TECHNICAL MEMORANDUM

DATE 17 December 2019 **Project No.** 19127573-380-TM-Rev0

TO Michel Groleau, Agnico Eagle Mine Limited

CC Jennifer Range, David Brown, John Faithful, and Julien Lacrampe

FROM Kristina Skeries, Adwoa Cobbina **EMAIL** kskeries@golder.com

EFFECTS OF WET YEAR SCENARIOS ON WATER MANAGEMENT

1.0 INTRODUCTION

To support responses to ECCC-TC4 for the Water Licence Amendment application (Agnico Eagle 2019) and Commitment 7 from the Technical Meeting held 29-30 October 2019, Agnico Eagle Mines Limited (Agnico Eagle) retained Nuqsana Golder to update the Site and Downstream Water Balance and Water Quality model used in the Water Licence Amendment application.

ECCC-TC4 recommends that Agnico Eagle:

- *Identify the type, extent, timing and duration of water management issues associated with wet climate years that could potentially be encountered for the combined Approved Project and the proposed Expansion Projects.*
- *Clarify how the proposed mitigation measures would address the type, extent, timing and duration of potential water management issues associated with wet climate years for the combined Approved Project and proposed Expansion Projects.*
- *Update the Water Management Plan to incorporate the information requested above.*

Commitment 7 further expands on ECCC-TC4 and requests that Agnico Eagle:

- *Update 1:10 and 1:100 years wet year scenario with 2000-2018 climate dataset.*
- *Provide the monthly exceedance volumes for the wet-year scenarios using the 2000-2018 dataset for freshet of 2020 (June); and*
- *Evaluate potential WQ exceedances associated with the water quantity exceedances derived from the 2000-2018 dataset, and provide updated WQ predictions for arsenic & phosphorus under this scenario, focusing on the receivers.*

The updates provided in this memorandum are intended to provide insight into how the occurrence of a wet year will affect water management conditions on site and water quality in the receiving environment.

Golder Associates Ltd.
1931 Robertson Road, Ottawa, Ontario, K2H 5B7, Canada T: +1 613 592 9600 F: +1 613 592 9601

Golder and the G logo are trademarks of Golder Associates Corporation

2.0 APPLICATION OF WET YEAR SCENARIOS

2.1 Development of Wet Year Scenarios

Previous versions of the water balance (Golder 2019) considered average monthly precipitation from the Baker Lake A Environment and Climate Change Canada (ECCC) station (ID2300500) from 1950 to 2015 derived by others (SNC 2015).

Wet scenarios were examined in the water balance to assess the sensitivity of a single wet year on water quantity and to further refine water management practices. The wet year scenarios were developed as described below.

A frequency analysis was performed on the annual precipitation records of the Baker Lake A for hydrologic years (October to September) 1950 to 2018. The results are shown in Table 1 for a range of return periods. To address the uncertainty inherent to climate change during the operation period in the absence of detailed site-specific climate change studies, ECCC requested that a more recent, shorter period of record be used for the frequency analyses. In response to ECCC's request, a frequency analysis was performed on the Baker Lake A station record from 2000 to 2018. The results are also shown in Table 1. Using this method, although the average annual precipitation is reduced by 2%, the 10-year total annual precipitation is increased by 2% and the 100-year total annual precipitation is increased by 14% from the former method.

Table 1: Annual Precipitation for a Range of Return Periods at Baker Lake

	Annual Precipitation (mm)	
Return Period	**1950 – 2018 Record**	**2000 – 2018 Record**
Average	248.7 [1]	243.9
10-year – Wet	330.4	335.5
100-year – Wet	397.1	451.9

Note: 1 = Source: SNC 2015

The 10-year and 100-year return periods were selected to develop two wet scenarios, as follows:

- The annual precipitation values derived from the 2000 to 2018 period were distributed on a monthly basis following the average monthly distribution of the Baker Lake A station
- The resulting monthly values were split between rainfall and snow water equivalent (SWE) using the proportions of the existing mean annual scenario (Golder 2019)
- Undercatch factors were applied to the resulting monthly rainfall and SWE values separately, following the methods described in the existing water balance (Golder 2019)

The resulting 10-year and 100-year wet precipitation values are provided in Table 2 and Table 3 for the full and recent Baker Lake datasets, respectively. The average precipitation values of the existing water balance (Golder 2019) are also provided for comparison.

Table 2: Average, 10-Year Wet, and 100-Year Wet Scenarios – Full Baker Lake Record

Month	Average [1, 2]			10-Year – Wet [2]			100-Year – Wet [2]		
	Precip.	Rainfall	SWE	Precip.	Rainfall	SWE	Precip.	Rainfall	SWE
Jan	6.9	0	6.9	9.1	0	9.1	11.0	0	11.0
Feb	6.3	0	6.2	8.3	0	8.3	10.0	0	10.0
Mar	9.1	0	9.1	12.1	0	12.1	14.5	0	14.5
Apr	13.7	0	13.3	17.7	0	17.7	21.2	0	21.2
May	13.3	0	8.1	10.8	0	10.8	12.9	0	12.9
Jun	21.1	33.4	0	44.3	44.3	0	53.3	53.3	0
Jul	38.5	38.5	0	51.2	51.2	0	61.5	61.5	0
Aug	42.7	42.7	0	56.8	56.8	0	68.3	68.3	0
Sep	41.5	41.5	0	55.1	55.1	0	66.2	66.2	0
Oct	28.8	0	22.5	29.8	0	29.8	35.8	0	35.8
Nov	16.8	0	16.6	22.0	0	22.0	26.5	0	26.5
Dec	10	0	10.0	13.2	0	13.2	15.9	0	15.9
Annual	**248.7**	156.1	92.6	**330.4**	207.4	123.0	**397.1**	249.2	147.8

Notes: 1 = from Golder (2019); 2 = Exclusive of undercatch corrections

Table 3: Precipitation Under Average, 10-Year Wet, and 100-Year Wet Scenarios – Recent Baker Lake Record

Month	Average [1]			10-year – Wet [1]			100-year – Wet [1]		
	Precip.	Rainfall	SWE	Precip.	Rainfall	SWE	Precip.	Rainfall	SWE
Jan	6.7	0	6.7	9.3	0	9.3	12.5	0	12.5
Feb	6.1	0	6.1	8.4	0	8.4	11.3	0	11.3
Mar	8.9	0	8.9	12.3	0	12.3	16.6	0	16.6
Apr	13.0	0	13.0	17.9	0	17.9	24.1	0	24.1
May	7.9	0	7.9	10.9	0	10.9	14.7	0	14.7
Jun	32.7	32.7	0	45.0	45.0	0	60.6	60.6	0
Jul	37.8	37.8	0	52.0	52.0	0	70.0	70.0	0
Aug	41.9	41.9	0	57.7	57.7	0	77.7	77.7	0
Sep	40.7	40.7	0	56.0	56.0	0	75.4	75.4	0
Oct	22.0	0	22.0	30.3	0	30.3	40.8	0	40.8
Nov	16.3	0	16.3	22.4	0	22.4	30.1	0	30.1
Dec	9.8	0	9.8	13.4	0	13.4	18.1	0	18.1
Annual	**243.9**	153.1	90.8	**335.5**	210.6	124.9	**451.9**	283.6	168.2

Note: 1 = Exclusive of undercatch corrections

2.2 Update of Water Balance Model

The existing water balance (Golder 2019) was updated as follows:

- An annual precipitation selector was added to allow the user to select the precipitation scenario. The following options were provided:
  1) Average
  2) 10-year wet
  3) 100-year wet
- A virtual storage pond was added to the water management ponds that were found to overflow to track the additional volume of water that must be managed in a wet year, relative to the average scenario.

The model was run under the two wet year scenarios applied to the following simulation periods:

1) October 2019 to September 2020, to assess the 2019/2020 winter. Over this particular winter, excess water from the Whale Tail Attenuation Pond is pumped to GSP-1. This is the peak contact water year for the saline water ponds.
2) October 2024 to September 2025, to assess the 2025 hydrological year. This is the year with the ultimate site footprint, resulting in the maximum water to be managed overall.

2.3 Results

2.3.1 Site Water Balance – Full Record

Under the 2019/2020 and 2025 wet year scenarios using the full Baker Lake record, the peak monthly exceedances are presented in Table 4. The resulting monthly water quantity exceedances beyond the current permitted site capacity are summarized as follows:

- Exceedances are expected to occur in the freshet of 2020 (June) from the Whale Tail Attenuation Pond under 10-year and 100-year wet scenarios.
- There are no additional water quantity exceedances expected during operations.

In June 2020, Quarry 1 will still be available and will have capacity that can be used to handle the potential excess flows, per Agnico Eagle's adaptive management plan.

Table 4: Water Management Exceedances for the Whale Tail Expansion Project under Wet Year Conditions – Full Baker Lake Record

Year	Precipitation Condition of the Hydrological Year	Exceedance (m^3/month)	
		10-year - Wet	100-year - Wet
2019	Average	0	0
2020 (June)	Wet	145,000	232,000
2021	Average	0	0
2022	Average	0	0
2023	Average	0	0
2024	Average	0	0
2025 (June)	Wet	0	0

2.3.2 Site Water Balance – Recent Record

Under the 2019/2020 and 2025 wet year scenarios using the recent Baker Lake record, the peak monthly exceedances are presented in Table 5. The resulting monthly water quantity exceedances beyond the current permitted site capacity are summarized as follows:

- Exceedances are expected to occur in the freshet of 2020 (June) from the Whale Tail Attenuation Pond under 10-year and 100-year wet scenarios.
- There are no additional water quantity exceedances expected during operations under the 10-year wet scenario.
- Under the 100-year wet scenario, exceedances are also expected to occur in the freshet of 2025 (June) from the IVR Attenuation Pond. Overflow from the IVR Attenuation Pond can be directed to the Whale Tail Attenuation Pond as a part of adaptive management; however, even after this diversion, an excess of 17,500 m^3 beyond the capacity of the site remains to be managed.

In June 2020, Quarry 1 will still be available and will have capacity that can be used to handle the potential excess flows, per Agnico Eagle's adaptive management plan. For the potential surplus occurring in 2025, these flows will be taken into consideration for the final design of the water management infrastructure for the Whale Tail Expansion Project.

Table 5: Water Management Exceedances for the Whale Tail Expansion Project under Wet Year Conditions – Recent Baker Lake Record

Year	Precipitation Condition of the Hydrological Year	Exceedance (m^3/month)	
		10-year – Wet	100-year – Wet
2019	Average	0	0
2020 (June)	Wet	161,000	499,000
2021	Average	0	0
2022	Average	0	0
2023	Average	0	0
2024	Average	0	0
2025 (June)	Wet	0	17,500

2.3.2.1 Receiving Environment Water Quality

To assess water quality in the receiving environment, all excess water in the 10-year and 100-year wet year scenarios using the full and recent Baker Lake record was assumed to be stored temporarily on site and discharged in August to either Mammoth Lake (2020) or to Whale Tail Lake (South Basin) (2025). The excess water was assumed to go through the water treatment plant prior to discharge.

Results (Figure 1 to Figure 4) show some variation in water quality in Mammoth Lake and Whale Tail Lake (South Basin) for years that the 10-year and 100-year wet scenarios were applied, as well as variation for the application of the full (solid lines) versus recent (dashed lines) climate data set. In general, trends show an improvement in receiver concentrations of total arsenic and total phosphorus in the wetter years compared to the average year (original) conditions. Although the wet years require more water to be discharged from site at the treatment limit, the simultaneous increase in natural catchment runoff to the downstream lakes provides a

counteraction to this effect. The concentrations also show a similar trend in the scenarios where the recent climate data record is applied, as the recent data record is slightly higher in annual precipitation when compared to the full record. The exception is the average year for both records; the recent climate data record has a lower average annual precipitation than the full climate data record, and the resulting concentrations are slightly higher when it is applied.

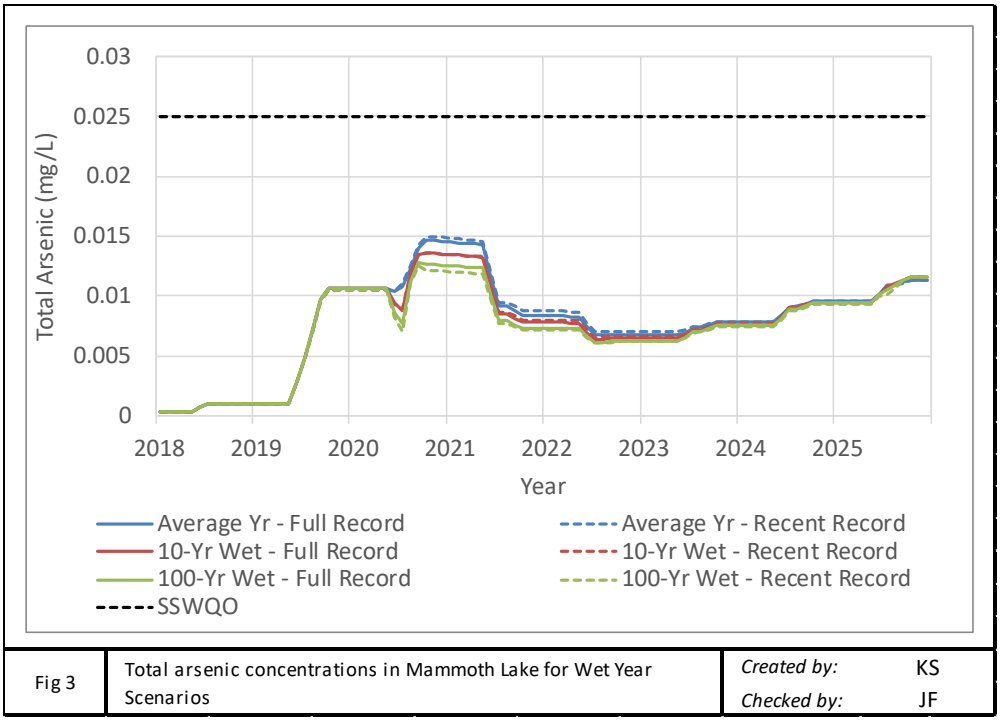


Fig 3	Total arsenic concentrations in Mammoth Lake for Wet Year Scenarios	*Created by:* KS *Checked by:* JF

Note: results do not include cryo-concentration effects.

Figure 1: Total Arsenic Concentrations in Mammoth Lake for Wet Year Scenarios

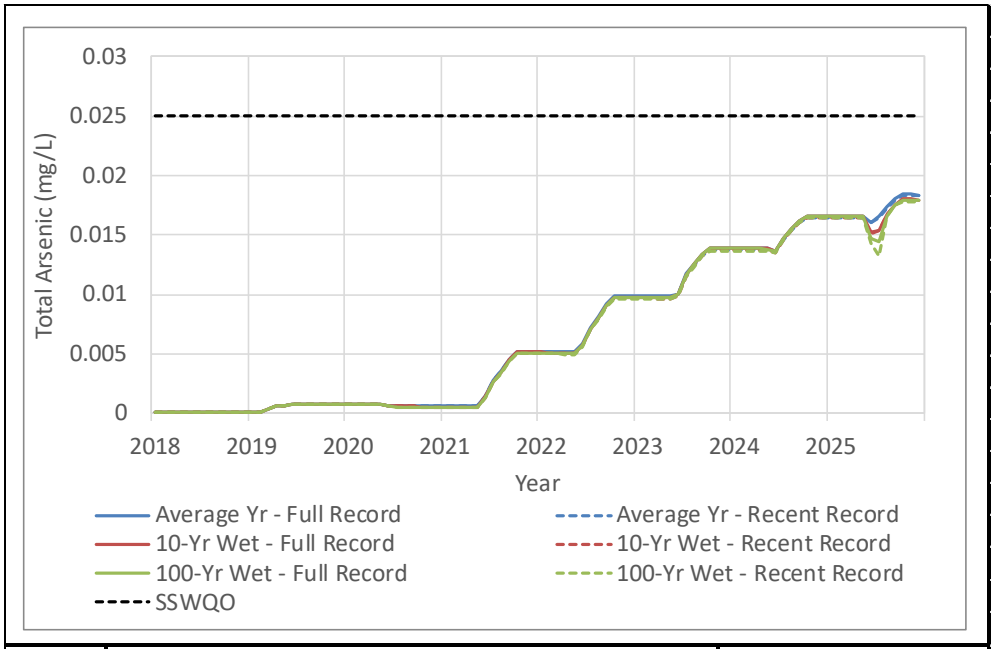


Fig 4	Total arsenic concentrations in Whale Tail Lake (South Basin) for Wet Year Scenarios	*Created by:* KS *Checked by:* JF

Note: results do not include cryo-concentration effects.

Figure 2: Total Arsenic Concentrations in Whale Tail Lake (South Basin) for Wet Year Scenarios

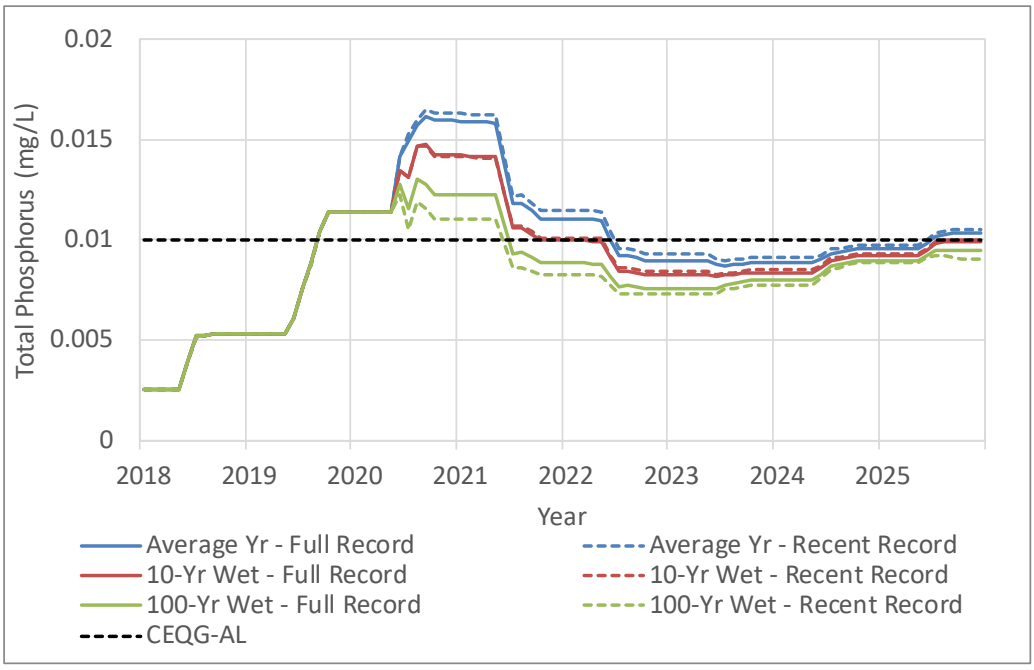


Fig 5	Total phosphorus concentrations in Mammoth Lake for Wet Year Scenarios	*Created by:*	KS
		Checked by:	JF

Note: results do not include cryo-concentration effects.

Figure 3: Total Phosphorus Concentrations in Mammoth Lake for Wet Year Scenarios

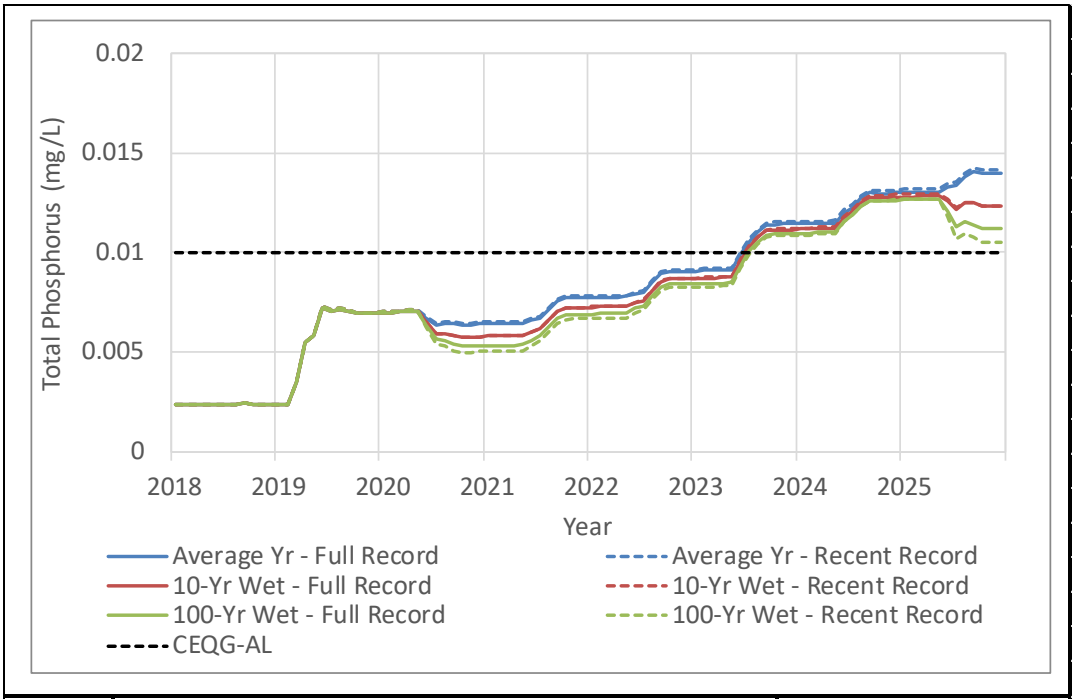


Fig 6	Total phosphorus concentrations in Whale Tail Lake (South Basin) for Wet Year Scenarios	*Created by:*	KS
		Checked by:	JF

Note: results do not include cryo-concentration effects.

Figure 4: Total Phosphorus Concentrations in Whale Tail Lake (South Basin) for Wet Year Scenarios

3.0 CLOSURE

This technical memorandum was prepared and reviewed by the undersigned.

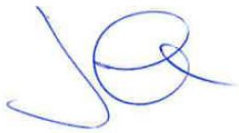
Prepared By:

Kristina Skeries
Environmental Specialist, MSc

Adwoa Cobbina, MASc
Water Resources Engineer

Reviewed By:

John Faithful, BSc (Hons)
Principal, Senior Water Quality Specialist



Julien Lacrampe, P.Eng. (NWT/NU)
Senior Water Resources Engineer

KS/AC/JF/JL/jr
https://golderassociates.sharepoint.com/sites/113014/project files/5 technical work/stage-1_irs/03_model_updates/rev0/19127573-380-tm-wetyear-rev0.docx

REFERENCES

Agnico Eagle (Agnico Eagle Mines Limited). 2019. 2AM-WTP1826 Technical Comment Responses, Whale Tail Pit – Expansion Project. Submitted to the Nunavut Water Board 7 October 2019.

Golder (Golder Associates Ltd.). 2019. Whale Tail Pit – Expansion Project. 2019 Mean Annual Water Balance Update. 18108905-294-RPT-Rev1. May 2019.

SNC (SNC Lavalin Inc.). 2015. Whale Tail Pit Project. Permitting Level Engineering. Geotechnical and Water Management Infrastructure. 11 December 2015.