Tailings Management Plan
Doris North Project, Nunavut

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TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

1.0 PURPOSE AND SCOPE OF THE TAILINGS MANAGEMENT PLAN

The Tailings Management Plan provides information on how mill tailings will be handled in a safe and environmentally sound manner at the Miramar Hope Bay Ltd (MHBL) Doris North Project (Doris North) in Nunavut.

This plan outlines the management strategy and procedures to be used to manage:

- The deposition of flotation tailings produced through the milling of ore; and
- All water to be released from the Tail Lake tailings containment system.

The purpose of this document is to provide a consolidated summary of information on the operation of the tailings containment area (Tail Lake) at the Doris North Project during the operational phase of the project. These procedures are an integral component of the overall Environmental Protection Plan (EPP) for the proposed Doris North Project and will be periodically reviewed and updated as the Doris North mine moves through construction, operations, and final closure and reclamation. This Plan is a “living document” and will be reviewed and updated periodically during the mine life to ensure that site experience with tailings management procedures are captured and shared amongst all operating staff (adaptive management).

This Management Plan is a component of the Doris North Environmental Management System and will be updated after the water license has been issued to incorporate any new commitments made by MHBL during the license process and to incorporate any conditions contained within the water license relating to the handling and disposal of mill tailings. This Management Plan is to be reviewed annually during the first quarter of each calendar year by the mine’s environmental staff and updated as needed to reflect changes in operating procedures. The revised Tailings Management Plan will be made available to the appropriate mine operating staff with appropriate refresher training and sent to the Nunavut Water Board for inclusion in the public registry.

The Tailings Management Plan is intended to provide the mine’s operating staff with a summary of the operating and management procedures for the disposal of mill tailings into the Tail Lake tailings containment system that were developed through the environmental assessment and project design process. It similarly provides a summary of the same to the regulatory agencies and to the land owner who have regulatory interest over the mine facilities.

This Plan is not intended to be a design document for the tailings containment area facility. The reader is referred to the following sources for design information:

- Design of the Tailings Containment Area, Doris North Project, Hope Bay, Nunavut, Canada, prepared for MHBL by SRK Consulting (Canada) Inc., dated March 2007. (Supporting Document S1 to the Revised Water License Application Support Document, April 2007)
    - All Sections.

- Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, Nunavut, Canada, prepared for MHBL by SRK Consulting (Canada) Inc., dated March 2007. (Supporting Document S4 to the Revised Water License Application Support Document, April 2007)
  - Drawing G-02 General Arrangement;
  - Drawings T-01 thru T-14 Tailings Containment System Design Drawings.

- Technical Specifications for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, Hope Bay, Nunavut, Canada, prepared for MHBL by SRK Consulting (Canada) Inc., dated March 2007. (Supporting Document S3 to the Revised Water License Application Support Document, April 2007)
  - Section 11 Tailings Containment Area Components;
  - General specifications for clearing and stripping is contained in Section 4;
  - General specifications for excavation is contained in Section 5;
  - General specifications for drilling and blasting is contained in Section 6;
  - General specifications for fill materials is contained in Section 7;
  - General specifications for geosynthetics is contained in Section 8; and
  - General specifications for fill placement is contained in Section 9.

The reader is referred to the following documents for additional information on the water quality model developed for the tailings containment area and for further information on the water management and discharge strategy:

- Tail Lake Water Quality Model, Doris North Project, Hope Bay, Nunavut, Canada, prepared for MHBL by SRK Consulting (Canada) Inc., dated October 2005. (Supporting Document A2 to the Technical Support Document to the Final Environmental Impact Statement submitted to the Nunavut Impact Review Board, October 2005)
  - All sections.

- Water Quality Model Doris North Project, Hope Bay, Nunavut, Canada, prepared for MHBL by SRK Consulting (Canada) Inc., dated March 2007. (Supporting Document S6 to the Revised Water License Application Support document, April 2007)
  - All sections.

This tailings management plan is not intended to be the Operation, Maintenance and Surveillance Manual (OMS manual) for the Tail Lake tailings containment system as defined by the Mining Association of Canada[1]. MHBL will arrange for SRK to develop an OMS manual for the Tail Lake tailings containment system before the first deposition of tailings into the system (expected in the 4th quarter of 2008). In this way the OMS manual can include the as-built drawings and construction information (including location, operation and maintenance procedures for instrumentation). Similarly MHBL will arrange for SRK to develop an Emergency Preparedness Plan (EPP) as defined by the Canadian Dam Association prior to the start of operations (4th quarter of 2008).

[1] Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities, dated September 2002 by The Mining Association of Canada.

2.0 CONSTRUCTION OF TAILINGS CONTAINMENT AREA (TCA) (TAIL LAKE)

Flotation tailings and a small volume of treated barren bleed solution produced during the milling process will be deposited in Tail Lake located about 5 km from the proposed mill location (see Figure 2-1). Operation of the tailings containment area (TCA) is based on sub-aqueous disposal of tailings, requiring a minimum water cover of 3 m at any given time. Furthermore, tailings is to be deposited within the deepest sections of the TCA, and only water will be in contact with the two containment dams at any given time. Based on this mode of operation, the North and South Dams have been designed as lined, frozen core water retaining structures.[2]

Tail Lake, with its normal water level of about elevation 28.3 m above mean sea level (mamsl), occupies about 81 ha of an isolated basin south-east of the mill site. The lake is generally shallow, but does have a few pockets as deep as 6 m, as confirmed by bathymetric survey.[3]

The tailings impoundment is sized to operate as a zero discharge facility during the two years of operation, if necessary; however, the proposed water management strategy is based on the annual release of supernatant from the impoundment. In addition, under the most conservative water balance assumptions, Tail Lake would take just over five years to reach the design Full Supply Level (FSL) of 33.5 m with no discharge[4]. A permanent spillway will be constructed at this elevation, to prevent the possibility of dam overtopping.

2.1 Construction of Dams and Embankments

The two dams will be constructed as water retaining structures. They will be frozen core dams founded on non-organic permafrost and/or bedrock. The frozen core integrity will be ensured by the installation of passive thermosyphons in the key trench, immediately underneath the frozen core. Secondary containment will also be provided by installation of a geosynthetic clay liner (GCL) upstream of the core. The core, transition (filter) and outer shell construction materials will be processed local quarry rock. The detailed design reports for these two dam structures can be found within the following documents:

- Design of the Tailings Containment Area, Doris North Project, prepared by SRK Consulting (Canada) Inc., dated March 2007, (Supporting Document S1 to the Revised Water License Application Document, April 2007);
- Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, prepared by SRK Consulting (Canada) Inc., dated March 2007, (Supporting Document S4 to the Revised Water License Application Support Document, April 2007); and

[2] Section 5, Design of the Tailings Containment Area, Supporting Document S1 to the Revised Water License Application Support Document, April 2007.
[3] Bathymetric Surveys, Hope Bay Project, Hope Bay, Nunavut. Golder Associates Ltd, October 2006.
[4] Section 6.3 and Section 9, Design of the Tailings Containment Area. Supporting Document S1 to the Revised Water License Application Support Document, April 2007.

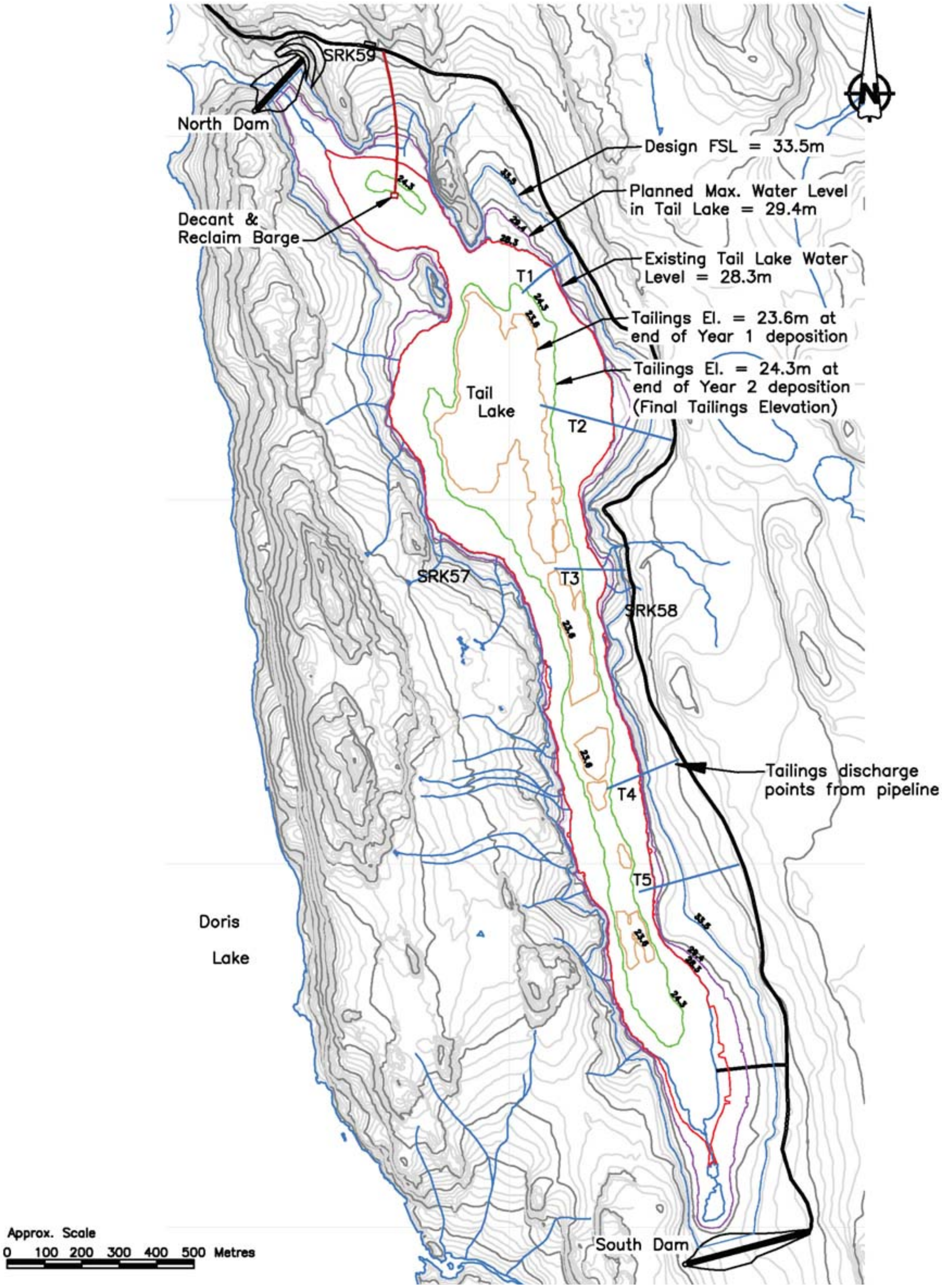

Figure 2.1: Site Plan of Tail Lake

- Technical Specifications for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, prepared by SRK Consulting (Canada) Inc., dated March 2007, (Supporting Document S3 to the Revised Water License Application Support Document, April 2007).

The geometric design of the dams has been based on the results of numerous field investigations, including seven detailed geotechnical drilling programs between 2002 and 2006, and a geophysical survey completed in 2006. These investigations specifically targeted geotechnical and thermal information at potential dam locations and along the perimeter of Tail Lake. The subsurface investigations included the installation of temperature measuring devices (thermistors) in selected holes, to aid in the determination of temporal permafrost conditions. Ground temperature measurements along the dam alignments indicate that permafrost is present over the entire length of the dams, with mean annual ground temperatures ranging between -9 °C and -7 °C.

Detailed equipment to monitor the dam performance will be built-in during the construction phase, and a rigorous monitoring and reporting program will be followed through to final decommissioning of the dams[5].

2.2 Roads, Pipelines and Distribution Lines

Tailings will be deposited into Tail Lake, necessitating a 5.5 km, 5 m wide all-weather service road. A 127 mm diameter insulated tailings feed line and a 100 mm diameter, insulated and heat traced return water pipeline will be placed on the shoulder of the road, taking up at least 1.5 m of the roadway space. The pipelines will be placed on the outside edge of the roadway, i.e., closest to the Tail Lake shoreline. This will minimize the number of pipe crossings required.

A pump house pad will be constructed next to the tailings service road close to the North Dam (Figure 2-1). The control instrumentation for the tailings decant and reclaim water systems will be housed in a structure erected on this pad.

[5] Additional information on the location and operation of this monitoring equipment is found in Section 11.1.3, Design of the Tailings Containment Area, Supporting Document S1 to the Revised Water License Application Support Document, April 2007.

3.0 TAILINGS DEPOSITION

Flotation tailings and treated barren bleed solution (tailings) produced during the milling process will be deposited in Tail Lake about 5 km from the proposed mill location. Tail Lake is 81 ha in size within a catchment area of 4.4 km^2. The normal water level in Tail Lake is 28.3 m above sea level. Detailed bathymetry for Tail Lake confirms that it is a shallow lake, with a maximum depth of 6 m. Tail Lake has a discontinuous outflow into Doris Lake immediately upstream of Doris Creek. Ogama Lake (158 ha in size) is situated immediately south of Tail Lake and its normal water level is at 24.3 m above sea level. The height of land between the lakes is at 33 m above sea level. The normal volume of Tail Lake is approximately 2.2 million m^3.

The tailings will be pumped as a slurry with a solids content of 36% solids by weight and will be discharged sub-aqueously into Tail Lake. The discharge location will not be fixed, but will be moved around such that the tailings impoundment can be sequentially filled from its deepest location. This deposition methodology will enable the final closure water level to be returned to its pre-deposition value of 28.3 m. Tailings will be pumped from the mill to Tail Lake via a 127 mm insulated pipeline. The pipeline route will be southwest from the mill site towards the northwest shore of Doris Lake. From there the pipeline will continue along the Doris Lake shore towards a crossing at Doris Creek before continuing south-west towards the Tail Lake shoreline. The maximum piping distance from the mill to the southern tip of Tail Lake will be 5.5 km.

Return water will be pumped from Tail Lake to the plant through a heat traced and insulated 100 mm diameter HDPE line. Both tailings and return water pipelines will follow the alignment of the tailings service road.

Operationally the pipe settling and freezing risk will be managed by constructing emergency dump catch basins strategically along the pipeline to allow drainage of the pipeline in the event of a pump stopping. This would ensure controlled containment of the tailings. The emergency dump catch basins located outside the Tail Lake watershed will be sized to hold the contents of both the tailings and reclaim water pipelines. Within the Tail Lake watershed, the reclaim water line will drain by gravity onto the tundra and into Tail Lake; consequently, the emergency dump catch basins within the Tail Lake watershed have been sized to hold only the contents of the tailings pipeline.

The emergency dump catch basins have been sized to allow two sequential fillings plus an additional 0.5 m of freeboard. Containment in each basin will be provided by HDPE lining. In the event of a spill of tailings or reclaim water operational personnel must take the following actions:

1. Shut down the mill tailings or reclaim water pumps immediately to bring spill to a halt;
2. Initiate the Spill Contingency Plan[6] reporting and response measures as quickly as possible after halting the spill;
3. Repair the cause of the Spill before resuming pumping;

[6] Section 6, Emergency Response and Contingency Plan, Supporting Document S10a to the Revised Water License Application Support Document, April 2007.

4. Pump the fluid reporting to the emergency dump catch basins effected by the spill back into the tailings containment area as soon as practically possible; and
5. Recover the settled tailings solids reporting to the emergency dump catch basins using a small backhoe or bobcat loader and return the solids to the TCA as soon as practically possible. Hoarding must be placed over each emergency sump catch basin and the area heated if freezing conditions prevail.

The mill superintendent will arrange to have these emergency dump catch basins inspected at a minimum frequency of once per week. Following the spring melt and immediately following any significant rain events (> 20 mm in 24 hours) the mill superintendent will arrange to have these emergency dump catch basins pumped out to ensure that capacity is maintained within these catch basins for their intended purpose. The precipitation water pumped out must be returned to the TCA to prevent any pre-existing contaminants contained in these catch basins being released outside the tailings water management system.

4.0 TAIL LAKE WATER MANAGEMENT

A water management strategy for the Tail Lake tailings containment system was developed by SRK Consulting (Canada) Inc. (SRK) for MHBL and is a component of the Water Quality Model[7]. The following management plan is drawn from this source.

4.1 Objectives

The primary objective of the Tail Lake water management strategy is to meet CCME guidelines (Canadian Water Quality Guidelines) for parameters of concern (see Table 4.1)[8] to protect freshwater aquatic life in Doris Creek, downstream of the waterfall. These guidelines were established by the Canadian Council of the Ministers of Environment and represent a vigorous determination of levels for each parameter that are protective of aquatic life within fresh waters in Canada. These are guidelines not regulated limits and incorporate a highly conservative approach in determining from scientific research world wide at what level of each parameter are harmful effects noted on aquatic life. Consequently they provide guidance as to levels of each parameter in receiving waters below which there is assurance of "low to no" risk of adverse effect on aquatic life. It should be noted that quite often natural levels of parameters within Canadian freshwaters may already exceed the CCME Guideline values. Consequently by meeting the CCME Guidelines in the receiving water, MHBL is striving to ensure that there will be no adverse effect on aquatic life downstream of its discharge point.

Table 4.1: Schedule 4 Discharge Limits under MMER

Parameter	Units	Maximum Monthly Mean	Maximum in a Composite	Maximum Grab Sample
Arsenic (As)	ug/L	500	750	1000
Copper (Cu)	ug/L	300	450	600
Lead (Pb)	ug/L	200	300	400
Nickel (Ni)	ug/L	500	750	1000
Zinc (Zn)	ug/L	500	750	1000
Total Suspended Solids	mg/L	15	22.5	30
Total CN	mg/L	1.0	1.5	2.0
Radium 226	Bq/L	0.37	0.74	1.11

MHBL chose to meet these CCME Guideline values at a point immediately downstream of a 4.3 m waterfall in Doris Creek as this is the closest point at which Arctic Char can come into contact with the water released from the TCA. This waterfall acts as natural barrier to the migration of Arctic Char and other downstream fish species up into Doris Lake.

[7] Section 5.2, Water Quality Model, Supporting Document S6 to the Revised Water License Application Support Document, April 2007.

[8] MHBL expects to meet all CCME Guideline values for the parameters of concern listed in Table 4.1 at the monitoring point down stream of the waterfall within Doris Creek with the possible exception of nitrite. The predicted levels of nitrite are only marginally above CCME Guideline values (see Table 4.2 in Water Quality Model Report (Supporting Document S6 to the Revised Water License Application Support Document, April 2007) and will only occur for a very short duration as nitrite will quickly convert to nitrate in the receiving waters.

Technology does not exist that will allow MHBL to treat the water to be released from Tail Lake to these CCME Guideline values, consequently MHBL acknowledges that it cannot achieve the CCME Guidelines at the end of the discharge pipe from Tail Lake. MHBL's discharge strategy relies on metering the amount of water released from Tail Lake so that it can mix and for most parameters be diluted with the outflow water from Doris Lake so that the combined water meets the CCME Guideline values immediately after mixing through the drop over the waterfall. The location of the discharge pipe was placed immediately upstream of this waterfall to protect all aquatic life upstream of the discharge point within Doris Lake and the upper reaches of Doris Creek (Tail Lake naturally drains into Doris Lake near the outflow point). In other words the proposed end of pipe discharge point was selected to minimize to the greatest extent possible the amount of Doris Creek that will be exposed to the end of pipe discharge before it mixes with the receiving water as it goes over the waterfall.

The Federal Government acknowledges that CCME Guidelines are to be used for guidance purposes only and are thus not incorporated into regulated discharge standards. The Federal discharge standards that apply to the Canadian mining industry are set out in Schedule 4 of the Metal Mining Regulation under the Fisheries Act. These are based on best-practical-available-technology for water treatment and not meant to be protective of aquatic life. In most regulatory jurisdictions these end of pipe discharge standards are assessed on a case by case basis to determine acceptable levels of impact once mixed in the receiving waters, in other words the assessment is conducted on a case by case basis and typically relies upon a natural mixing zone within the receiving waters. Under the MMER regulation, the end-of-pipe discharge from Tail Lake must meet the MMER discharge limits by law (see Table 4.1) and pass the LC_{50} fish toxicity test.

However, MHBL recognizes that discharge of water from Tail Lake at these limits would not result in water quality meeting CCME guidelines in Doris Creek. Consequently MHBL devised a discharge strategy that allows for the load (kgs) of contaminants discharged from Tail Lake to be varied in proportion to the background flow and load in Doris Creek so that CCME guideline concentrations are consistently being met in Doris Creek below the point of mixing. To be successful, this approach departs from the traditional fixed end of pipe discharge limit normally contained in water licenses and replaces it with a fixed allowable concentration in the receiving water.

In the event that water quality as sampled immediately downstream of the waterfall does not meet the CCME Guideline values for the parameters of concern, MHBL personnel are to take the following actions:

- Immediately discontinue the discharge of water from Tail Lake by turning off the discharge pump;
- Obtain new analytical data from the monitoring points within Tail Lake and within Doris Creek upstream of the discharge point and re-calculate the allowable discharge rate using the process set out below in Section 4.3;
- Adjust the allowable discharge rate in the PLC controller and re-start the Tail Lake discharge pump; and

- Re-sample the water in Doris Creek at the monitoring point downstream of the waterfall and have it analyzed to verify that CCME Guideline values are being met for the parameters of concern.

In the unlikely event that CCME Guideline values downstream cannot be met for any discharge rate from Tail Lake then the discharge system should be shut down and no water discharged until the reason can be assessed by MHBL's environmental team[9].

Tail Lake can be operated successfully at several lower than optimum discharge rates. In the event that maximum allowable discharge flow rates are lower than estimated within the water quality model, the proposed control system will automatically adjust to the lower flow rates.

In the unlikely event that no discharge is possible at, or after commencement of operations, water balance modelling has shown that Tail Lake has sufficient capacity to store water for several years after operations would cease. During this time it will be possible to monitor changes in water quality in Tail Lake and, either commence active discharge if suitable conditions develop, or, project water quality into the future to the time that the FSL will be reached. The effects of natural discharge would be re-assessed for that time and if acceptable for natural discharge, Tail Lake would be allowed to fill to its FSL and then allowed to overflow naturally until solute concentrations approach CCME guidelines to enable discharge of excess water contained in Tail Lake and allow breaching of the North Dam. This represents the first contingency strategy.

A second contingency is available for the management of the water contained in Tail Lake. The water quality monitoring undertaken in the early stages of the 'holding' period will identify the solutes that may be of concern at the time the FSL is reached. This will provide ample time to identify water treatment requirements, if any, that may be required to enable discharge of excess water when the FSL is reached. Construction and commissioning of a water treatment plant would represent a second level contingency; however it is unlikely that this contingency would ever have to be developed.

4.2 Doris Creek Flow Monitoring

A pressure transducer will be installed at a suitable location within Doris Creek to facilitate real time monitoring of flow. The pressure transducer will be connected to a programmable logic controller (PLC) that would record flows in Doris Creek and be used to control the discharge flow rate. If initial monitoring suggests that greater accuracy is required, a flow monitoring weir may be constructed in Doris Creek at a location approximately 50 to 100 m upstream of the waterfall, as dictated by site conditions.

During periods of active discharge, the flow level in Doris Creek will be monitored visually on a daily basis and checked against the real time monitoring results. For this purpose, a staff gauge will be installed at the location where the pressure transducer is located. The area will also be inspected on a daily basis for ice and any debris, and cleared as required to ensure accurate monitoring of flows.

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[9]The contingency management strategies in such an event are presented in Section 5.3, Water Quality Model, Supporting Document S6 to the Revised Water License Application Support Document, April 2007.

4.3 Determination of the Discharge Rate

The discharge rate would be determined once it has been established that discharge may proceed. The following steps would be undertaken.

First, prior to discharge Tail Lake water would be assessed to determine if it meets MMER criteria as listed in Table 4.1 above.

It is also a requirement of the MMER criteria that the water not be acutely toxic. If these criteria are exceeded, water would not be discharged from the TCA. For example, if the copper concentration is at or above 300 ug/L, water would not be discharged.

The baseline water quality monitoring results have indicated that occasionally some parameters may naturally exceed the CCME guidelines. While the intent is to not exceed CCME guidelines in Doris Creek, discharge from the TCA should be constrained only if the discharge water would further increase the concentrations of those parameters that exceed CCME guidelines. If, for example, selenium is the only solute in Doris Creek that exceeds its guideline (say at a concentration of 1.5 ug/L), and, the selenium concentration in the TCA is below that (say 1.2 ug/L) then any amount of discharge would in fact cause a decrease in the selenium concentration downstream of the discharge point. The volume of discharge would then be determined subject to meeting CCME guidelines for all remaining parameters and selenium would be excluded as a constraint.

Therefore, the next step in determining the allowable discharge volume would be as follows. Solute concentrations in Doris Creek would be compared to the CCME guidelines for the protection of freshwater aquatic life as listed in Table 4.2, and those that exceed these values would be identified*.*

Table 4.2: Summary of CCME Water Quality Guidelines

Parameter	Units	CCME WQG
Aluminium (Al)	ug/L	100[10]
Arsenic (As)	ug/L	5
Cadmium (Cd)	ug/L	0.017
Chromium (Cr)	ug/L	1[11]
Copper (Cu)	ug/L	2
Iron (Fe)	ug/L	300
Lead (Pb)	ug/L	1
Mercury (Hg)	ng/L	26
Molybdenum (Mo)	ug/L	73
Nickel (Ni)	ug/L	25

[10] Where CCME Guideline is dependent on other water quality values, the mean values of these parameters were used to calculate the guideline for the Doris North Project. Al is dependent on pH and hardness and thus this guideline value is a calculated value.
[11] The guideline for chromium is for Cr(VI+) and not total chromium; ammonia, nitrate and nitrite are in units of nitrogen equivalency

Parameter	Units	CCME WQG
Selenium (Se)	ug/L	1
Silver (Ag)	ug/L	0.1
Thallium (Tl)	ug/L	0.8
Zinc (Zn)	ug/L	30
Ammonia-N	mg/L	1.27
Nitrate-N	mg/L	2.94
Nitrite-N	mg/L	0.060[12]
pH	pH	6.5-9.0
Free CN	mg/L	0.005

For each parameter identified to exceed its CCME guideline in Doris Creek, its concentration in Doris Creek would be compared to its concentration in Tail Lake, and if the concentration in Tail Lake is above that in Doris Creek, water would not be discharged.

If the concentrations in Tail Lake of these parameters are above their corresponding concentrations in Doris Creek, these parameters would be excluded from further consideration in determining the allowable volume of discharge.

The Allowable Discharge Volume Ratio (ADVR) would be calculated as follows:

$$ADVR(Cu) = (CCME_{Cu} - [Cu]_{DC}) / ([Cu]_{TL} - CCME_{Cu})$$

Where $[Cu]_{DC}$ = copper concentration in Doris Creek (mg/L),

$[Cu]_{TL}$ = copper concentration in Tail Lake (mg/L), and

$CCME_{Cu}$ = CCME Freshwater Aquatic Guideline for copper (mg/L).

The ADVR for other key parameters would then be calculated on the same basis. The lowest ADVR ($ADVR_{MIN}$) would then be selected as the controlling ADVR. Note that nitrite is expected to oxidize rapidly within Doris Creek and field monitoring would be undertaken to assess actual oxidation rates and determine allowances for calculation of the ADVR. For example, if the ADVR for chromium is 0.23 and that for copper is 0.35, then the ADVR for chromium would be selected for further evaluation.

The key parameters (parameters of concern) that will be measured for effluent characterization and water quality monitoring are listed in Table 4.3.[13]

[12] The CCME Guideline for Nitrite was updated in December 2006 (Update 6.0.1) to reflect Nitrite measured Nitrite-nitrogen which is equivalent to 0.197 mg/L Total Nitrite.

Table 4.3: Parameters to be measured for effluent characterization and water quality monitoring

Deleterious substances and pH[1,2]	**Required Effluent Characterization and Water Quality Monitoring Parameters[2,3]:**	**Required Additional Water Quality Monitoring Parameters**	**Site-Specific Parameters[6]**
Arsenic	Aluminium	Dissolved oxygen[5]	Chromium
Copper	Cadmium	Temperature[5]	Manganese
Lead	Iron		Selenium
Nickel	Mercury[4]		Total phosphorus
Zinc	Molybdenum		Nitrite[7]
Radium 226	Ammonia		Conductivity
Total cyanide	Nitrate		Calcium
Total suspended solids	Alkalinity		Chloride
pH	Total hardness		Magnesium
			Potassium
			Sodium
			Sulphate
			Dissolved organic carbon[5] Total organic carbon [5]

Notes:

1. List of parameters regulated (deleterious substances and pH) as per Schedule 3 of the MMER; concentration limits specified in the regulation (Schedule 4).
2. All concentrations are total values; dissolved concentrations may also be reported; effluent loading (Section 20 of MMER) will also be calculated and reported.
3. List of parameters required for effluent characterization and water quality monitoring as per Schedule 5 of the MMER
4. Analysis of mercury may be discontinued if the concentration of total mercury in effluent is less than 0.10 µg/L in
   12 consecutive samples of effluent.
5. In situ measured parameters only for water quality monitoring (in receiving waters).
6. These other parameters are potential contaminants or supporting parameters; analysis is optional and may be added based on site specific historical monitoring data or geochemistry data.
7. Nitrite will not be considered as a controlling parameter for the calculation of the ADVR and TDR unless actual concentrations significantly exceed the predicted values

In the next step, the target discharge rate (TDR) is calculated as follows:

$$TDR = Q_{DC} * 0.8 * ADVR_{MIN}$$

Where TDR = target discharge rate (m^3/s), and

$ADVR_{MIN}$ = lowest allowable discharge ratio.

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[13] Section 5.2.3 and Table 5.1, Water Quality Model, Supporting Document S6 to the Revised Water License Application Support Document, April 2007.

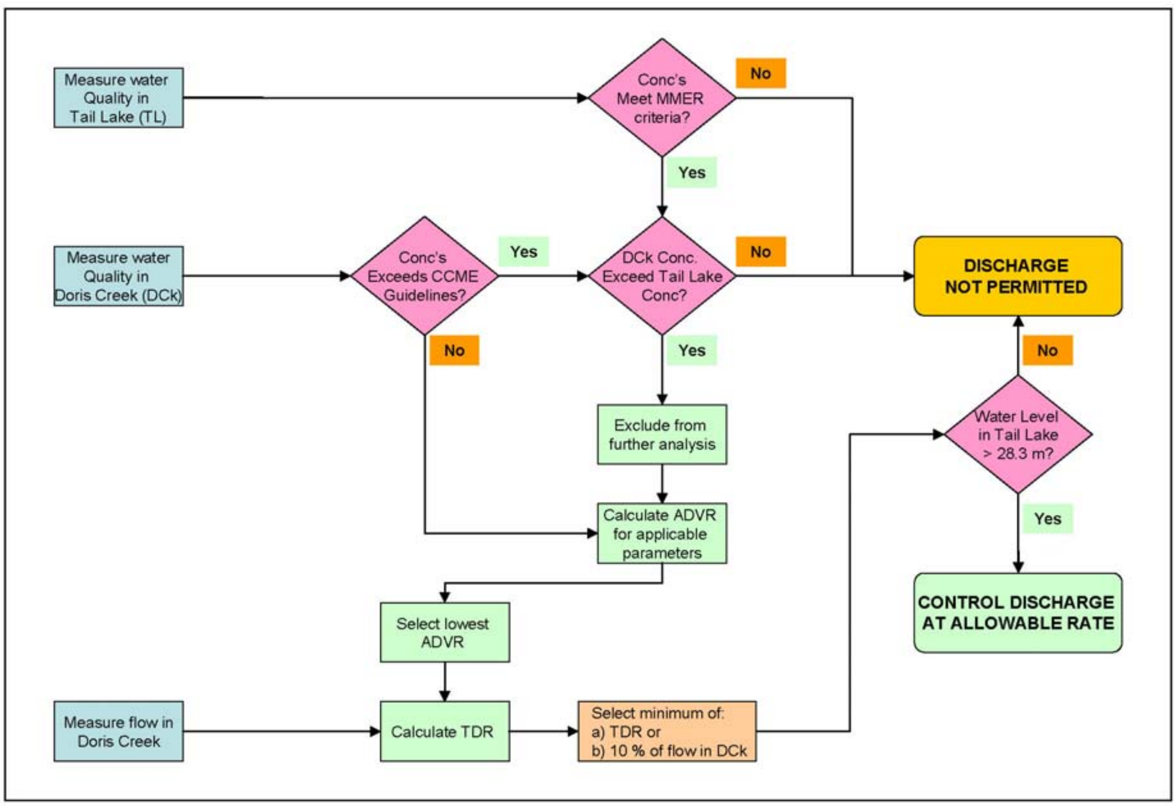
The factor 0.8 is a factor of safety that will ensure that the discharge flow remains at or below 80 percent of the maximum flow rate at which concentrations would be equal to CCME guidelines in Doris Creek. This conservatism is applied to allow for potential upset conditions in flows or analytical results.

Furthermore, the control simulation modelling[14] indicated that, initially when the solute concentrations are low in Tail Lake, there may be no constraints on the discharge rate. For this reason two additional constraints have been placed on the discharge rate as follows:

- First, the discharge rate cannot exceed 10 % of the flow in Doris Creek; and
- Second, the water in Tail Lake will not be drawn down below the current elevation of 28.3 m ASL to ensure that an adequate water cover is maintained.

The overall decision process is illustrated in Figure 4.1.

Figure 4.1: Decision Flow Diagram for Determining Discharge Flow Rate



[14] Section 6, Water Quality Model. Supporting Document S6 to the Revised Water License Application Support Document, April 2007.

The ADVR and TDR will be calculated at least once every 48 hours during the discharge season with the calculation tied to the frequency of water quality monitoring analytical data provided by the on-site environmental laboratory. The ADVR and TDR will be calculated for each set of water quality data obtained.

How often the ADVR and TDR are to be re-calculated should be tied to the rate of change of water quality within Tail Lake and Doris Creek. Given the relative sizes of these water bodies MHBL does not expect that the water quality within the two water bodies will change very quickly. Consequently MHBL has proposed that the ADVR and TDR be re-calculated every second day.

This assumption will be verified through water quality monitoring conducted once operations begin. The results of this monitoring will be plotted for each measured parameter against time. From this data the rate of change for each parameter can be determined and compared to its water quality objective and the operational or active ADVR. For example if the rate of change of copper concentration is less than 2 ppb per month in Tail Lake, and at a dilution of about 20:1 in Doris Creek, the rate of change in the receiving environment would translate to a net incremental increase of 0.1 ppb in the receiving environment over a one month period at the proposed fixed ADVR. In such a case sampling and analysis every second day is not likely to be meaningful. A frequency of once per week will be more reasonable in this case if only to confirm that concentrations are not changing rapidly. The water quality modelling indicates that the rate of change is likely to be very small; in the order of about 0.5 ppb per month during operations. Based on this example, the anticipated change over a one month period would be well within analytical error and could not be reliably detected.

MHBL will determine the rate of change for all key parameters before making a decision to reduce the sampling and analytical frequency. If these calculations indicate that the water quality in Tail Lake is changing at a significantly more rapid rate than predicted then MHBL will return the frequency at which the ADVR and TDR are calculated to once every 24 hours. This will also require a similar increase in the frequency of water quality sampling and analysis for both two sampling points used in this calculation.

4.4 Discharge Control

The discharge system will comprise the installation of a discharge control system that will accurately control and measure the discharge flow rate over a flow range spanning 50 L/s to 275 L/s. A programmable logic controller (PLC) will be used to both control the discharge rate as well as log instantaneous flow rates and cumulative discharge volumes. The flow would be controlled with an actuated flow control valve, with excess flow recycled back to Tail Lake. The PLC will actuate the flow control valve to discharge Tail Lake water at a fixed ratio, equal to the TDR, relative to the flow in Doris Creek.

Discharge will occur 24 hours per day, 7 days per week during the open water season and will commence as soon as practical after the start of the open water season providing that the operating conditions as set out in Section 4.5 are being met. The real time flow monitoring and PLC control will allow the discharge rate to be adjusted on a continuous basis to meet the target discharge rate.

The start of the discharge season will not start until ice conditions allow for flow measurements within Doris Creek (as described in Section 4.2 above) and the requirements under the MMER are verified, specifically:

- That water quality within Tail Lake meets the MMER regulated discharge limits; and
- The water in Tail Lake passes the LC_{50} fish toxicity test

The pump intakes in Tail Lake (for the operational period) will be mounted on a floating barge system well away from the tailings discharge point to minimise suspended solids in the intake. Silt curtains will be installed around the pump intake to minimise intake of suspended solids.

The discharge to Doris Creek will be located sufficiently downstream from the flow monitoring location to ensure that the discharge will not interfere with flow measurements in Doris Creek, but sufficiently upstream of the waterfall to ensure complete mixing with Doris Creek water. The outlet will be placed such that the discharge flow will not lead to erosion or degradation of the creek bed. This will be achieved by ensuring that the creek bottom at the point of discharge is armoured either by natural rock or by placing large pieces of non-acid generating rock to provide such armouring to prevent erosive scour at the point of discharge. MHBL will visually monitor the discharge location to ascertain whether significant erosive scour is taking place. MHBL does not feel that a diffuser mechanism will be required but if scour is noted then a diffuser will be installed. Total Suspended Solids will be monitored in Doris Creek monitoring point to be sited downstream of the waterfall and can be used as a backup to the visual monitoring discussed in the previous sentence.
Discharge from Tail Lake will always be proportional to the background flow in Doris Creek and will increase flows within Doris Creek by no more than about 5% of background flows. Consequently the risk of downstream bank erosion is considered relatively small. Spring freshet flows are typically the highest natural flows seen in the creek and these occur early in the open water season and quickly drop off (typically within two weeks). Consequently the risk of downstream bank erosion is at its highest during the peak freshet flow and will quickly pass each spring. MHBL will visually monitor for such erosion during daily sampling at the monitoring point located downstream of the waterfall.

In the unlikely event that significant erosion resulting from the MHBL discharge is noted, then MHBL will initiate the following actions:

- Immediately terminate the discharge from Tail Lake to allow Doris Creek to return to natural background;
- Halt further discharge until the measured flow in Doris Creek falls to at least 90% of the measured peak freshet flow. At this point the discharge from Tail Lake can be re-started;
- Conduct additional geotechnical and geo-morphological inspections of the downstream banks where erosion was noted and develop an adaptive management plan; and
- Consult with the KIA, the NWB and DFO once an adaptive strategy has been devised and seek authorization for implementation of such a strategy.

4.5 Operational Strategy

Starting in Year 1, the discharge strategy will be implemented as follows:

- Prior to commencement of milling, the laboratory will be set-up and analytical procedures developed, documented and verified. Sampling protocols will also be documented and verified;

- Two weeks prior to commencement of operations (assuming a spring start-up), water quality in Tail Lake and Doris Creek will be monitored every second day to establish baseline conditions[15]. The sampling point for water quality in Tail Lake will be the discharge from the reclaim water pump house set on a floating barge on Tail Lake. This barge will be left in place on the lake year round and equipped with circulation capacity to keep the water below the barge from freezing. This is the same point in the lake from where the discharge pump will draw water for discharge into Doris Creek. Samples will be obtained from the barge at depths of 1.0 m, 1.5 m and 2.0 m for this initial two week period (the discharge pump intake will be set at a depth of 1.5 m);

- Real-time monitoring of the flows in Doris Creek will commence as soon as practical during the open water season. The pressure transducer would be connected to a programmable logic controller (PLC) that would record flows in Doris Creek and be used to control the discharge flow rate;

- Commencing with the start of tailings deposition, water quality within Tail Lake will be monitored every second day for a further period of two weeks again at a depth of 1.0 m, 1.5 m and 2.0 m. After two weeks the frequency will be lowered to a minimum of once per week at a single depth of 1.5 m on the assumption that, given the relative size of Tail Lake, the water quality within the lake will not change very quickly. Consequently MHBL has proposed that the frequency of sampling be decreased to a minimum of once per week at a depth of 1.5 m after this initial two week period has passed. The results of this monitoring will be plotted for each measured parameter against time. From this data the rate of change for each parameter can be determined and compared to its water quality objective and the predicted concentration from the water quality model. MHBL will determine the rate of change for all key parameters before making a decision to reduce the sampling and analytical frequency. If these calculations indicate that the water quality in Tail Lake is changing at a significantly more rapid rate than predicted then MHBL will return the frequency of sampling to once every 24 hours until it can be shown that the water quality within Tail Lake is not varying quickly on a day to day basis; and

[15] Table 1, Monitoring and Follow-Up Plan, Supporting Document S10m to the Revised Water License Application Support Document, April 2007.

- Before any discharge commences, Tail Lake water (taken from the reclaim floating pump house at a depth of 1.5 m) will be submitted for toxicity testing and metals analysis. Only if the water meets MMER criteria will discharge from Tail Lake commence. The flow ratio will be calculated for each sampling event and adjusted as necessary. The discharge flow will be controlled by the automated flow control system which will use the real time flow monitoring in Doris Creek to control the discharge flow rate. Flow rates will automatically be logged by the flow control system.

In subsequent years, it is anticipated that at the start of the open water season the analytical turnaround time will likely prevent discharge for the first few days, however a similar sampling frequency will be used for the first two weeks of the discharge period (daily at depths of 1.0 m, 1.5 m and 2.0 m) and then decreased to once per week at a single depth of 1.5 m for the remainder of the discharge season.

The downstream together with the upstream and Tail Lake water quality monitoring results will be used to verify the performance of the discharge system at regular intervals and to make flow control adjustments as appropriate.

As part of the control strategy, the actual water quality in Tail Lake will be compared with the predicted water quality on a monthly basis to assess the accuracy of the model. If significant deviation is noted then the model will be recalibrated to the actual water quality observed in Tail Lake. The model will be rerun if there is a more than 20% deviation above the predicted concentrations for any of the critical or significant parameters (MMER, CCME). The model will then be rerun to assess potential implications on the discharge strategy and to determine future operational requirements. This comparison of actual water quality to predicted water quality in Tail Lake will be communicated to the NWB for inclusion in the public registry as part of the monthly Surveillance Network Program reporting. Model calibration would be required only if the model significantly underestimates solute concentrations in Tail Lake AND it is shown to potentially have a significant impact on the water management strategy.

The water quality modeling was undertaken with the explicit purpose of establishing the limitations on the potential for discharging water from the TCA. Therefore measured water quality will be compared to the predicted water quality. The parameters will include MMER criteria as well as the CCME parameters of concern and will include the nutrients. If the predictions over-estimate actual concentrations no additional assessment will be undertaken. In the event that actual concentrations significantly exceed predicted concentrations, the source streams will be analysed and compared to the assumptions that were adopted in the water quality model. The source loadings will accordingly be adjusted in the water quality model to assess future constraints on the discharge strategy. If the modelling shows that there will be no significant impacts on the discharge strategy the progress of water quality will be tracked to ensure that the conclusion holds. In the event that the predictions show a significant constraint on achieving the water management strategy, then measures to contain or limit that source will be investigated. Should it not be possible to control the source, then the implications with respect to the discharge strategy/holding time will be assessed. It may then be possible through adaptive management to revise the discharge strategy. In the event that the discharge strategy cannot be revised to accommodate the changes in water quality, water treatment requirements will be established. Because of the long holding time available, it will be possible to design and implement a suitable water treatment system to continue to meet the project objectives of meeting CCME Guidelines in the receiving environment.

This report, “Tailings Management Plan, Doris North Project, Nunavut, April 2007”, has been prepared by Miramar Hope Bay Ltd.

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