Denison Mines

Wheeler River Project

Final Environmental Impact Statement

November 2024

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LA-5 Discharge Concentration Assessment

DATE:

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Denison Mines is currently assessing options for the discharge of process water from the Wheeler River Project to a nearby lake, Whitefish Lake North (also identified herein as LA-5).

The following memorandum provides an assessment of the effect of site discharge on constituent concentrations within the receiving waters, as well as preliminary results of the mixing zone for a conceptual offshore multi-port diffuser design. This assessment is in addition to an original assessment dated September 9, 2022, of the effect of site discharge on constituent concentrations within the receiving waters. The following assessment considers additional parameters, as specified by Schedule 4 of the MDMER and assesses the potential impact on assimilative capacity due to climate change.

1.0 Predicting Constituent Concentrations in LA-5

To determine the effects of site discharge on the downstream environment, it is important to characterize the water quantity and quality of both the site discharge and the background environment. A hydrological assessment of the study area was conducted by NewFields Canada (2021) and a water quality assessment, including identifying applicable screening concentrations representing constituent levels protective of aquatic life, was conducted by Ecometrix (2021). Key aspects of each report are presented below for reference.

1.1 Whitefish Lake North Water Quality Model

The effluent from the site would be discharged to Whitefish Lake North (LA-5) through an engineered, offshore, submerged, multiport diffuser, designed to maximize the mixing potential and reduce the spatial extent of the mixing zone. For further diffuser configuration information,

see Section 0. Upon discharge, the effluent flows with the lake current, both downstream and offshore, and gradually mixes across lake until fully mixed. Key definitions of terms related to this section are provided below:

Mixing Zone: An area of water contiguous to a point source or definable non-point source where the water quality does not comply with one or more of the Water Quality Objectives (WQOs)

Edge of the Mixing Zone: The point within the constituent plume at which water quality objectives are met.

Well mixed: The point in which the water column is completely mixed, i.e., no vertical or horizontal concentrations gradients exist, and no further dilution occurs.

Equation 1 provides a basis to quantify the degree of mixing required to achieve the water quality objective (WQO) within the mixing zone.

$$D = \frac{C_E - C_L}{C_F - C_L} \qquad \textbf{Equation 1}$$

where *D* is the required dilution, C_E is the concentration in the effluent, C_L is the concentration in LA-5, and C_F is the concentration in LA-5 at the edge of the mixing zone. For this assessment, C_F is assumed equal to the WQO (i.e., the concentration at the edge of the mixing zone is equal to the screening concentration).

However, unlike a river system, where water is instantly carried downstream, the north basin of LA-5 is more similar to a small lake, which may be subject to recirculation of effluent. As a result, the background concentration in LA-5 may increase over time due to site discharge. This potential increase in background concentration could influence the required dilution to meet WQOs at the edge of the mixing zone and therefore must be considered.

Constructing a mass balance for LA-5 by considering local inflows, outflows, and site discharge gives a steady-state (well mixed) condition for the concentration of a constituent in LA-5 as

$$C_L = \frac{C_B \cdot Q_B + C_E \cdot Q_E}{Q_L} \qquad \textbf{Equation 2}$$

where C_B is the background concentration of an identified constituent in LA-5, Q_B is the background flow rate into LA-5, and Q_E is the flow rate for the effluent discharge.

Equation 2 provides an estimate of constituent concentrations within the well mixed portion of LA-5 (outside the influence of the mixing zone). Substituting Equation 2 into Equation 1 provides a basis to estimate the dilution required to meet WQOs at the edge of the mixing zone.

1.2 Model Inputs

To assess constituent concentrations within LA-5 using Equation 1 and Equation 2 information about local inflow rates, site discharge rates, background water quality and site discharge water quality is required. Each of these inputs are discussed below.

1.2.1 Hydrological Inputs

For the purpose of calculating water quality predictions within LA-5, the expected average effluent discharge rate of 0.0101 m^3/s (36.5 m^3/hr) was considered. Furthermore, to be conservative, it was assumed that discharge from the site remains constant throughout the year; however, this may not be the case and will be addressed through the permitting phase.

To assess the variability in inflow rates to LA-5, three flow scenarios were considered for the water quality evaluation. These flow scenarios are summarized below with monthly average flow rates summarized in Table 1-1 and model input flow rates summarized in Table 1-2:

1. **7Q10 Low Flow:** The 7Q10 low flow is defined as "*the lowest flow averaged over a period of seven consecutive days that can be statistically expected to occur once every 10 climatic years.*" This flow condition was (0.616 m^3/s) used to assess concentrations under an extreme low flow event. The 7Q10 flow rate used in this assessment was provided to Ecometrix by NewFields Canada. The value was calculated by NewFields as the inflow from SA-6 to Whitefish Lake and therefore considered representative of the flow in the northern basin of LA-5. Please refer to Appendix 8-C (Table 3-3: 7Q10 Estimated Discharge).

2. **Monthly Low Flow:** The monthly low flow condition was calculated from historical data from the Water Survey of Canada (WSC) flow monitoring station on the Wheeler River (Station 06DA005, 57°28'40"N, 104°59'50"W) pro-rated for watershed size as the basis to estimate average monthly flows in the north basin of LA-5. The monthly low flow into LA-5 occurs in March and is given to be 1.04 m^3/s.

3. **Monthly Average Flow:** The monthly average flow condition was calculated from historical data from the Water Survey of Canada (WSC) flow monitoring station on the Wheeler River (Station 06DA005, 57°28'40"N, 104°59'50"W) pro-rated for watershed size as the basis to estimate annual average flows in the north basin of LA-5. The monthly average flow into LA-5 occurs is calculated as 1.40 m^3/s.

Table 1-1: Monthly Baseline Flows to LA-5

Month	Baseline (m^3/s)
Jan	1.14
Feb	1.08
Mar	1.04
Apr	1.21
May	1.94
Jun	1.94
Jul	1.63
Aug	1.43
Sep	1.38
Oct	1.45
Nov	1.36
Dec	1.19
Annual	**1.40**

Table 1-2: Estimated Flow Rates

Flow Parameters	Unit	Value
Discharge Rate	m^3/s	0.0101
LA-5 7Q10	m^3/s	0.616
LA-5 Monthly Low Flow	m^3/s	1.04
LA-5 Monthly Average Flow	m^3/s	1.40

For more detail related to site discharge rates and hydrology, see Ecometrix (2021) and Appendix 8-C of the EIS.

1.3 Water Quality Inputs

Water quality objectives for the receiving environment were obtained from existing federal and provincial guidelines. In general, the lowest of the federal or provincial (Saskatchewan) guidelines were used. In some instance, screening concentrations for select parameters are

adjusted for hardness, DOC, and pH. For a complete description on water quality guidelines, see Ecometrix (2021).

Baseline surface water quality data for LA-5 were collected from 2016 to 2019 and are reported in the 2020 Wheeler River Project Baseline Aquatic Environment Study (Ecometrix, 2020; EIS Appendix 8-D). Baseline surface water quality data was also collected previously, starting in 2012 (Golder, 2014). Background water quality was defined by 95th percentile concentrations for constituents in LA-5. The 95th percentile generates a conservative baseline for water quality.

A summary of background water quality is provided in Table 1-3 with select water quality objectives provided in Table 1-5.

Estimates of constituent concentrations in site effluent were communicated to Ecometrix from Denison Mines on 25 May 2022 with an update provided in December of 2023. The predicted concentrations for select constituents in effluent are summarized in Table 1-4.

A summary of background water quality and screening concentrations is provided in Table 1-3.

Table 1-3: Summary of Background Water Quality and Screening Concentrations

Constituent	Unit	Background Concentrations
General Chemistry, Nutrients and Anions		
Alkalinity	mg/L	12.4
Ammonia (as N)	mg/L	0.068
Un-Ionized Ammonia	mg/L	0.00019
Hardness	mg/L (as CaCO3)	5.26
Conductivity	µS/cm	21.7
Nitrate	mg/L	<0.249
pH	pH Unit	7.0
Phosphorus	mg/L	<0.01
Sulphate	mg/L	0.69
TDS	mg/L	28.3
Temperature	deg C	15
TSS	mg/L	3.9
Chloride	mg/L	0.39
Metals		
Aluminum	mg/L	0.00758

Constituent	Unit	Background Concentrations
Arsenic	mg/L	0.0001
Cadmium	mg/L	0.000019
Chromium	mg/L	<0.0005
Cobalt	mg/L	<0.0001
Copper	mg/L	<0.0002
Cyanide	mg/L	N/A
Iron	mg/L	0.181
Lead	mg/L	<0.0001
Manganese	mg/L	0.0198
Mercury	mg/L	<0.00001
Molybdenum	mg/L	<0.0001
Nickel	mg/L	<0.0001
Selenium	mg/L	<0.0001
Strontium	mg/L	0.015
Thallium	mg/L	<0.0002
Uranium	mg/L	<0.0001
Vanadium	mg/L	<0.0001
Zinc	mg/L	0.0011
Radiological		
Lead-210	Bq/L	<0.02
Polonium-210	Bq/L	<0.005
Radium-226	Bq/L	<0.0059
Thorium-230	Bq/L	<0.01
Uranium-238	Bq/L	<0.0012
Uranium-234	Bq/L	<0.0012

Table 1-4: Predicted Site Effluent Water Quality

Constituent	Unit	Predicted Discharge Concentrations (Max Expected)
General Chemistry, Nutrients and Anions		
Alkalinity	mg/L	12.4
Ammonia (as N)	mg/L	3.9
Un-Ionized Ammonia	mg/L	0.0129
Hardness	mg/L (as CaCO3)	250 [1]
Conductivity	µS/cm	21.7
Nitrate	mg/L	0.249
pH	pH Unit	7.0
Phosphorus	mg/L	0.01
Sulphate	mg/L	2600
TDS	mg/L	6420
Temperature	deg C	16.5
TSS	mg/L	6
Chloride	mg/L	600
Metals		
Aluminum	mg/L	0.051
Arsenic	mg/L	0.006
Cadmium	mg/L	0.0018
Chromium	mg/L	0.025
Cobalt	mg/L	0.0027
Copper	mg/L	0.02
Cyanide	mg/L	NA
Iron	mg/L	0.0039
Lead	mg/L	0.0003
Manganese	mg/L	0.03
Mercury	mg/L	0.00001
Molybdenum	mg/L	2.5
Nickel	mg/L	0.0138
Selenium	mg/L	0.042
Strontium	mg/L	1.68
Thallium	mg/L	0.0006
Uranium	mg/L	0.057

Constituent	Unit	Predicted Discharge Concentrations (Max Expected)
Vanadium	mg/L	0.059
Zinc	mg/L	0.042
Radiological		
Lead-210	Bq/L	0.42
Polonium-210	Bq/L	0.15
Radium-226	Bq/L	0.15
Thorium-230	Bq/L	0.9
Uranium-238	Bq/L	0.7
Uranium-234	Bq/L	0.7

Notes

Bolded values are those that exceed the screening concentrations

* Hardness induced guideline, assuming hardness >250 mg/L

** Hardness induced guideline, assuming hardness >250 mg/L, pH=7.0, DOC = 5.26 mg/L

Un-ionized ammonia calculated

1) Hardness value provided here is not the expected hardness in effluent, but was selected as a concentration at which to evaluate a high hardness condition at the edge of the mixing zone for interpretation of modelled results against water quality guidelines.

Table 1-5: Screening Concentrations

Parameter	Units	Short-term Screening Criteria (background hardness)	Short-term Screening Criteria (Hardness induced [>250 mg/L])	Source	Note	Long-term Screening Criteria (background hardness)	Long-term Screening Criteria (Hardness induced [>250 mg/L])	Source	Note
General Chemistry, Nutrients and Anions									
Alkalinity	mg/L	--	--	--	--	--	--	--	
Ammonia (as N)	mg/L	--	--	--	--	5.74	5.74	SEQG/CCME	(4)
Un-Ionized Ammonia	mg/L	--	--	--	--	0.019	6.98	SEQG/CCME	
Hardness	mg/L	--	--	--	--	--	--	--	--
Conductivity	µS/cm	--	--	--	--	--	--	--	--
Nitrate	mg/L	550	550	CCME		3.0	3.0	SEQG	--
pH	pH units	--	--	--	--	6.5-9.0	6.5-9.0	SEQG/CCME	--
Phosphorus	mg/L	--	--	--	--	0.004 - 0.01	0.004 - 0.01	CCME	(17)
Sulphate	mg/L	--	--	--	--	128	429	BC MOE	(12)
TDS	mg/L	--	--	--	--	500	500	SEQG	--
Temperature	°C	--	--	--	--	ambient temp	ambient temp	--	--
TSS	mg/L	--	--	--	--	background + 5 mg/L	background + 5 mg/L	CCME	--
Chloride	mg/L	640	640	SEQG/CCME	(6)	120	120	SEQG/CCME	(6)
Metals									
Aluminum	mg/L	--	--	--	--	0.1	0.1	SEQG/CCME	(5)
Arsenic	mg/L	--	--	--	--	0.005	0.005	SEQG/CCME	--
Cadmium	mg/L	0.00011	0.0053	SEQG/CCME	(18)	0.00004	0.00034	SEQG/CCME	--
Chromium	mg/L	--	--	--	--	0.001	0.001	SEQG/CCME	
Cobalt	mg/L	--	--	--	--	0.000295	0.00149	FEQG	(10)
Copper	mg/L	0.0009	0.004	SEQG	(19)	0.0002	0.0005	FEQG	(23)
Cyanide	mg/L	--	--	--	--	--	--	--	--

Parameter	Units	Short-term Screening Criteria (background hardness)	Short-term Screening Criteria (Hardness induced [>250 mg/L])	Source	Note	Long-term Screening Criteria (background hardness)	Long-term Screening Criteria (Hardness induced [>250 mg/L])	Source	Note
Iron	mg/L	--	--	--	--	0.3	0.3	SEQG/CCME	--
Lead	mg/L	--	--	--	--	0.001	0.007	SEQG/CCME	(8)
Manganese	mg/L	0.501	15	CCME	(3)	0.21	0.64	SEQG/CCME	(3)
Mercury	mg/L	--	--	--	--	0.000026	0.000026	CCME	--
Molybdenum	mg/L	--	--	--	--	0.073	0.07	CCME	(16)
Nickel	mg/L	--	--	--	--	0.025	0.07	CCME	(16)
Selenium	mg/L	--	--	--	--	0.001	0.001	CCME	--
Strontium	mg/L	--	--	--	--	2.5	2.5	FEQG	(11)
Thallium	mg/L	--	--	--	--	0.0008	0.0008	SEQG/CCME	--
Uranium	mg/L	0.033	0.033	CCME		0.015	0.015	SEQG/CCME	--
Vanadium	mg/L	--	--	--	--	0.12	0.12	FEQG	(13)
Zinc	mg/L	0.008	0.204	CCME	(9)(20)	0.007	0.058	CCME	(9)(22)
Radiological									
Lead-210	Bq/L	--	--	--	--	0.2	0.2	HC	--
Polonium-210	Bq/L	--	--	--	--	0.1	0.1	HC	--
Radium-226	Bq/L	--	--	--	--	0.11	0.11	SEQG	--
Thorium-230	Bq/L	--	--	--	--	0.6	0.6	HC	--
Uranium-238	Bq/L	--	--	--	--	3.0	3	HC	--
Uranium-234	Bq/L	--	--	--	--	3.0	3	HC	--

Notes:

All parameters listed as total concentrations unless otherwise specified.

Saskatchewan Water Quality Objectives, SEQG on-line (https://envrbrportal.crmp.saskatchewan.ca/seqg-search/), SEQG for the protection of aquatic life were selected, based on total concentrations.

Bold numbers indicate exceedance of long-term criteria.

Bold and italicized indicate exceedance of short-term criteria and long-term criteria.

SEQG – Saskatchewan Environmental Quality Guidelines – Water Quality Guidelines for Freshwater Aquatic Life.

CWQG – Canadian Council of Ministers of the Environment – Canadian Water Quality Guidelines for the Protection of Aquatic Life.

SSWQO – Saskatchewan Surface Water Quality Objectives.

DOC – Dissolved organic carbon.

TDS – Total dissolved solids.

TKN – Total Kjeldahl Nitrogen.

TOC – Total organic carbon.

TSS – Total suspended solids.

Narrative – Temperature - Maximum Weekly Average Temperature: Thermal additions to receiving waters should be such that the maximum weekly average temperature is not exceeded. Short-term Exposure to Extreme Temperature: Thermal additions to receiving waters should be such that the short-term exposures to maximum temperatures are not exceeded. Exposures should not be so lengthy or frequent as to adversely affect the important species.

(3) Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life - Manganese, Appendix B - Canadian Water Quality Guidelines Calculator (pH = 7.5, hardness = 15 mg/L). Guideline is based on dissolved manganese. Benchmark = exp(0.878[ln(hardness)] + 4.76) where the benchmark is expressed in dissolved manganese concentration (µg/L), and hardness is measured as CaCO3 equivalents in mg/L.

(4) Total ammonia-N calculated from the total ammonia guideline for a temperature of 15°C and a pH of 7.0, Un-ionized Ammonia from Table 1 of temperature and pH Canadian Water Quality Guidelines for the Protection of Aquatic Life - Ammonia (https://ccme.ca/en/res/ammonia-en-canadian-water-quality-guidelines-for-the-protection-of-aquatic-life.pdf).

(5) Based on a pH of >6.5.

(6) Based on water hardness >0 to <17 mg/L.

(7) Based on water hardness >0 to <82 mg/L.

(8) Based on water hardness >0 to ≤60 mg/L equation used at hardness of 5.26. At hardness >180 mg/L, the CWQG is 7 µg/L

(9) Guideline is based on dissolved zinc.

(10) Environment Canada 2017. Federal Environmental Quality Guidelines, Cobalt, May. Based on equation and site-specific baseline hardness of 15 mg/L.

(11) ECCC 2020. Federal Environmental Quality Guidelines Strontium. July.

(12) BC MECCS 2021. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture. https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf

(13) Environment Canada 2016. Federal Environmental Quality Guidelines, Vanadium. May.

(14) Health Canada 2020. Guidelines for Canadian Drinking Water Quality Summary Table. September. https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/ewh-semt/alt_formats/pdf/pubs/water-eau/sum_guide-res_recom/summary-table-EN-2020-02-11.pdf

(15) BC MECCS 2020. Source Drinking Water Quality Guidelines, Guideline Summary Ministry of Environment & Climate Change Strategy Water Protection & Sustainability Branch.

(17) Framework - guideline for oligotrophic waterbody 4-10 µg/L.

(18) Based on water hardness of >0 to <5.3 mg/L.

(19) Based on hardness of 5 mg/L (Short-term equation is (e{0.979123[ln(hardness)]-8.64497})*1000 (SEGQ via AEP 1996b).

(20) Based on benchmark = exp(0.833[ln(hardness mg·L-1)] + 0.240[ln(DOC mg·L-1)] + 0.526). Site-specific background hardness is 5.26 mg/L (95th percentile of LA-5 and LA-6). Site-specific DOC is 2.2 (arithmetic mean for LA-5 and LA-6), induced hardness of 250.5 mg/L used as upper limit of extrapolation available.

(21) based on water hardness of > 250 mg/L (CaCO3) (251 mg/L).(22) based on CWQG = exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625). Where background hardness is 5.26 mg/L, pH = 6.61, DOC = 2.24 mg/L.

(23) based on FEQG BLM with pH=6.61 (pH= 7 under induced conditions), DOC =2.24 mg/L, background hardness of 5.26 mg/L (or induced hardness of 9 mg/L).

1.4 Water Quality Results

Water quality predictions for each of the three flow scenarios (described in Section1.2.1) are provided in Table 1-6. Parameters with well mixed concentrations above the screening criteria where background water quality was used when considering toxicity modifying factors include cadmium.

All parameters are below the induced screening criteria in the well mixed portion of LA-5.

1.4.1 Maximum Predicted Discharge Concentrations

Furthermore, an investigation into site discharge water quality predictions was completed to identify any parameters that require more than 30% of the available assimilative capacity of the receiver (Saskatchewan, 2015). Based on the three flow scenarios (described in Section 1.2.1), it was determined using CORMIX (Cornell Mixing Zone Expert System) that the dilution at 100 m (maximum mixing zone distance as specified by Saskatchewan surface water quality objectives (2015)) was 350:1, effluent to lake water. Based on this prediction, the maximum allowable effluent concentrations, such that parameter concentrations comply with selected sets of WQOs (background and induced toxicity modifiers) at 100 m, were calculated by substituting Equation 1 into Equation 2 and re-arranging as

$$C_E = \frac{C_B \cdot Q_B(1-D) + D \cdot C_F \cdot Q_L}{Q_L + Q_E \cdot (D-1)} \qquad \textbf{Equation 3}$$

As per Saskatchewan water quality objectives the maximum allowable discharge was calculated by considering 30% of the difference between the predicted value in Equation 3 and the background concentration. The maximum allowable predicted effluent concentrations for each of the flow scenarios and for two sets of screening criteria are presented in Table 1-7 and Table 1-8.

Parameters where the available assimilative capacity is less than the max predicted discharge concentration (highlighted in blue), indicating the potential need for treatment. For the screening criteria subject to background water quality (Table 1-7), these parameters include sulphate, chromium (influence by DLs in background), molybdenum, selenium (influence by DLs in background). For the screening criteria subject to induced (by effluent) water quality (Table 1-8), these parameters include chromium (influence by DLs in background), molybdenum, selenium (influence by DLs in background).

Parameters whose available assimilative capacity exceed short term criteria listed in Table 1-5 (Table 1-7 and Table 1-8, highlighted in yellow) for both sets of screening criteria include chloride, cadmium, copper, manganese, uranium, and zinc.

Note that although cyanide is a parameter identified in Schedule 4 of the MDMER, it was not considered in the above assessment due to the lack of background cyanide concentration in the receiver. Furthermore, cyanide will not be present in the effluent as not part of the mining process.

Table 1-6: Well Mixed Water Quality Results

Constituent	Unit	Screening Concentration - Background Modifiers	Screening Concentration - Induced Modifiers	Discharge Concentration (max predicted)	LA-5 Well Mixed (7Q10)	LA-5 Well Mixed (Monthly Low)	LA-5 Well Mixed (Average)
General Chemistry, Nutrients and Anions							
Alkalinity	mg/L	N/A	N/A	12.4	12.4	12.4	12.4
Ammonia (as N)	mg/L	5.74	5.74	3.9	0.13	0.11	0.10
Un-Ionized Ammonia	mg/L	0.019	0.019	0.0129	0.08	0.05	0.03
Hardness	mg/L (as CaCO3)	N/A	N/A	250	9	8	7
Conductivity	µS/cm	N/A	N/A	21.7	21.7	21.7	21.7
Nitrate	mg/L	3	3.0	0.249	0.249	0.249	0.249
pH	pH Unit	6.5 - 9.0	6.5 - 9.0	7.0	7.0	7.0	7.0
Phosphorus	mg/L	0.01	0.01	0.01	0.005	0.005	0.005
Sulphate	mg/L	128	429	2600	43	26	19
TDS	mg/L	500	500	6420	131	90	74
Temperature	deg C	16.5	17	16.5	15.0	15.0	15.0
TSS	mg/L	8.9	9	6	4	4	4
Chloride	mg/L	120	120	600	10	6	5
Metals							
Aluminum	mg/L	0.1	0.1	0.051	0.01	0.01	0.01
Arsenic	mg/L	0.005	0.005	0.006	0.0002	0.0002	0.0001
Cadmium	mg/L	0.00004	0.00034	0.0018	0.00005	0.00004	0.00003
Chromium	mg/L	0.001	0.001	0.025	0.001	0.001	0.001
Cobalt	mg/L	0.000295	0.001493	0.0027	0.000142	0.000125	0.000119
Copper	mg/L	0.0002	0.0005	0.02	0.00046	0.00031	0.00026
Cyanide	mg/L	N/A	N/A	N/A	0.0	0.0	0.0

DATE: 21 November 2024

TO: Xavier Lu Dac, Janna Switzer, Denison Mines

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Constituent	Unit	Screening Concentration - Background Modifiers	Screening Concentration - Induced Modifiers	Discharge Concentration (max predicted)	LA-5 Well Mixed (7Q10)	LA-5 Well Mixed (Monthly Low)	LA-5 Well Mixed (Average)
Iron	mg/L	0.3	0.3	0.0039	0.178	0.179	0.180
Lead	mg/L	0.001	0.007	0.0003	0.00005	0.00005	0.00005
Manganese	mg/L	0.21	0.640	0.03	0.020	0.020	0.020
Mercury	mg/L	0.000026	0.000026	0.00001	0.000010	0.000010	0.000010
Molybdenum	mg/L	0.073	0.073	2.5	0.04	0.02	0.02
Nickel	mg/L	0.025	0.025	0.0138	0.0003	0.0002	0.0001
Selenium	mg/L	0.001	0.001	0.042	0.001	0.001	0.000
Strontium	mg/L	2.5	2.5	1.68	0.04	0.03	0.03
Thallium	mg/L	0.0008	0.001	0.0006	0.0002	0.0002	0.0002
Uranium	mg/L	0.015	0.015	0.057	0.001	0.001	0.001
Vanadium	mg/L	0.12	0.12	0.059	0.0011	0.0007	0.00
Zinc	mg/L	0.013	0.058	0.042	0.002	0.001	0.001
Radiological							
Lead-210	mg/L	0.2	0.2	0.42	0.026	0.024	0.023
Polonium-210	mg/L	0.1	0.1	0.15	0.007	0.006	0.006
Radium-226	mg/L	0.11	0.11	0.15	0.008	0.007	0.007
Thorium-230	mg/L	0.6	0.6	0.9	0.024	0.019	0.016
Uranium-238	mg/L	3	3	0.7	0.013	0.008	0.006
Uranium-234	mg/L	3	3	0.7	0.013	0.008	0.006

DATE: 21 November 2024

TO: Xavier Lu Dac, Janna Switzer, Denison Mines

REF: LA-5 Discharge Concentration Assessment

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Table 1-7: Predicted Maximum Allowable Effluent Concentrations (Background Toxicity Modifiers)

Constituent	Unit	Screening Concentration (Background WQ)	Discharge Concentration (max predicted)	Maximum Allowable Effluent Concentration (7Q10)	Maximum Allowable Effluent Concentration (Monthly Low Flow)	Maximum Allowable Effluent Concentration (Monthly Average Flow)
General Chemistry, Nutrients and Anions						
Alkalinity	mg/L	N/A	12.4	No Applicable WQO		
Ammonia (as N)	mg/L	5.74	3.9	89.9	136.3	170.1
Un-Ionized Ammonia	mg/L	0.019	0.0129	0.30	0.45	0.56
Hardness	mg/L (as CaCO3)	N/A	250	No Applicable WQO		
Conductivity	µS/cm	N/A	21.7	No Applicable WQO		
Nitrate	mg/L	3.0	0.249	45.8	70.5	88.5
pH	pH Unit	6.5 - 9.0	7.0	6.5 - 9.0	6.5 - 9.0	6.5 - 9.0
Phosphorus	mg/L	0.007	0.01	0.040	0.057	0.107
Sulphate	mg/L	128	**2600**	2017	3058	3817
TDS	mg/L	500	**6420**	7499	11356	14169
Temperature	deg C	17	16.5	38.8	51.0	60.0
TSS	mg/L	9	6	83	124	154
Chloride	mg/L	120	**600**	1895	2873	3586
Metals						
Aluminum	mg/L	0.1	0.051	1	2	3
Arsenic	mg/L	0.005	**0.006**	0.078	0.118	0.147
Cadmium	mg/L	0.00004	**0.0018**	0.0004	0.0005	0.0006
Chromium	mg/L	0.001	**0.025**	0.012	0.021	0.027
Cobalt	mg/L	0.000295	**0.0027**	0.0040	0.0064	0.0083
Copper	mg/L	0.0002	**0.02**	0.002	0.003	0.004
Cyanide	mg/L	N/A	N/A	No Predicted Discharge Concentration		
Iron	mg/L	0.3	0.0039	2.1	3.0	3.7
Lead	mg/L	0.001	0.0003	0.02	0.02	0.03
Manganese	mg/L	0.21	0.03	3.82	5.79	7.22
Mercury	mg/L	0.000026	0.00001	0.00034	0.00056	0.00072

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Constituent	Unit	Screening Concentration (Background WQ)	Discharge Concentration (max predicted)	Maximum Allowable Effluent Concentration (7Q10)	Maximum Allowable Effluent Concentration (Monthly Low Flow)	Maximum Allowable Effluent Concentration (Monthly Average Flow)
Molybdenum	mg/L	0.073	**2.5**	1.1	1.7	2.1
Nickel	mg/L	0.025	0.0138	1.11	1.68	2.10
Selenium	mg/L	0.001	**0.042**	0.015	0.023	0.029
Strontium	mg/L	2.5	1.68	39.4	59.7	74.5
Thallium	mg/L	0.001	0.0006	0.011	0.018	0.023
Uranium	mg/L	0.015	**0.057**	0.24	0.36	0.45
Vanadium	mg/L	0.12	0.059	1.9	2.9	3.6
Zinc	mg/L	0.013	**0.042**	0.19	0.29	0.36
Radiological						
Lead-210	Bq/L	0.2	**0.42**	3.0	4.7	5.9
Polonium-210	Bq/L	0.1	**0.15**	1.5	2.4	3.0
Radium-226	Bq/L	0.11	**0.15**	1.7	2.6	3.3
Thorium-230	Bq/L	0.6	**0.9**	9	14	18
Uranium-238	Bq/L	3	0.7	47.5	72.0	89.9
Uranium-234	Bq/L	3	0.7	47.5	72.0	89.9

Notes

(1) Bolded values are those that exceed the Screening concentrations.

(2) Highlighted blue values indicate predicted discharge concentrations above maximum allowable effluent concentrations (as per Saskatchewan requirements) for different background flow conditions.

(3) Highlighted yellow values indicate predicted discharge concentrations above short-term values.

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Table 1-8: Predicted Maximum Allowable Effluent Concentrations (Induced Toxicity Modifiers)

Constituent	Unit	Screening Concentration (Induced WQ)	Discharge Concentration (max predicted)	Maximum Allowable Effluent Concentration (7Q10)	Maximum Allowable Effluent Concentration (Monthly Low Flow)	Maximum Allowable Effluent Concentration (Monthly Average Flow)
General Chemistry, Nutrients and Anions						
Alkalinity	mg/L	N/A	12.4	No Applicable WQO		
Ammonia (as N)	mg/L	5.74	3.9	89.9	136.3	170.1
Un-Ionized Ammonia	mg/L	0.019	0.0129	0.30	0.45	0.56
Hardness	mg/L (as CaCO3)	N/A	250	No Applicable WQO		
Conductivity	µS/cm	N/A	21.7	No Applicable WQO		
Nitrate	mg/L	3.0	0.249	45.8	70.5	88.5
pH	pH Unit	6.5 - 9.0	7.0	6.5 - 9.0	6.5 - 9.0	6.5 - 9.0
Phosphorus	mg/L	0.007	0.01	0.040	0.057	0.107
Sulphate	mg/L	429	**2600**	6784	10286	12841
TDS	mg/L	500	**6420**	7499	11356	14169
Temperature	deg C	16.5	16.5	38.8	51.0	60.0
TSS	mg/L	9	6	83	124	154
Chloride	mg/L	120	**600**	1895	2873	3586
Metals						
Aluminum	mg/L	0.1	0.051	1	2	3
Arsenic	mg/L	0.005	**0.006**	0.078	0.118	0.147
Cadmium	mg/L	0.00034	**0.0018**	0.0051	0.0077	0.0096
Chromium	mg/L	0.001	**0.025**	0.012	0.021	0.027
Cobalt	mg/L	0.0015	**0.0027**	0.0229	0.0352	0.0442
Copper	mg/L	0.0005	**0.02**	0.007	0.010	0.013
Cyanide	mg/L	N/A	N/A	No Predicted Discharge Concentration		
Iron	mg/L	0.3	0.0039	2.1	3.0	3.7
Lead	mg/L	0.007	0.0003	0.11	0.17	0.21
Manganese	mg/L	0.640	0.03	9.84	14.91	18.61
Mercury	mg/L	0.000026	0.00001	0.00034	0.00056	0.00072

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Constituent	Unit	Screening Concentration (Induced WQ)	Discharge Concentration (max predicted)	Maximum Allowable Effluent Concentration (7Q10)	Maximum Allowable Effluent Concentration (Monthly Low Flow)	Maximum Allowable Effluent Concentration (Monthly Average Flow)
Molybdenum	mg/L	0.07	**2.5**	1.1	1.7	2.1
Nickel	mg/L	0.15	0.0138	2.37	3.60	4.50
Selenium	mg/L	0.001	**0.042**	0.015	0.023	0.029
Strontium	mg/L	2.5	1.68	39	60	75
Thallium	mg/L	0.001	0.0006	0.011	0.018	0.023
Uranium	mg/L	0.015	**0.057**	0.24	0.36	0.45
Vanadium	mg/L	0.12	0.059	1.9	2.9	3.6
Zinc	mg/L	0.058	0.042	0.9	1.4	1.7
Radiological						
Lead-210	Bq/L	0.2	**0.42**	3.0	4.7	5.9
Polonium-210	Bq/L	0.1	**0.15**	1.5	2.4	3.0
Radium-226	Bq/L	0.11	**0.15**	1.7	2.6	3.3
Thorium-230	Bq/L	0.6	**0.9**	9	14	18
Uranium-238	Bq/L	3	0.7	47.5	72.0	89.9
Uranium-234	Bq/L	3	0.7	47.5	72.0	89.9

Notes

(1) Bolded values are those that exceed the Screening concentrations.

(2) Highlighted blue values indicate predicted discharge concentrations above maximum allowable effluent concentrations (as per Saskatchewan requirements) for different background flow conditions.

(3) Highlighted yellow values indicate predicted discharge concentrations above short-term values.

2.0 Preliminary Mixing Zone Assessment

In addition to concentration predictions, a preliminary mixing zone assessment was conducted for the discharge of water from the site to LA-5. This assessment was conducted assuming induced water quality criteria in the receiving environment. This preliminary mixing zone assessment furthers the discussion and determines the extent/size of the area of WQO exceedance within LA-5.

The proposed discharge from the site to LA-5 will be through an engineered, offshore, submerged, multiport diffuser, designed to maximize the mixing potential and minimize the spatial extent of the mixing zone. A mathematical model referred to as CORMIX (Cornell Mixing Zone Expert System) was used to predict the rate of mixing of the discharge with distance from the diffuser (hence, the spatial extent of the mixing zone). CORMIX was developed by Cornell University (Jirka and Akar, 1991), is supported by the United States Environmental Protection Agency, and is a widely recognized model for the analysis of mixing characteristics.

The conceptual design for the diffuser used in the assessment consisted of a diffuser line with 3 evenly spaced nozzles with each nozzle approximately 0.07 m in diameter. The diffuser line is located approximately 115 m offshore from the north shoreline and 440 m from the west shoreline, in approximately 3 m of water. The diffuser extends from the north shoreline from a single pipe which reaches a "T" that extends parallel to the north shoreline (Figure 2-1). The exact design configuration will be optimized as required during the engineering design and permitting phase to ensure optimal performance of the diffuser specific to site conditions.

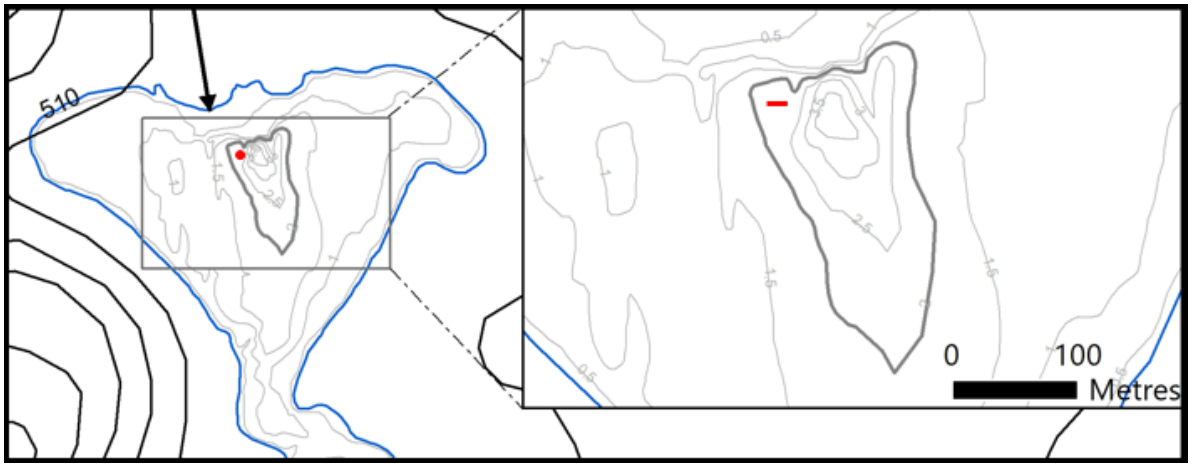


Figure 2-1: Approximate Diffuser Location

Simulations were carried out to assess the size of the mixing zone under different flow scenarios. To assess the size of a mixing zone within a lake, CORMIX uses local current velocities around

the diffuser rather than volumetric flow rates. For this investigation, current velocities near the diffuser were estimated by converting river (from LA-6 to LA-5) volumetric flow rates to current speeds using the cross-sectional area of the river. This characterization of current speed near the diffuser is appropriate since the current diffuser design is placed near the mouth of the river. Estimates of current velocities were provided to Ecometrix from NewFields Canada (please refer to Appendix 8-C [Table 3-3: 7Q10 Estimated Discharge]). To assess variability in river flow rates, current velocity estimates were made by considering the minimum, average, and maximum flow rates through the mouth of the river. Current velocities used in the mixing zone assessment are summarized in 2-1.

Table 2-1: Estimated Current Velocities near the Diffuser

Flow Condition	Current Velocity (m/s)
Minimum	0.1
Average	0.23
Maximum	0.297

The extent of the mixing zone for concentrations predicted in Section 1.4 with different current velocities is given in Table 2-2. Under all flow scenarios, the size of the mixing zone for all constituents remains less than 5 m[1].

Table 2-2: Mixing Zone Size under Various Flow Conditions

Mixing Zone Distance (m)			
Current Velocity (m/s)	**7Q10**	**Monthly Low Flow**	**Monthly Average Flow**
0.1	4.2	0.7	0.5
0.23	0.8	0.1	0.05
0.297	0.5	0.1	0.05

[1] We note that in response to the EIS review process and comment Round 4 IR-114, the hardness induced guideline for Cu (hardness 9 mg/L, pH 7, DOC 2.24, temperature 13C), and this was in relation to interpreting the well mixed results, which are downstream of the mixing zone. Using the expected parameters at the edge of the mixing zone (hardness 250 mg/L, pH 7, DOC 2.24, temperature 13C), the size of the mixing zone for copper remains less than 5 m.

(1) Under all flow conditions, all constituents meet screening concentrations within the mixing zone.

3.0 Potential Thermal Effects

The site is expected to discharge to LA-5 year-round. Since effluent is stored in on-site ponds, it is anticipated that during the summer months, effluent temperatures and lake temperatures are both subject to the same ambient conditions, resulting in similar water temperatures. However, in the winter, the ponds may have a slight increase in temperature (compared to lake temperature) to prevent freezing of the ponds.

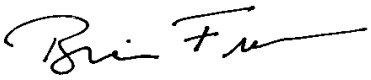
It is assumed that the effluent temperature in the winter would be approximately 5°C, while the ice-covered lake would have a temperature of 3-4°C. This results in a temperature differential of 1-2°C at end of pipe, leading to a slight temperature increase of the well-mixed (beyond the extend of the mixing zone) portion of LA-5 by approximately 0.2°C. Qualitatively, this suggests that there is a low thermal impact in the well-mixed portion of LA-5, a low thermal impact within the small mixing zone, and a low temporal occurrence (the largest temperature difference occurring under ice).

4.0 Closure

The information provided and statements made herein are to the best of our knowledge, information, and belief as of the date of this document. With respect to the information contained in this report, any errors or omissions made are not reflected and may be adjusted for accordingly.

Respectively Submitted,

Harry Gaebler, Ph.D.
Applied Mathematician/Environmental Modeller



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5.0

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