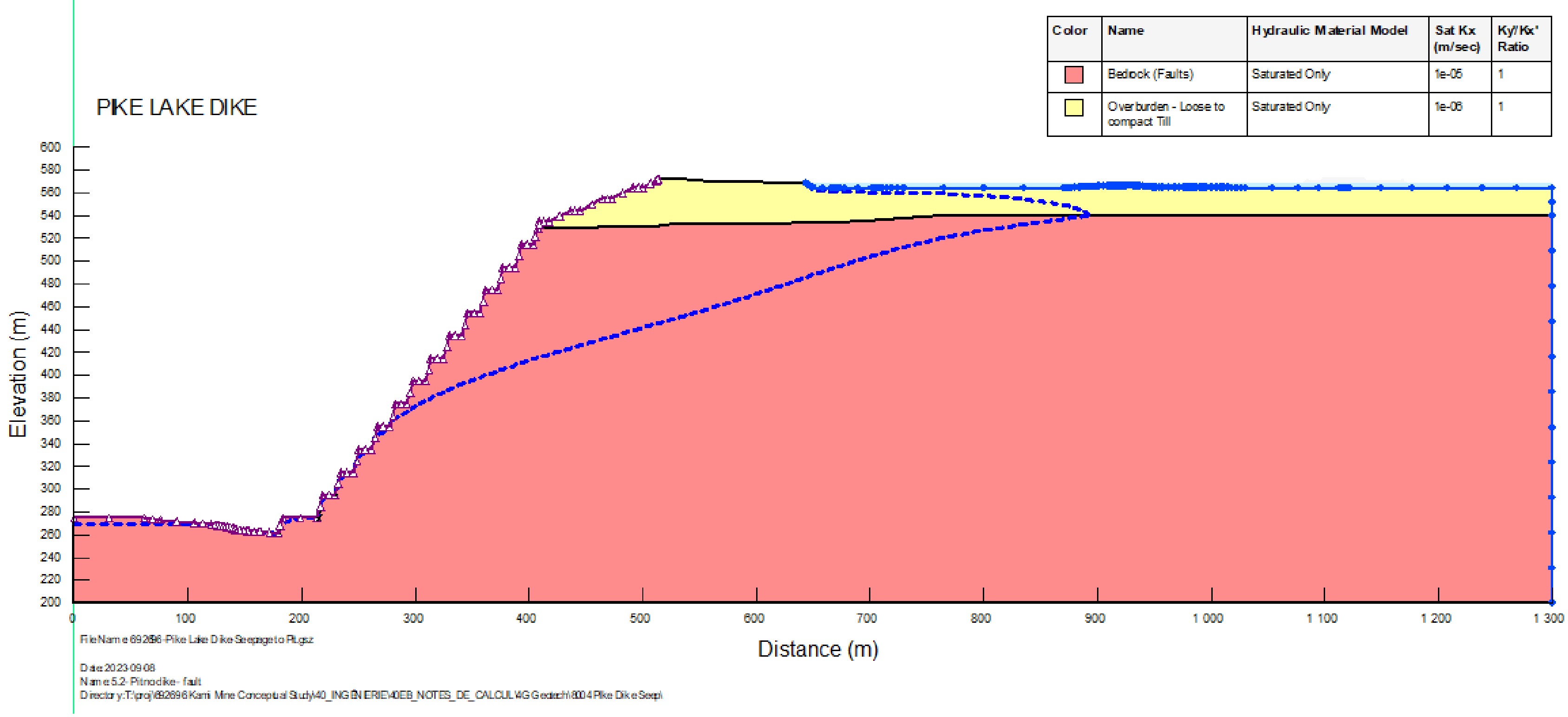
File Name: 692896-Pike Lake Dike-Seepage to Pit.gsz

Date: 2023-09-08
Name: 6.2- Pit with dike - fault
Directory: T:\proj\692896 Kami Mine Conceptual Study\40_INGÉNIERIE\40EB_NOTES_DE_CALCUL\4G Geotech\8004 Pike Dike Seep\

Analysis: Fractured Bedrock – With Pike Lake Dike

SNC·LAVALIN

TOTAL SEEPAGE: 83 m^3/day



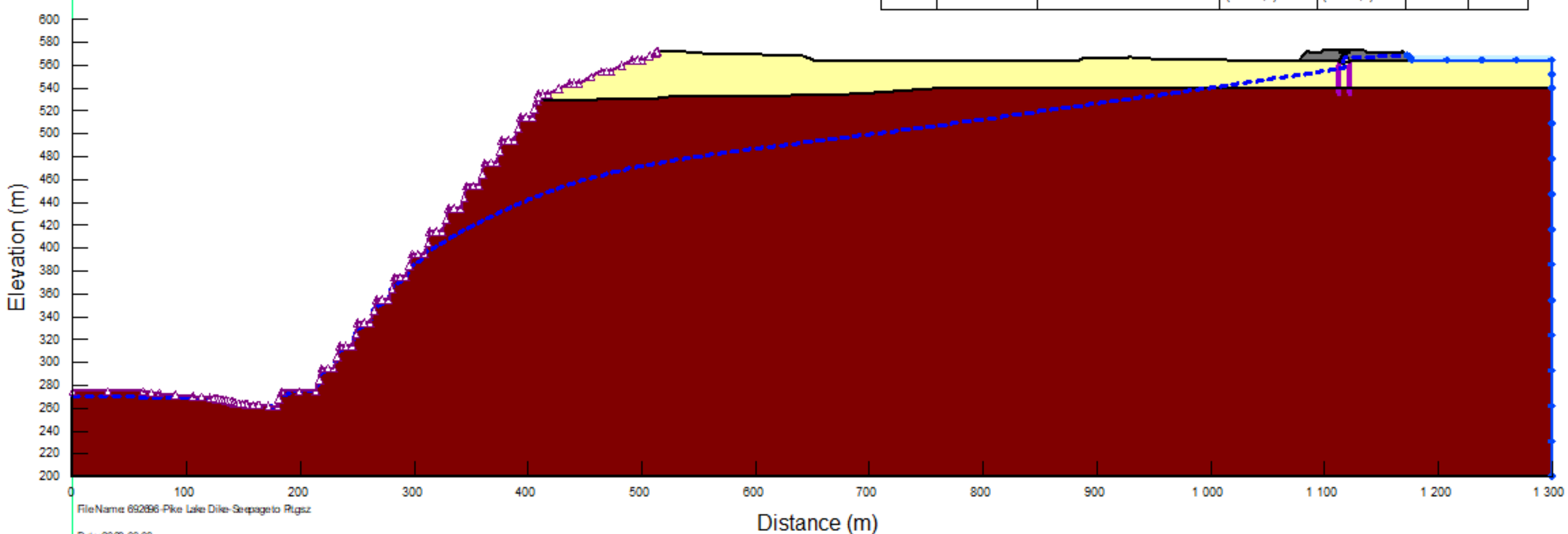
Analysis: Fractured Bedrock – Without Pike Lake Dike

SNC • LAVALIN

TOTAL SEEPAGE: 0.5 m^3/day

PIKE LAKE DIKE

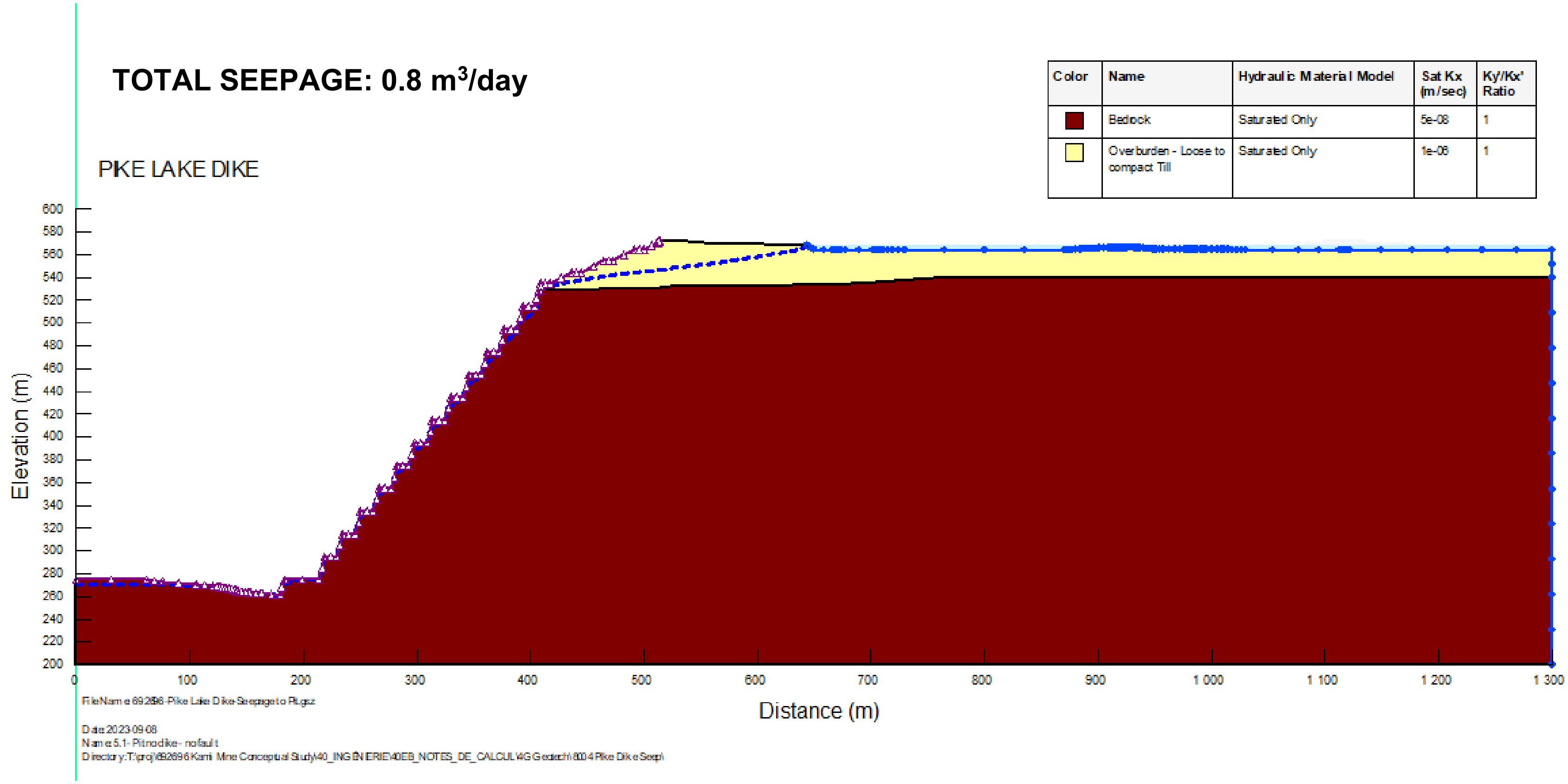
Color	Name	Hydraulic Material Model	Vol. WC. Function	K-Function	Sat Kx (m/sec)	Ky/Kx' Ratio
	Bedrock	Saturated Only			5e-08	1
	Grouting	Saturated Only			1e-09	1
	Overburden - Loose to compact Till	Saturated Only			1e-06	1
	Rockfill (1) (sat/unsat)	Saturated / Unsaturated	Gravel VWC function (WC=0,3)	Gravel k function (WC=0,3)		1
	Sand	Saturated / Unsaturated	Sand WVC funtion (WC=0,3)	Sand K funtion (WC=0,3)		1



File Name: 692696-Pike Lake Dike-Seepage to Pit.gsz

Date: 2023-09-08
Name: 6.1- Pit with dike - no fault
Directory: T:\proj\692696 Kami Mine Conceptual Study\40_INGÉNIERIE\40EB_NOTES_DE_CALCUL\4G Geotech\8004 Pike Dike Seep\

Analysis: Good Quality Bedrock – With Pike Lake Dike



Analysis: Good Quality Bedrock – Without Pike Lake Dike

Appendix I

Proposed Geotechnical Campaign

There is little or no geotechnical information available directly in the alignment of the dams, dikes and basins planned for the water management of the site.

This appendix presents a high-level geotechnical program that will have to be refined and implemented in order to proceed to the next level of engineering.

The Tables in the following pages show the proposed boreholes with their respective proposed depth, and the information available in nearby existing boreholes (in shaded blue).

The Figures in the following pages show the alignment of the earthworks and the proposed location for geotechnical boreholes.

It is important to note that at least two (2) planned boreholes have to be done on a barge during winter, in Pike Lake and Mid Lake. Part of the future campaigns could be done in winter to include these boreholes.

Also, before implementing the geotechnical campaign in the Rose South Waste Rock Stockpile area, it will be important to have the entire detailed topography of the area. Currently, for the south part of the site, no detailed topography is known, and there is a 5 to 10 m gap between the two available sets of topography. When the topographical information will be complete, this could lead to changes in the basin and ditch's location.

In general, the testing program should include, but not be limited to:

- Field tests: Test pits, boreholes (N index), geophysical survey, permeability tests, soil sampling, rock sampling.
- Laboratory tests: Granulometries and sedimentations, water content test, characterization of rock with water testing, direct shear tests (laboratory testing will depend on the encountered soils and rock).

Following this first campaign it may be required to plan a second campaign to optimize the different infrastructure locations.

Appendix I

Proposed Geotechnical Campaign

Table I-1: Proposed and Available Boreholes for Mid Lake Dam

Location	Borehole number	Depth of borehole (m)	Overburden Thickness (m)	Expected or observed overburden type
Mid Lake Dam	ML-01	65	N/A	Silty sand (Till)
Mid Lake Dam	ML-02	40	N/A	Silty sand (Till)
Mid Lake Dam	ML-03	40	N/A	Sand, sand with gravel (Till)
Total Depth Proposed Boreholes		145		
Mid Lake Dam	ROB-11-07	60.1	52.4	Very dense silty sand (Till)
Mid Lake Dam	ROB-11-08A/B	29.0	22.9	Compact to dense, very dense silty sand with gravel, silty clayey sand (Till)
Mid Lake Dam	ROB-11-09	30.5	25.9	Loose to compact sand, dense to very dense sand with gravel (Till)

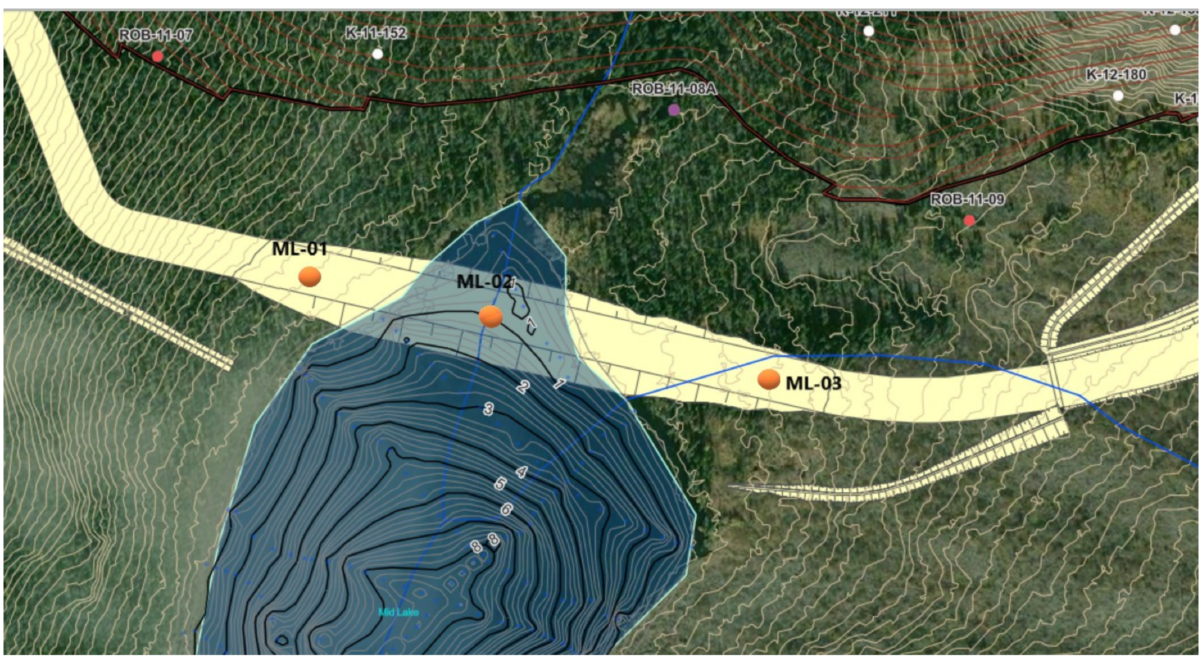


Figure I-1: Proposed Boreholes for Mid Lake Dam

Appendix I

Proposed Geotechnical Campaign

Table I-2: Proposed and Available Boreholes for Elfie Lake West Dam

Location	Borehole Number	Depth of Borehole (m)	Overburden Thickness (m)	Expected or Observed Overburden Type
Elfie Lake West Dam	EL-01	20	N/A	Loose to very dense silty sand (Till)
Elfie Lake West Dam	EL-02	20	N/A	Loose to very dense silty sand (Till)
Total Depth Proposed Boreholes		40		
Elfie Lake West Dam	ROB-11-10	7.6	3.6	Loose to very dense silty sand to sandy silt, trace of gravel (Till)
Elfie Lake West Dam	K-10-68	234 (inclined 45 degrees)	7.4	N/A
Elfie Lake West Dam	K-10-59	569 (inclined 50 degrees)	6.8	N/A
Elfie Lake West Dam	K-10-60	131 (inclined 55 degrees)	19.7	N/A

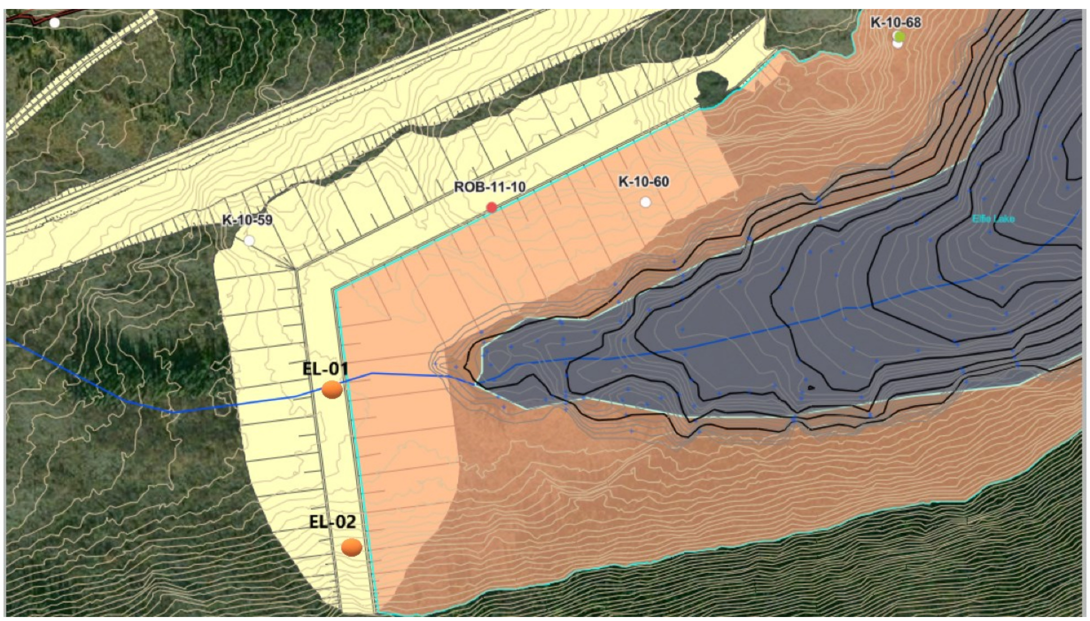


Figure I-2: Proposed Boreholes for Elfie Lake Dam

Appendix I

Proposed Geotechnical Campaign

Table I-3: Proposed and Available Boreholes for End Lake East Dam

Location	Borehole Number	Depth of Borehole (m)	Overburden Thickness (m)	Expected or Observed Overburden Type
End Lake East Dam	EL-03	15	N/A	Silty sand (Till)
End Lake East Dam	EL-04	15	N/A	Silty sand (Till)
End Lake East Dam	EL-05	15	N/A	Silty sand (Till)
Total Depth Proposed Boreholes		45		

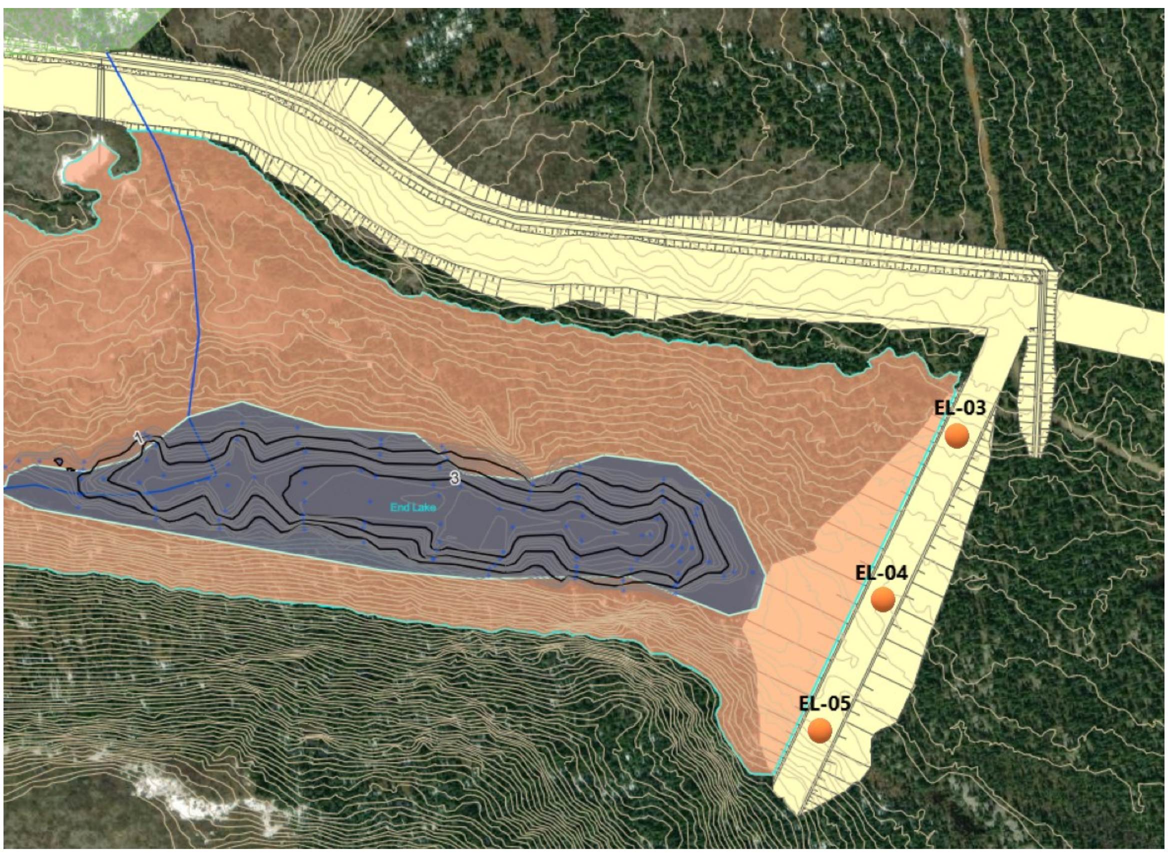


Figure I-3: Proposed Boreholes for End Lake Dam

Appendix I

Proposed Geotechnical Campaign

Table I-4: Proposed and Available Boreholes for Rose Pit Collection Pond

Location	Borehole number	Depth of borehole (m)	Overburden Thickness (m)	Expected or observed overburden type
Collection Pond	SP-01	15	n.a.	Silty sand (Till)
Collection Pond	SP-02	25	n.a.	Silty sand (Till)
Collection Pond	SP-03	15	n.a.	Silty sand (Till)
Collection Pond	SP-04	25	n.a.	Silty sand (Till)
Total Depth Proposed Boreholes		80		
Sedimentation Pond	ROB-11-12	7.5	3.9	Compact to very dense silty sand with gravel (Till)

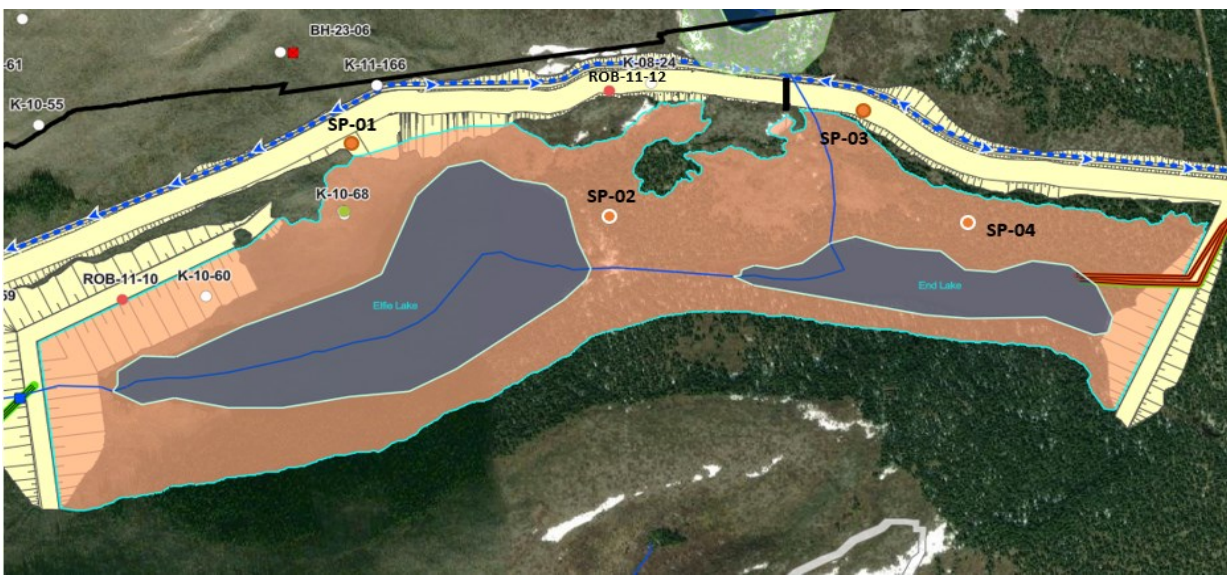


Figure I-4: Proposed Boreholes for Rose Pit Collection Pond

Appendix I

Proposed Geotechnical Campaign

Table I-5: Proposed and Available Boreholes for Pike Lake Dike

Location	Borehole Number	Depth of Borehole (m)	Overburden Thickness (m)	Expected or Observed Overburden Type
Pike Lake Dike	PL-01	45	N/A	Silty sand (Till)
Pike Lake Dike	PL-02(*)	35	N/A	Silty sand (Till)
Pike Lake Dike	PL-03	25	N/A	Silty sand (Till)
Total Depth Proposed Boreholes		105		
Pike Lake Dike	ROB-11-02	25.9	21.4	Loose to very dense silty sand, trace of gravel, cobbles and boulders (Till)
Pike Lake Dike	ROB-11-16	16.5	12.2	Compact silty sand with gravel to silty sand (Till)
* PL-02 has to be drilled from a barge in winter.				

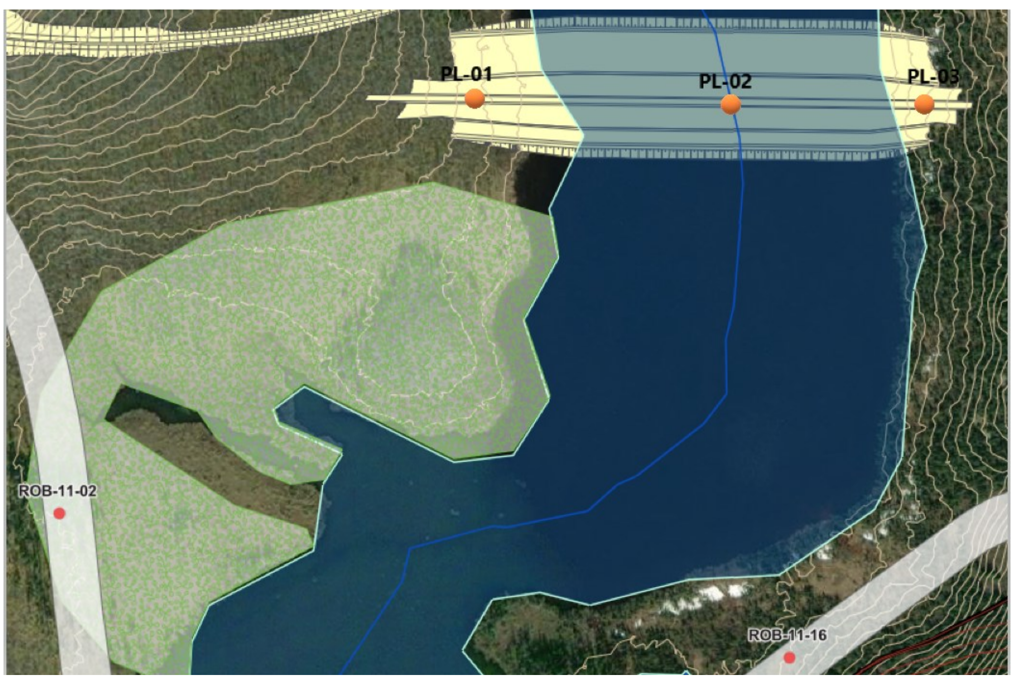


Figure I-5: Proposed Boreholes for Pike Dike

Appendix I

Proposed Geotechnical Campaign

Table I-6: Proposed and Available Boreholes for Rose North Overburden Stockpile Basin

Location	Borehole Number	Depth of Borehole (m)	Overburden Thickness (m)	Expected or Observed Overburden Type
Rose North	RN-01	25	N/A	Sandy silt (Till)
Rose North	RN-02	25	N/A	Sandy silt (Till)
Rose North	RN-03	25	N/A	Sandy silt (Till)
Total Depth Proposed Boreholes		75		

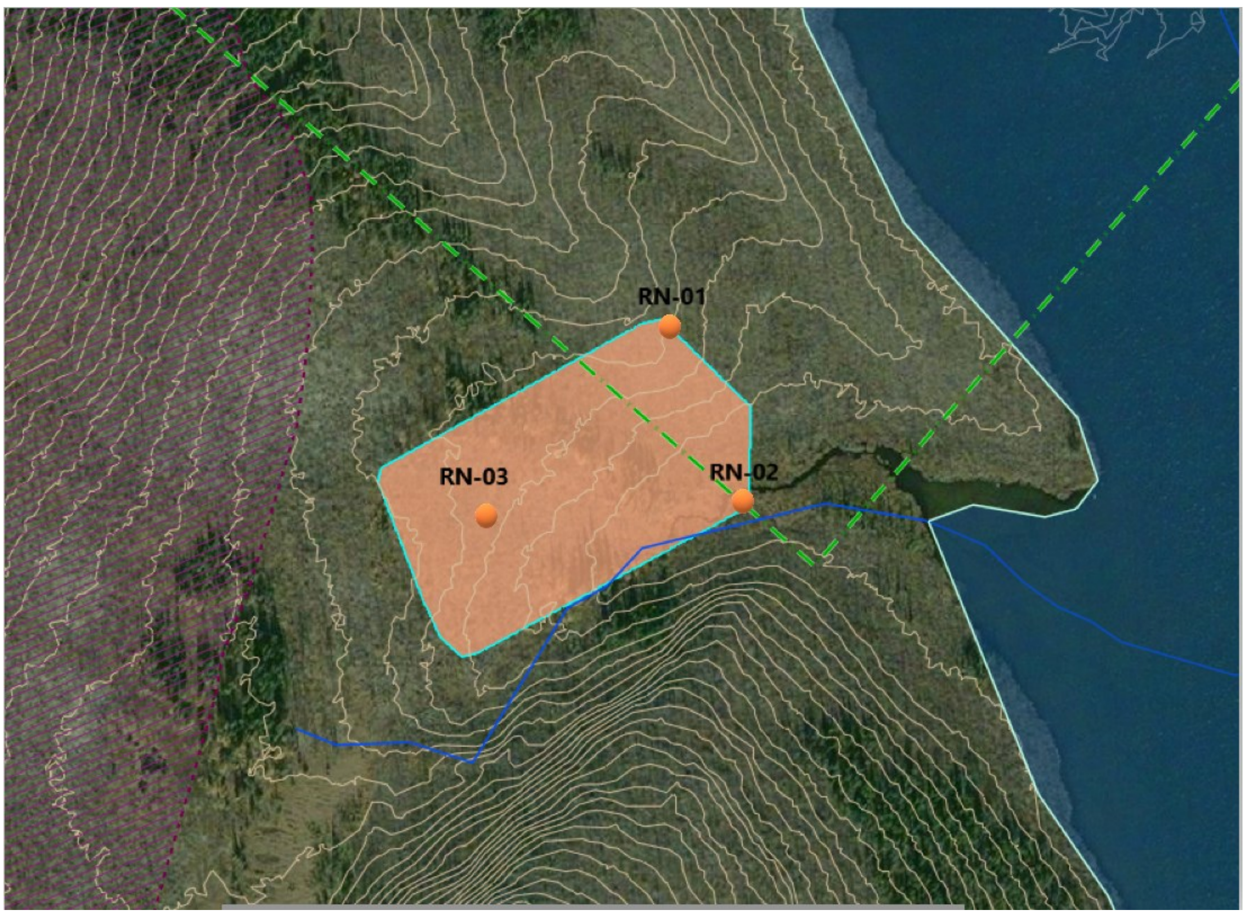


Figure I-6: Proposed Boreholes for Rose North Overburden Stockpile Basin

Appendix I

Proposed Geotechnical Campaign

Table I-7: Proposed and Available Boreholes for Rose South Waste Rock Stockpile Basin – North Basin

Location	Borehole Number	Depth of Borehole (m)	Overburden Thickness (m)	Expected or Observed Overburden Type
Rose South	RS-01	25	N/A	Sandy silt (Till)
Rose South	RS-02	25	N/A	Sandy silt (Till)
Total Depth Proposed Boreholes		50		

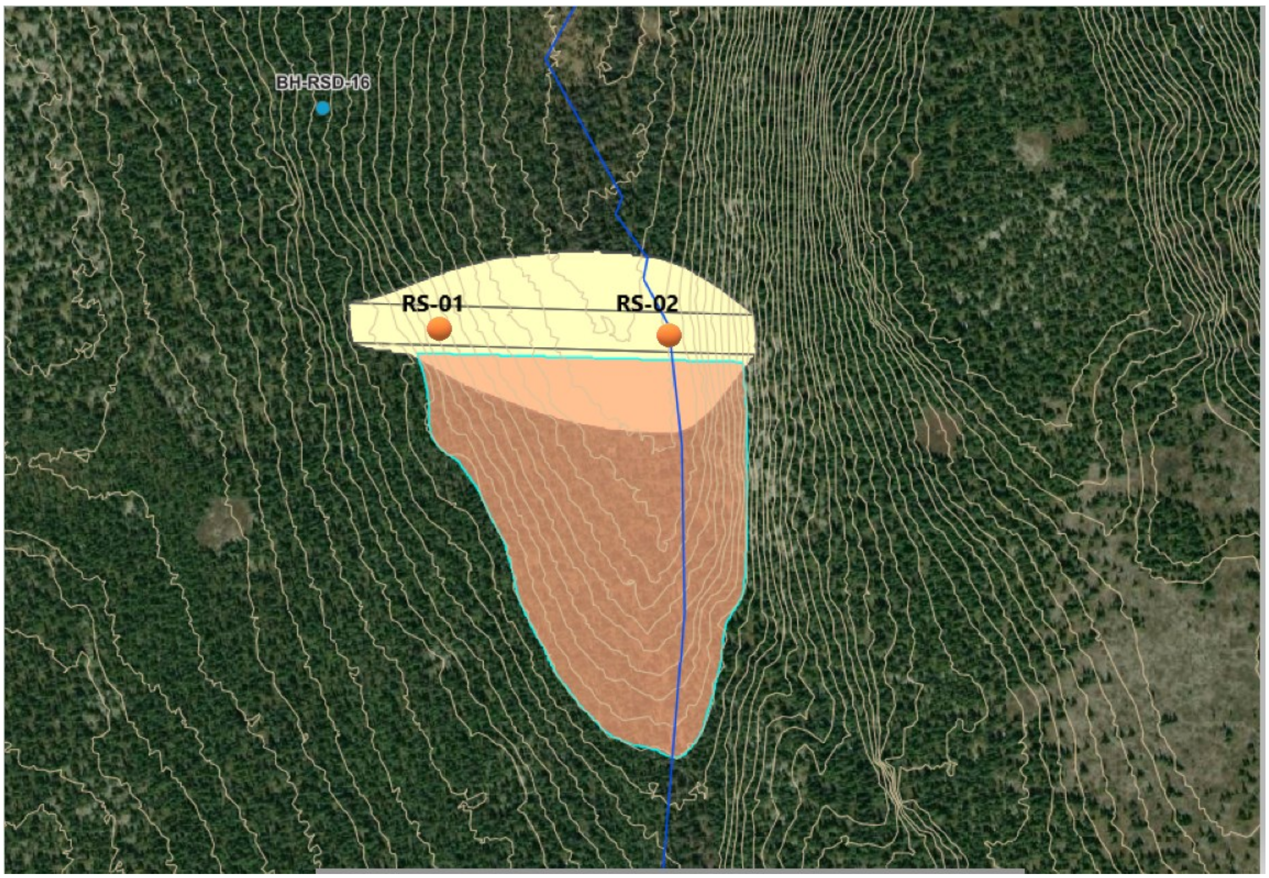


Figure I-7: Proposed Boreholes for Rose South Waste Rock Stockpile Basin – North Basin

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Proposed Geotechnical Campaign

Table I-8: Proposed and Available Boreholes for Rose South Waste Rock Stockpile Basin – West Basin

Location	Borehole Number	Depth of Borehole (m)	Overburden Thickness (m)	Expected or Observed Overburden Type
Rose South	RS-03	10	N/A	Silty sand (Till)
Rose South	RS-04	10	N/A	Silty sand (Till)
Rose South	RS-05	10	N/A	Silty sand (Till)
Total Depth Proposed Boreholes		30		
Rose South	BH-RSD-13	7.5	2.4	Compact to dense silty sand, occasional cobbles (Till)

Figure I-8: Proposed Boreholes for Rose South Waste Rock Stockpile Basin – West Basin

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Table I-9: Proposed and Available Boreholes for Rose South Waste Rock Stockpile Basin – East Basin

Location	Borehole Number	Depth of Borehole (m)	Overburden Thickness (m)	Expected or Observed Overburden Type
Rose South	RS-06	40	N/A	Silty sand with gravel (Till)
Rose South	RS-07	40	N/A	Silty sand with gravel (Till)
Rose South	RS-08	40	N/A	Silty sand with gravel (Till)
Total Depth Proposed Boreholes		120		
Rose South	BH-RSD-05	23.2	18.2	Compact to dense silty sand with gravel (Till)
Rose South	BH-RSD-06	20.3	N/A	Compact to very dense silty sand with gravel, occasional cobles and boulders (Till)

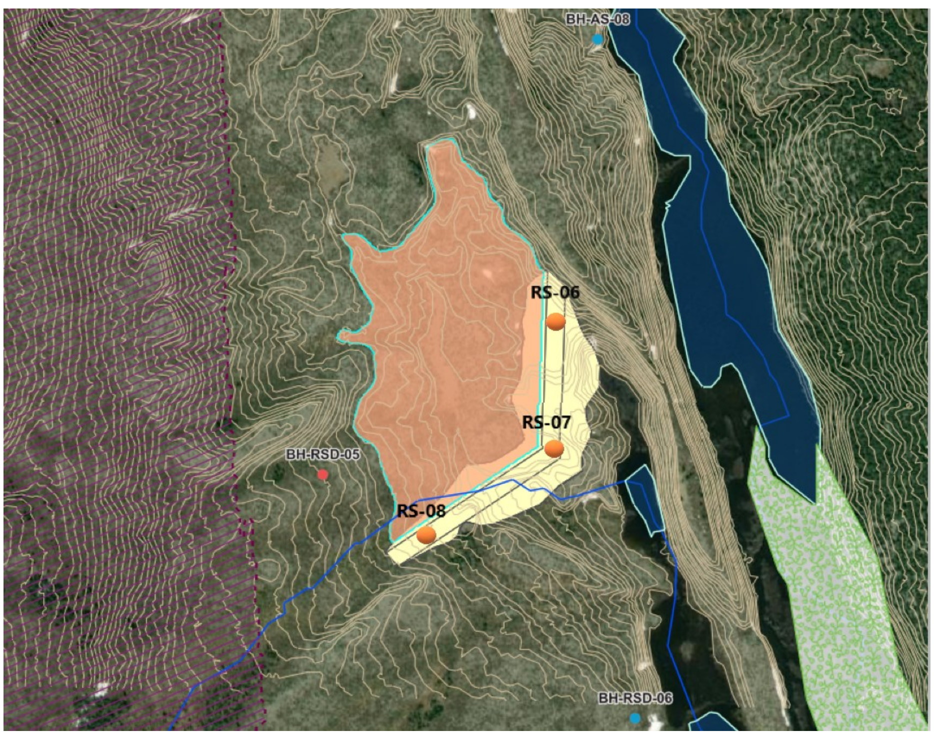

Figure I-9: Proposed Boreholes for Rose South Waste Rock Stockpile Basin – East Basin

Appendix I

Proposed Geotechnical Campaign

Table I-10: Proposed and Available Boreholes for Rose South Waste Rock Stockpile Basin – South-West Basin

Location	Borehole Number	Depth of Borehole (m)	Overburden Thickness (m)	Expected or Observed Overburden Type
Rose South	RS-09	15	N/A	Silty sand, gravel, cobbles (Till)
Rose South	RS-10	15	N/A	Silty sand, gravel, cobbles (Till)
Rose South	RS-11	15	N/A	Silty sand, gravel, cobbles (Till)
Total Depth Proposed Boreholes		45		
Rose South	BH-RSD-13	7.5	2.4	Compact to dense silty sand, occasional cobbles (Till)
Rose South	BH-TF-55A	10.8	5.8	Compact silty sand with gravel to poorly graded sand with silt and gravel, occasional cobbles (Till)

Figure I-10: Proposed Boreholes for Rose South Waste Rock Stockpile Basin – South-West Basin

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