REPORT

Nearfield Mixing Modelling in Mammoth Lake and in Whale Tail Lake (South Basin)

Technical Meeting Commitment 26

Submitted to:

Agnico Eagle Mines Limited

Submitted by:

Golder Associates Ltd.

102, 2535 - 3rd Avenue S.E., Calgary, Alberta, T2A 7W5, Canada

+1 403 299 5600

19115196-333-RPT-Rev0

12 July 2019

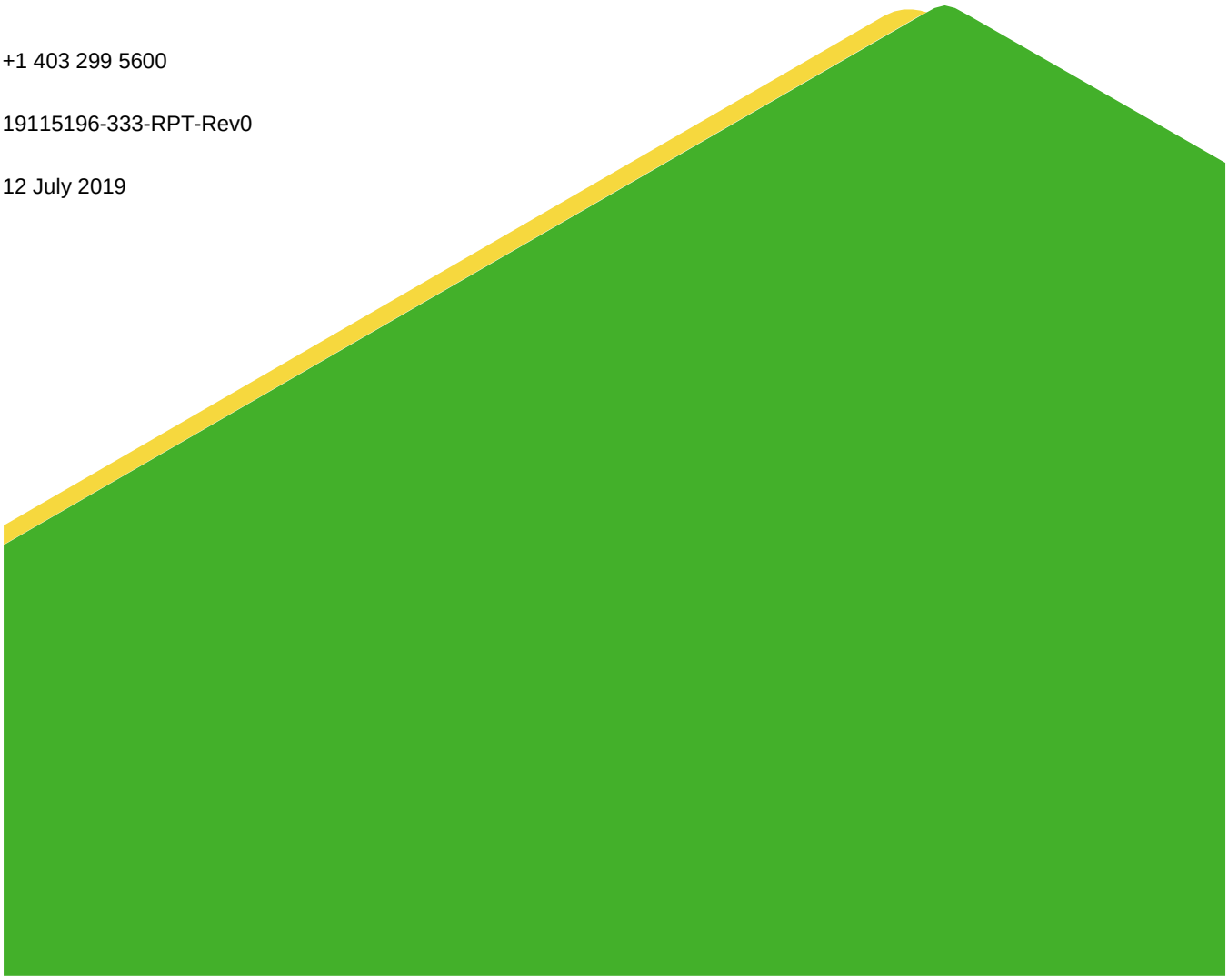


Table of Contents

1.0 BACKGROUND 1

2.0 MIXING ZONE ESTIMATION 1

3.0 SITE CONDITIONS 2

4.0 TREATED EFFLUENT DISCHARGE CONDITIONS 2

5.0 DIFFUSER DESIGN 3

6.0 SIMULATION SCENARIOS 3

7.0 CORMIX MODEL SIMULATION RESULTS 4

7.1 Mammoth Lake 4

7.1.1 Comparison to Previous Near-field Mixing Assessment 5

7.2 Whale Tail Lake (South Basin) 6

7.2.1 Comparison to Previous Near-field Mixing Assessment 7

8.0 POTENTIAL FOR EFFECTS IN THE MIXING ZONE 7

9.0 CONCLUSIONS 9

10.0 REFERENCES 12

TABLES

Table 1: Comparison of Dilution Factor Requirements in the Nearfield Mixing Zone, Start of Mine and End of Planned Discharge to the Receiver Lakes 2

Table 2: Treated Effluent Flow Rate and TDS concentration 2

Table 3: Simulation Scenarios for Mammoth Lake Nearfield Modelling, Summer 3

Table 4: Simulation Scenarios for Plume in Whale Tail Lake (South Basin) 4

Table 5: Model Results for Nearfield Mixing in Mammoth Lake, Summer 5

Table 6: Model Results for Plumes in Whale Tail Lake (South Basin) 7

Table 7: Diffuser Design Information 9

FIGURES

Figure 1: Section View and Plan View of Plumes for Scenario 1 6

APPENDICES

APPENDIX A

Required Dilution Factors for the Estimation of the Mixing Zone Boundary

1.0 BACKGROUND

Agnico Eagle Mines Limited – Meadowbank Division (Agnico Eagle) is developing the Whale Tail Pit Project (Approved Project) in Nunavut. As part of the mine development, treated effluent (from the Water Treatment Plants[1] [WTP]) is planned to be released to Mammoth Lake during operations. Agnico Eagle is considering an expansion to the Approved Project (Expansion Project). As part of the mine development, treated effluent (from the WTP) and captured seepage through the Whale Tail Dike (dike seepage) are planned to be released to Whale Tail Lake (South Basin) during operations.

Nearfield modelling was conducted to confirm that the proposed diffuser(s) would provide adequate mixing in the nearfield (Golder 2019a,b). Following review of the Project by regulatory agencies, further nearfield modelling was requested during the Technical Meeting (June 11-13, 2019) for a time period near the end of planned discharge to the receiver lakes when ambient water quality parameters would be affected by the effluent discharge (Commitment 26; refer to the NIRB Public Registry, NIRB Document ID 325434). To address Commitment 26, this report provides a summary of the modelling conducted for ambient conditions in Mammoth Lake and Whale Tail Lake (South Basin) near the end of planned treated effluent discharge to the receiver lakes. This report shall be read in conjunction with the attached Important Information and Limitations of this Report. This information is important for the proper use and interpretation of this report.

2.0 MIXING ZONE ESTIMATION

The intention of the treated effluent discharge objectives is to set the allowable effluent concentrations at the end-of-pipe and edge of a regulatory mixing zone. These allowable concentrations were utilized to design the diffuser to achieve the required dispersion within the mixing zone. A radius of 100 m from the point of discharge is widely used for environmental compliance assessments for the size of a mixing zone. For example, the Guidelines for the Discharge of Treated Municipal Wastewater in the Northwest Territories (NWT 1992) provide guidance that the limits of initial mixing zone are 100 m from all points of discharge. The reference to 100 m is consistent with the maximum extent (radius) of regulated mixing zone boundaries for many discharges to receiving environments in Canada (e.g., MVLWB/GNWT 2017). For the current study, a 100 m regulatory mixing zone was applied.

Previous analysis (Golder 2019a,b) evaluated required dilution factors (DF) at the start of mine operations for COPCs in treated effluent to meet their respective site-specific water quality objective (SSWQO), CEQG, and/or CDWQG benchmarks in the receiving lake when ambient water quality would be similar to baseline conditions. The current analysis assesses mixing at the end of the planned operational discharge to Mammoth and Whale Tail (South Basin) lakes (i.e., Mammoth Lake, 2021; and Whale Tail [South Basin], 2026) when ambient lake water quality in each respective receiver lake represents the maximum projected COPC concentration in the fully mixed receiving lakes. The required DF are therefore different than the previous analysis, as summarized in Table 1.

Effluent water quality, receiving water quality guidelines and the calculated DF required to meet the CEQG are provided in Tables A1 and A2 of Appendix A.

[1]Water Treatment Plant or WTP in this report refers to any or all water treatment plants at site including the TSS-arsenic Water Treatment Plant (C-WTP, O-WTP) and Salt Water Treatment Plant (S-WTP)

Table 1: Comparison of Dilution Factor Requirements in the Nearfield Mixing Zone, Start of Mine and End of Planned Discharge to the Receiver Lakes

Lake	Dilution Factor (Start of Mine)			Dilution Factor (End of planned treated effluent discharge to the Receiver Lakes)			
	Summer Discharge	Winter Discharge	Critical Parameter	Summer Discharge	Critical Parameter	Winter Discharge	Critical Parameter
Mammoth	27	27	P	12	Cu	1.6	P
Whale Tail (South Basin)	16.7	4.1	P	19	NO_3	18	Cu

3.0 SITE CONDITIONS

The only change in site conditions at the end of planned treated effluent discharge to the receiver lakes is the Lake TDS concentrations for Mammoth Lake and Whale Tail Lake (South Basin) (Golder 2019a,b). The site conditions are summarized below.

- Water temperature is 2°C, 8°C, 10°C and 6°C in June, July, August and September, and is between 0°C to 4°C in winter.
- Lake current speeds are calculated based on wind speeds. The high current is assumed to have 1% chance be exceeded and is 0.28 m/s. the low current is assumed to have 99% chance to be exceeded, and is 0.006 m/s.
- Mammoth Lake TDS concentration is predicted to be 101 mg/L in summer and 95.5 mg/L in winter, and Whale Tail Lake (South Basin) TDS concentration is predicted to be 48 mg/L in summer and in winter.
- Mammoth lake water depth is 8.30 m at the proposed diffuser location, and Whale Tail Lake (South Basin) diffuser depth is 9.1 m. The ice thickness is assumed to be 2.0 m in both lakes.

4.0 TREATED EFFLUENT DISCHARGE CONDITIONS

Table 2 presents the updated treated effluent discharge condition information at the end of mine life (Agnico Eagle 2019).

Table 2: Treated Effluent Flow Rate and TDS concentration

Flows				
Scenario		**Units**	**Mammoth**	**Whale Tail South**
Summer	High Flow	m^3/s	0.36	0.34
	Low Flow	m^3/s	0.033	0.031
Winter	High Flow	m^3/s	0.01002	0.0011
	Low Flow	m^3/s	0.00905	0.00068
TDS				
Scenario		**Units**	**Mammoth**	**Whale Tail South**
Summer	Minimum	mg/L	75	65
	Maximum	mg/L	469	267
Winter	Minimum	mg/L	6.3	68
	Maximum	mg/L	12	68

Note: As per the previous analysis, it was assumed that effluent temperature is similar to lake water temperature.

5.0 DIFFUSER DESIGN

The diffuser port diameter for Mammoth Lake is the same as previously utilized with details provided in Technical Note "Treated Water Diffuser Design" by SNC Lavalin (Document number 651298-800-40ER-0002, Feb. 13, 2019). The diffuser information for Whale Tail Lake (South Basin) is the same as previously utilized from the Golder memorandum in May 2019 (Golder 2019b), with port height and nozzle diameter slightly modified based on the Mammoth Lake diffusers. The information is summarized in Section 9.0.

6.0 SIMULATION SCENARIOS

A number of simulation scenarios were determined to capture the range of ambient conditions (high and low lake currents) and effluent discharge conditions (low and high flows) in Mammoth Lake. These are summarized in Table 3 for summer open water conditions. The plumes in winter were not simulated as the required DF is as low as 1.6, which should be easily met a short distance from the diffuser.

Table 3: Simulation Scenarios for Mammoth Lake Nearfield Modelling, Summer

Scenario Number	1	2	3	4
Scenario Description	Summer, low current, low flow	Summer, low current, high flow	Summer, high current, low flow	Summer, high current, high flow
Conceptual Description	Mid-summer discharge, no wind	Freshet discharge (max rate), no wind	Mid-Summer discharge, with wind	Freshet discharge (max rate), with wind
Input Data for Treated Effluent				
Flow rate (m^3/s)	0.033	0.36	0.033	0.36
Nozzle exit velocity (m/s)	0.50	7.07	0.50	7.07
Temperature (°C) [1]	2	2	2	2
TDS concentration (mg/L) [2]	469	469	469	469
Density (kg/m^3)	1000.35	1000.35	1000.35	1000.35
Input Data for Ambient Conditions				
Net water depth (m) [3]	8.30	8.30	8.30	8.30
Current speed (m/s) [4]	0.006	0.006	0.28	0.28
Temperature (°C) [5]	2	2	2	2
TDS concentration (mg/L) [2]	101	101	101	101
Density (kg/m^3)	1000.05	1000.05	1000.05	1000.05

Note 1. Effluent temperature is assumed to be identical to ambient temperature.

Note 2. Golder (2019c), and total concentrations adjusted as per Technical comment response ECCC-TC17 (Agnico Eagle 2019).

Note 3. The average bed elevation along diffuser is 143.79m (from Figure 61-695-270-204 of SNC Lavalin 2019). September water level is 152.09 m.

Note 4. High and low current speed are from Table 3 of 28 May 2019 memorandum (Golder 2019a).

Note 5. Temperatures for June, July, August and September are respectively 2, 8, 10 and 6°C, and 2°C gives largest density difference between effluent and ambient.

A number of simulation scenarios were determined to capture the range of ambient conditions (high and low lake currents) and effluent discharge conditions (low and high flows) in Whale Tail Lake (South Basin). These are summarized in Table 4 for summer open water conditions and winter under ice conditions. The plumes in winter when Lake A53 is being dewatered have not been considered; as the dewatering volume is mixed with effluent, the concentrations to Whale Tail Lake (South Basin) are reduced. Otherwise, the winter plumes were considered to contain only dissolved constituents as the effluent is in the form of permeate from the S-WTP (SaltMaker), which would contain constituents only in dissolved form. The modelled plumes also consider only O-WTP and S-WTP

effluent discharge to Whale Tail Lake (South Basin), and no seepage effluent. However, ambient conditions in Whale Tail Lake (South Basin) account for the seepage effluent load.

Table 4: Simulation Scenarios for Plume in Whale Tail Lake (South Basin)

Scenario Number	1	2	3	4	5
Scenario Description	Summer, low current, low flow	Summer, low current, high flow	Summer, high current, low flow	Summer, high current, high flow	Winter
Conceptual Description	Mid-summer discharge, no wind	Freshet discharge (max rate), no wind	Mid-Summer discharge, with wind	Freshet discharge (max rate), with wind	SaltMaker Permeate of saline water, 90 m³/day; winter of 2025
Input Data for Treated Effluent					
Flow rate (m³/s)	0.031	0.34	0.031	0.34	0.0011
Nozzle exit velocity (m/s)	0.75	8.18	0.75	8.18	0.12
Temperature (°C) [1]	2	2	2	2	0
TDS concentration (mg/L) [2]	267	267	267	267	68
Density (kg/m³)	1000.19	1000.19	1000.19	1000.19	999.924
Input Data for Ambient Conditions					
Net water depth (m) [3]	9.1	9.1	9.1	9.1	7.1
Current speed (m/s) [4]	0.006	0.006	0.28	0.28	0.001
Temperature (°C) [5]	2	2	2	2	0
TDS concentration (mg/L) [2]	48	48	48	48	48
Density (kg/m³)	1000.01	1000.01	1000.01	1000.01	999.907

Note 1. Effluent temperature is assumed to be identical to ambient temperature.

Note 2. Golder (2019c), and total concentrations adjusted as per Technical comment response ECCC-TC17 (Agnico Eagle 2019).

Note 3. The water depth was from Section 5.1 of 28 May 2019 memorandum "Effluent plume modelling in Whale Tail Lake (South Basin)".

Note 4. High and low current speed are from Table 3 of 28 May 2019 memorandum (Golder 2019a).

Note 5. Temperatures for June, July, August and September are respectively 2, 8, 10 and 6°C, and 2°C gives largest density difference between effluent and ambient. It was assumed that lake winter water temperature is homogeneous and effluent temperature is identical to ambient temperature. 0°C gives the highest density difference.

7.0 CORMIX MODEL SIMULATION RESULTS

Similar to previous analysis, the commercial CORMIX (U.S. Environmental Protection Agency 1996) model was utilized to simulate nearfield mixing.

7.1 Mammoth Lake

The simulation results for summer nearfield mixing in Mammoth Lake are presented in Table 5 and can be summarized as follows:

- The effluent discharge behaves as a negatively buoyant plume. The plume initially rises vertically in the water column under the influence of momentum from the port exit velocity jet and then falls back to the lakebed under the influence of gravity. The zone of influence on mixing from the diffuser (under the momentum from the port exit velocity jet) is a relatively short distance (up to 13 m). Mixing outside this zone of influence is slower and according to ambient currents in the lake.
- For low lake current (scenarios 1 and 2), the required DF of 12 is met within 13 m from the diffuser;

- For high lake currents (scenarios 3 and 4), the required DF of 12 is met within 4 m from diffuser; and
- At 100 m distance from the diffuser, the DF is at least 28.

Table 5: Model Results for Nearfield Mixing in Mammoth Lake, Summer

Scenario	1	2	3	4
Scenario Description	Summer, low current, low flow	Summer, low current, high flow	Summer, high current, low flow	Summer, high current, high flow
Conceptual Description	Mid-summer discharge, no wind	Freshet discharge (max rate), no wind	Mid-Summer discharge, with wind	Freshet discharge (max rate), with wind
Required DF, S	12			
x(m) [1]	0.8	12.9	3.7	0.9
z(m) [1]	5.1	1.7	1.4	3.2
DF at x = 100 m	28	60.2	140	292

Note 1: x is horizontal distance from the port and z is height above lakebed where the required DF is met.

Figure 1 shows section view and plan view of the plume for Scenario 1. This figure indicates the following:

- The plume reaches its maximum (centreline) height of 5.4 m before it falls back to the lakebed;
- The plume extends a distance of approximately 4 m from the diffuser; and
- The plumes act independently, and they have a DF of about 40 before they fall back to the lakebed. As the plumes move away from the diffuser under ambient currents they start to interact and this reduces the potential DF at the mixing zone boundary to 28.

7.1.1 Comparison to Previous Near-field Mixing Assessment

In Golder 2019a, simulations were performed for open water season effluent flow rates of 800 m³/h and 400 m³/h, with a required DF was 27. The distances to meet the required DF for these flow rates were 59 m and 27 m, respectively, from the diffuser. Compared to these two distances, the maximum distance of 12.9 m in Table 1 is much shorter.

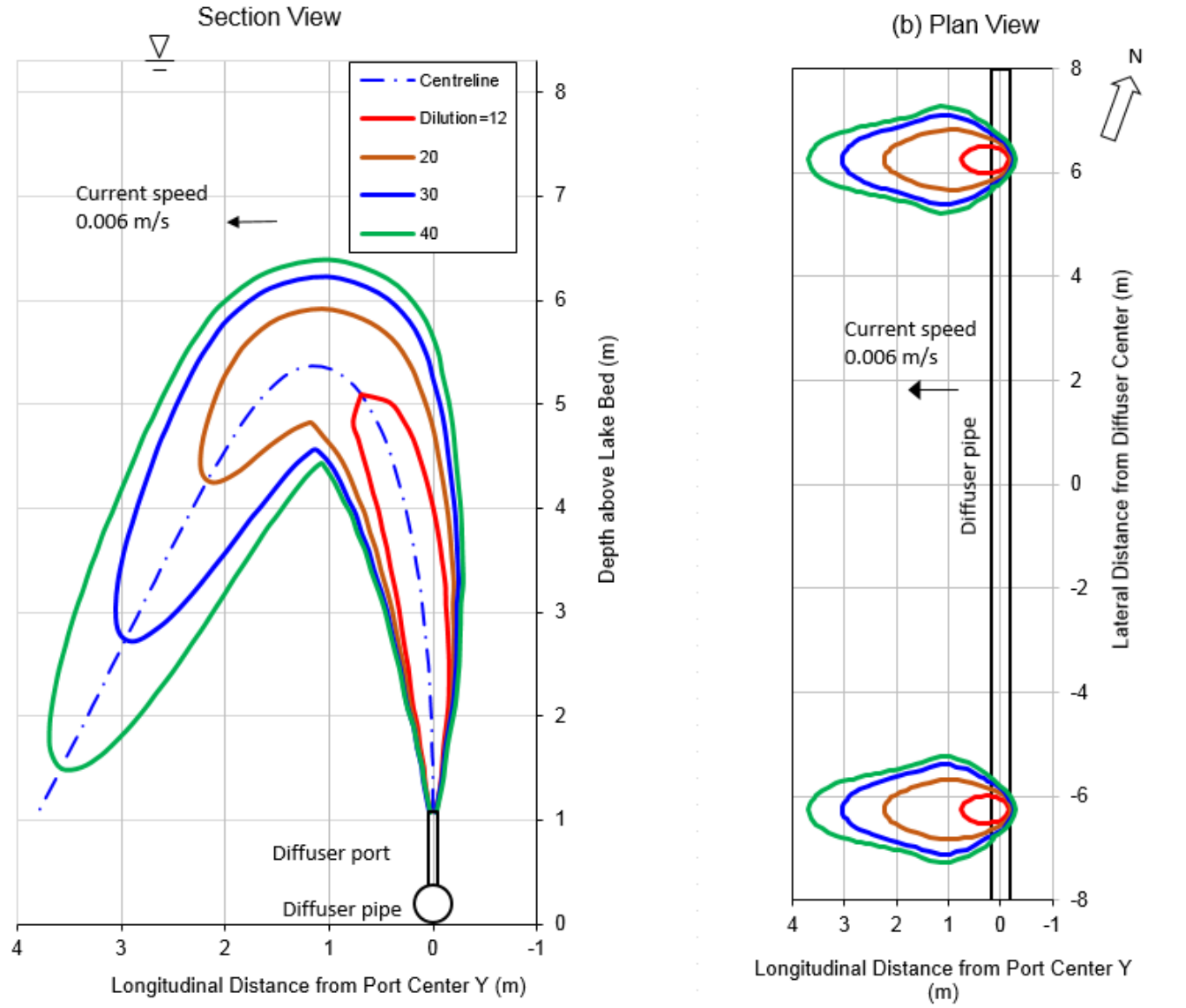


Figure 1: Section View and Plan View of Plumes for Scenario 1

7.2 Whale Tail Lake (South Basin)

The simulation results for summer nearfield mixing in Whale Tail Lake (South Basin) are presented in Table 6 and can be summarized as follows:

- The effluent discharge behaves as a negatively buoyant plume. The plume initially rises vertically in the water column under the influence of momentum from the port exit velocity jet and then falls back to the lakebed under the influence of gravity. The zone of influence on mixing from the diffuser (under the momentum from the port exit velocity jet) is a relatively short distance (up to 28 m). Mixing outside this zone of influence is slower and according to ambient currents in the lake.
- For low lake current in summer (scenarios 1 and 2), the required DF of 19 is met within 28 m from the diffuser;

- For high lake current in summer (scenarios 3 and 4), the required DF is met within 4 m from diffuser;
- For winter release, the required DF is met within 2 m distance from the diffuser; and
- At 100 m distance from the diffuser, the DF is at least 42 in summer and 25 in winter.

Table 6: Model Results for Plumes in Whale Tail Lake (South Basin)

Scenario	1	2	3	4	5
Scenario Description	Summer, low current, low flow	Summer, low current, high flow	Summer, high current, low flow	Summer, high current, high flow	Winter
Conceptual Description	Mid-summer discharge, no wind	Freshet discharge (max rate), no wind	Mid-Summer discharge, with wind	Freshet discharge (max rate), with wind	SaltMaker Permeate of saline water, 90 m³/day; winter of 2025
Required DF, S	19				18
x(m) [1]	1.0	28.2	6.6	1.4	1.5
z(m) [1]	1.4	2.5	1.6	4.1	3.5
DF at x = 100 m	42	48	91	204	25

Note 1: x is horizontal distance from port and z is height above lakebed where the required DF is met.

7.2.1 Comparison to Previous Near-field Mixing Assessment

In Golder 2019b, simulations were conducted for effluent flow rates of 800 m³/h and 214 m³/h in June to September, and the required DF was determined to be 16.7. The maximum distance to meet the required DF was 52 m from the diffuser for flow rates of 800 m³/h, and 20 m for flow rate of 400 m³/h. The maximum distance of 28.2 m in Table 2 for summer is in between these two distances at the start of the mine life.

In Golder 2019b, simulations were conducted for two winter effluent discharge rates of 17.5 m³/h and 161 m³/h, and the required DF was also 16.7. The maximum distances to meet that required DF for each discharge rate was 12 m and 86 m, respectively. The distance of 1.5 in Table 2 is much shorter than these distances at the start of mine life.

8.0 POTENTIAL FOR EFFECTS IN THE MIXING ZONE

The total volume of Mammoth Lake is approximately 6.29 Mm³ and the estimated volume of the near-field mixing zone in the proximity of the diffusers is 0.78 Mm³, which is 12% of the whole lake. However, modelling predicts that for the worst case (start of mine life), the maximum distance where the DF is met is 59 m from the diffuser port, this mixing zone represents a lake volume of 0.23 Mm³, which is 4% of the whole lake.

The total flooded volume of Whale Tail Lake (South Basin) is approximately 11.8 Mm³ and the estimated volume of the near-field mixing zone volume is approximately 0.78 Mm³, which is 7% of the total volume of the lake. However, modelling predicts that for the worst case (start of mine life), the maximum distance where the DF is met is 52 m from the diffuser port, this mixing zone represents a lake volume of 0.18 Mm³, which is 2% of the whole lake.

In circumstances where discharges to receiving environments are required, many jurisdictions allow defined areas within the receiving environment in the vicinity of the discharge (i.e., mixing zones) to avoid or prevent any

unacceptable impacts on the receiving environment. Within the volume of water that is represented by the mixing zone boundary in the receiving lakes, it is expected that there will be occurrences where SSWQO, CEQG, and/or CDWQG may be exceeded. However, there is provision in CCME (2008), with guidance in MVLWB/GNWT (2017), to allocate a proportion of receiving water bodies to allow for effective mixing and dispersion of a discharge within that waterbody (i.e., the mixing zone). Within this mixing zone area, elevated concentrations of COPCs can occur without significantly affecting the integrity of the water body as a whole, nor impairing water uses in the receiving environment. Certain principles in the design and application of discharges have to be adopted to permit regulation of these zones:

- Mixing zone should not impair the uses of a water body
- Mixing zones are not to be used as an alternative to reasonable and practical treatment of effluent
- Although exceedances of SSWQOs may be allowed within a defined mixing zone, the water quality within or discharged into it should never be acutely toxic to aquatic life
- The size of the mixing zone should be minimized to the extent practical.

The proposed size of the mixing zone in Mammoth Lake and Whale Tail Lake (South Basin) (i.e., 100 m diameter) was based on the following key considerations:

a) To make sure there was enough dispersion of the treated effluent so that concentrations of all COPCs at the mixing zone boundary remain below their respective water quality benchmarks

b) To appropriately encompass the turbulent mixing area near the diffuser structure

c) To align with the acceptability criteria for mixing zones listed in Section 3 of the draft guidance document for establishing regulated mixing zones in the Mackenzie Valley (MVLWB/GNWT 2017).

Within the mixing zone, COPCs such as aluminum, arsenic, copper, iron, phosphorus, and nitrate will be elevated briefly and require effective dispersion to meet SSWQOs, CEQG, and/or CDWQG at the edge of the mixing zone boundary. The near-field mixing results show that the required mixing distances from the diffuser under the planned operational pumping requirements during winter and summer for these COPCs to meet their respective SSWQO, CEQG, and/or CDWQG range from 59 m to 13 m in Mammoth Lake at the start and end of the operational discharge to this lake, and range from 52 m to 28 m in Whale Tail Lake (South Basin) at the start and end of the operational discharge to this lake. These distances are well within the proposed 100 m mixing zone dimensions for the Project. The required DFs are based on conservative modelling assumptions; for example, the ambient receiving lake water quality conditions are associated with the maximum modelled water chemistry for the fully mixed receiver lakes during operations. Peak ambient water chemistry conditions are also limited to a one-year duration (see water quality predictions for arsenic and phosphorus in the response to ECCC-TR-17), and during open water, lake currents will be subjected to a higher degree of wind-driven circulation that will further promote dispersion. Therefore, the mixing zone dimensions are also considered conservative.

As such, water quality conditions in the mixing zone during operational pumping for several COPCs will be above SSWQOs, CEQG, and/or CDWQG for a short duration. However, the elevated concentrations are not projected to be acutely toxic. Additionally, these exceedances will be limited to the mixing zone boundary, which represents a small proportion of the receiving lake; the higher concentrations in this limited mixing zone are not expected to impact the integrity and uses of the rest of the lake during discharge.

9.0 CONCLUSIONS

The maximum required DF were assessed based on conditions at the end of the respective treated discharge to each of the receiver lakes and were determined to be as follows:

- Mammoth Lake
  - 12 for summer release, based on copper
    - The DF for other noted COPCs include 6.6 for aluminum, 8 for arsenic, 6.8 for iron, and 3.8 for nitrate
  - 1.6 for winter release, based on total phosphorus
- Whale Tail Lake (South Basin)
  - 19 for summer release, based on nitrate
    - The DF for other noted COPCs include 3.2 for aluminum, 12.4 for arsenic, 9.6 for copper, and 4.5 for iron
  - 18 for winter release, based on copper
    - The DF for other noted COPCs include 1 for aluminum and iron

The design of the diffusers for both Mammoth Lake and Whale Tail Lake (South Basin) are summarized in Table 7.

Table 7: Diffuser Design Information

Parameter	Diffuser in Mammoth Lake		Diffuser in Whale Tail Lake (South Basin)	
	Diffuser for Summer Release	Diffuser for Winter Release	Diffuser for Summer Release	Diffuser for Winter Release
Number of diffuser pipes	2	1	2	1
Spacing between Diffusers (m)	100	-	100	-
Diffuser pipe inside diameter [2] (mm)	311.15	311.15	311.15	311.15
Number of ports in each diffuser	10	3	7	3
Port height (m) [3]	1.08	1.08	1.08	1.08
Port spacing (m)	12.5	14	14	14
Port inside diameter [4] (mm)	80	80	80	80
Nozzle inside diameter [5] (mm)	61.5	61.5	61.5	61.5

Note 1. Assumed the same design material from Source SNC-Lavalin Technical Note "Treated Water Diffuser Design", Document number 651298-8000-40ER-0002, 2019-02-13 and Golder 2019 design for Whale Tail South

Note 2. 14-inch DR17 HDPE pipe, inside diameter is 12.25 inch.

Note 3. Port height equals to ports of length (0.725m) and diffuser pipe diameter (14-inch).

Note 4. SNC-Lavalin Design document provided a diameter of 80 mm. It is not clear if it is inside diameter.

Note 5. SNC-Lavalin Design document provided nozzle opening diameter of 61 to 62 mm. An average value of 61.5 mm is used.

The nearfield mixing in both lakes were simulated based on conditions at the end of planned treated effluent discharge to the receiver lakes. The simulation results are summarized below:

- The required DF in Mammoth Lake is met within 13 m distance from the diffuser; and
- The required DF in Whale Tail Lake (South Basin) is met within 28 m distance from the diffuser.

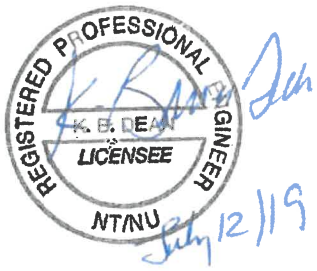
The following are concluded:

- The diffusers provide adequate mixing and resulting dilution for the timing of the end of planned operations treated effluent discharge to each of the receiving lakes (i.e., Mammoth Lake, 2021; and Whale Tail Lake (South Basin], 2026).
- Larger DF could be achieved by varying the nozzle diameter, but smaller nozzles would result in higher head losses.
- During operational pumping, several COPCs will be above SSWQOs, CEQG, and/or CDWQG for a short duration within the mixing zone boundary. However, the elevated COPC concentrations are not projected to be acutely toxic and their occurrences will be limited to a small proportional volume of the receiving lake (i.e., a maximum of 4% of Mammoth Lake and 2% of Whale Tail Lake [South Basin]) during their respective period of discharge). Occurrences of elevated COPC concentrations in these mixing zones are not expected to impact the integrity and uses of the rest of the lake during discharge.

Signature Page

Golder Associates Ltd.

Shouhong Wu
Ph.D., P.Eng. (AB), Senior Water Resources Engineer

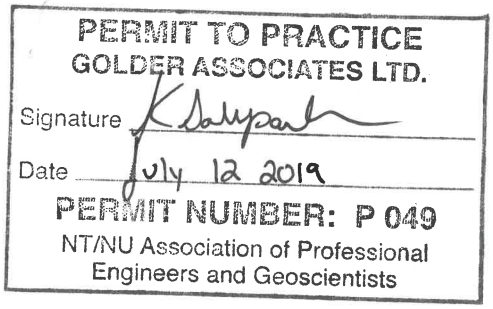


K. Bruce Dean, M.Sc., P.Eng.
Principal, Senior Water Resources Engineer

John Faithful
B.Sc. (Hons), Principal, Senior Water Quality Specialist

sw/bd/jr

https://golderassociates.sharepoint.com/sites/102931/stage c_techmeeting/03_tech_mtg_commitments/commitment_26/rev0/19115196-333-rpt-commitment26-plumesimulation-rev0.docx



10.0 REFERENCES

Agnico Eagle (Agnico Eagle Mines Limited). 2019. Technical Comment Responses Whale Tail Pit - Expansion Project. Submitted to Nunavut Impact Review Board. May 29, 2019Golder (Golder Associates Ltd.). 2019a. Effluent Plume Modelling in Mammoth Lake, Approved Project. Prepared for Agnico Eagle Mines Limited. Ref No. 1789310-247-TM-Rev0. 28 May 2019.

CCME (Canadian Council of Ministers for the Environment). 2008: Technical Supplement 2: Canada-wide Strategy for the Management of Municipal Wastewater Effluent, Environmental Risk Management Framework and Guidance, June 2008, Canadian Council of Ministers for the Environment, Winnipeg, MB.

Golder (Golder Associates Ltd). 2019a. Effluent Plume Modelling in Mammoth Lake. Approved Project. Prepared for Agnico Eagle Mines Limited. Ref No. 1789310-247-TM-Rev0. 28 May 2019.

Golder. 2019b. Effluent Plume Modelling in Whale Tail Lake (South Basin). Prepared for Agnico Eagle Mines Limited. Ref No. 1789310-240-TM-Rev1. 28 May 2019.

Golder. 2019c. Mine Site and Downstream Receiving Water Quality Predictions (Whale Tail Pit – Expansion Project). Prepared for Agnico Eagle Mines Limited. Ref No. 18108905-308-RPT_Rev0. May 2019.

MVLWB/GNWT (Mackenzie Valley Land and Water Board/Government of Northwest Territories). 2017. Guidelines for Effluent Mixing Zones. Mackenzie Valley Land and Water Board, Gwich'in Land and Water Board, Sahtu Land and Water Board, Wek'èezhìi Land and Water Board, and Government of the Northwest Territories. September 2017

NWT (Northwest Territories) 1992. Guidelines for the Discharge of Treated municipal Wastewater in the Northwest Territories.

SNC Lavalin. 2019. Technical Note "Treated Water Diffuser Design". Ref No. 651298-800-40ER-0002, Feb. 13, 2019.

U.S. Environmental Protection Agency. 1996. "User's manual for CORMIX".

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder can not be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project.

APPENDIX A

Required Dilution Factors for the Estimation of the Mixing Zone Boundary

Table A1: Required Dilution for Different Parameters in Mammoth Lake

Parameter			Winter Maximum (mg/L)		Summer Maximum (mg/L)		Winter Required Dilution		Summer Required Dilution	
	Amaruq Effluent Quality Criteria	CEQG aquatic life (mg/L)	Effluent (Dissolved)	Mammoth Lake (Maximum during Operations)	Effluent (Total)	Mammoth Lake (Maximum during Operations)	By Amaruq Effluent Quality Criteria	By CEQG Aquatic Life	By Amaruq Effluent Quality Criteria	By CEQG Aquatic Life
TDS	1400	-	12.2	95.5	469	101	-0.06		0.28	
Acidity	-	-	0.036	0.937	12.6	0.972				
Alkalinity	-	-	2.2	15.3	78.0	15.7				
SO4	-	-	0.98	7.41	47.0	7.61				
Ca	-	-	1.50	21.4	133	23.6				
Cl	-	120	5.10	41.5	261	45.8		-0.5		2.9
F	-	0.12	0.008	0.0678	0.347	0.0694		-1.1		5.49
Hg	-	0.000026	0.0000004	0.00000856	0.0000382	0.00000872		-0.5		1.71
Ag	-	0.0025	0.0000011	0.0000245	0.000111	0.0000250		0.0		0.03
Al	0.5	0.1	0.00000	0.0889	0.167	0.0881	-0.22	-8.0	0.19	6.64
As	0.1	0.025	0.00324	0.0146	0.102	0.0140	-0.1	-1.1	1.02	8.01
Ba	-	-	0.00258	0.0153	0.0709	0.0158				
Be	-	-	0.0000024	0.0000304	0.0000879	0.0000309				
B	-	1.5	0.0101	0.0804	0.583	0.0826		-0.05		0.35
Bi	-	-	0.0000031	0.0000542	0.0000864	0.0000549				
Cd	0.002	0.00004	0.00000250	0.0000146	0.0000687	0.0000150	-0.006	-0.5	0.03	2.15
Co	-	-	0.000041	0.000598	0.00387	0.000611				
Cr	0.02	0.001	0.00006	0.00276	0.00996	0.00277	-0.16	1.5	0.42	-4.07
Cu	0.1	0.002	0.00010	0.00143	0.00787	0.00146	-0.01	-2.3	0.07	11.88
Fe	1	0.3	0.009	0.242	0.648	0.240	-0.31	-4.0	0.54	6.78
K	-	-	0.146	1.67	10.7	1.71				
Li	-	-	0.00037	0.00239	0.00956	0.00245				
Mg	-	-	0.62	2.68	12.1	2.76				
Mn	-	-	0.0064	0.0593	0.530	0.0608				
Mo	-	0.073	0.000528	0.00181	0.0114	0.00188		-0.02		0.13
Ni	0.25	0.025	0.00021	0.00536	0.0476	0.00550	-0.02	-0.3	0.17	2.16
P	0.3	0.01	0.0062	0.0161	0.0559	0.0163	-0.03	1.62	0.14	-6.26
Pb	0.05	0.001	0.000027	0.000311	0.00204	0.000318	-0.006	-0.4	0.03	2.52
Sb	-	-	0.000050	0.000536	0.00534	0.000543				
Se	-	0.001	0.000024	0.000266	0.00192	0.000273		-0.3		2.27
Sr	-	-	0.0126	0.0550	0.243	0.0569				
Sn	-	-	0.000006	0.000132	0.000413	0.000134				
Tl	-	0.0008	0.0000006	0.0000154	0.0000550	0.0000156		-0.019		0.05
U	-	0.015	0.000155	0.000583	0.00345	0.000603		-0.03		0.2
V	-	-	0.00005	0.00103	0.00457	0.00104				
Zn	0.1	0.007	0.00026	0.00375	0.0112	0.00382	-0.04	-1.07	0.08	2.31
NO3	-	2.93	0.344	1.46	7.10	1.45		-0.8		3.83
Na	-	-	1.13	5.35	31.4	5.53				
NH3	16	-	0.0094	0.108	0.644	0.116	-0.01		0.03	
						Maximum	1.62		11.88	

Table A2: Required Dilution for Different Parameters in Whale Tail Lake (South Basin)

Parameter			Winter Maximum (mg/L)		Summer Maximum (mg/L)		Winter Required Dilution		Summer Required Dilution	
	Amaruq Effluent Quality Criteria	CEQG aquatic life (mg/L)	Effluent (Dissolved)	Mammoth Lake	Effluent (Total)	Mammoth Lake	By Amaruq Effluent Quality Criteria	By CEQG Aquatic Life	By Amaruq Effluent Quality Criteria	By CEQG Aquatic Life
TDS	1400	-	68.4	48.1	267	48	0.01		0.16	
Acidity	-	-	75.213	1.725	16.3	1.679				
Alkalinity	-	-	56.0	11.5	78.9	11.5				
SO4	-	-	1.99	6.33	52.0	6.33				
Ca	-	-	2.11	6.4	133	6.4				
Cl	-	120	5.70	10.5	261	10.4		0.0		2.29
F	-	0.12	0.155	0.0592	0.347	0.0593		1.6		4.74
Hg	-	0.000026	0.0000131	0.00001016	0.0000586	0.00001010		0.2		3.05
Ag	-	0.0025	0.0002000	0.0000247	0.000130	0.0000246		0.1		0.04
Al	0.5	0.1	0.10000	0.0692	0.168	0.0692	0.07	1.0	0.23	3.22
As	0.1	0.025	0.00324	0.0186	0.102	0.0182	-0.2	-2.4	1.02	12.35
Ba	-	-	0.00934	0.0101	0.0709	0.0101				
Be	-	-	0.0000500	0.0000265	0.0000879	0.0000266				
B	-	1.5	0.0650	0.0570	0.598	0.0569		0.01		0.37
Bi	-	-	0.0010950	0.0000551	0.0000895	0.0000546				
Cd	0.002	0.00004	0.00001000	0.0000099	0.0000687	0.0000100	0.00	0.0	0.03	1.95
Co	-	-	0.000492	0.000533	0.00409	0.000532				
Cr	0.02	0.001	0.00161	0.00212	0.01010	0.00212	-0.03	0.5	0.45	-7.12
Cu	0.1	0.002	0.01370	0.00133	0.00787	0.00132	0.13	18.36	0.07	9.62
Fe	1	0.3	0.295	0.202	0.648	0.202	0.12	1.0	0.56	4.54
K	-	-	0.694	1.74	13.6	1.74				
Li	-	-	0.00168	0.00205	0.00978	0.00204				
Mg	-	-	1.02	1.47	12.1	1.48				
Mn	-	-	0.0116	0.0536	0.562	0.0533				
Mo	-	0.073	0.000528	0.00086	0.0114	0.00086		0.0		0.15
Ni	0.25	0.025	0.00229	0.00606	0.0528	0.00604	-0.02	-0.2	0.19	2.46
P	0.3	0.01	0.0500	0.0158	0.0559	0.0158	0.12	-5.93	0.14	-6.91
Pb	0.05	0.001	0.000416	0.000252	0.00207	0.000252	0.003	0.2	0.04	2.43
Sb	-	-	0.000500	0.000749	0.00746	0.000749				
Se	-	0.001	0.000500	0.000321	0.00268	0.000318		0.3		3.47
Sr	-	-	0.0254	0.0402	0.243	0.0400				
Sn	-	-	0.000133	0.000134	0.000493	0.000134				
Tl	-	0.0008	0.0000200	0.0000165	0.0000752	0.0000165		0.004		0.07
U	-	0.015	0.000398	0.000326	0.00345	0.000327		0.0		0.21
V	-	-	0.00116	0.00106	0.00550	0.00106				
Zn	0.1	0.007	0.00500	0.00405	0.0167	0.00403	0.01	0.32	0.13	4.26
NO3 as N	-	2.93	0.344	2.55	10.00	2.54		-5.8		19.23
Na	-	-	25.40	3.67	31.4	3.65				
NH3 as N	16	-	2.0500	0.322	2.755	0.313	0.11		0.16	
						Maximum	18.36		19.23	

golder.com