



20 December 2018

Sahtu Land and Board File Numbers: S17L8-003 & S17X-004

Ms. Bonnie Bergsma
Sahtu Land and Water Board
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RE: Memorandum RE: Discharge of Sump Water into the Environment

Dear Ms. Bergsma:

BluMetric Environmental Inc. (BluMetric™) has been retained by Public Services and Procurement Canada (PSPC) to manage the assessment and characterization of soil and water quality for the Norman Wells Airside Land Treatment Unit (LTU). During this work, the concentrations of aluminum, iron, arsenic and manganese in the sump water from the Norman Wells Airside LTU, located on the Norman Wells Airport lands were measured above Transport Canada's (TC) Sahtu Land and Water Board Type B Water Licence S17L8-003 discharge criteria. This water was pumped into a tank for storage while next steps for this water were determined. BluMetric believes that these elevated parameters are likely natural and not related to the LTU, which contains soil contaminated with petroleum hydrocarbons (PHCs).

The following memo assesses background surface water concentrations, background groundwater concentrations, and the basis of the water licence criteria to evaluate if the discharge of sump water into the environment will result in undue risk to human health and aquatic receptors. Revised criteria to support the discharge of sump water in the environment are presented in consideration of a site-specific exposure scenario, where sump water is discharged to the ground. This memo has been prepared by BluMetric on behalf of TC.

SUMP WATER ANALYTICAL RESULTS

A surface water grab sample was collected from the sump on September 27, 2018 and again on October 9, 2018. The surface water sample was analyzed for general chemistry, metals, PHCs, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and per- and polyfluoroalkyl substances (PFAS).

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The surface water analytical results do not report any exceedances of the water licence criteria, with the exception of total aluminum, total iron, total arsenic, and total and dissolved manganese. The analytical results for the exceeding parameters, along with the water licence criteria, are presented in Table 1.

Table 1: Analytical Results for Aluminum, Iron, Arsenic, and Manganese in Sump Water*

Sample ID	MDL	Water License Criteria	SUMP1	SUMP Recheck2	SUMP Recheck1	SUMP
Date Sampled			9-Oct-2018	26-Sep-2018	26-Sep-2018	26-Sep-2018
Aluminum -Total	0.003	0.1	0.291000	0.840000	0.840000	0.678000
Aluminum -Dissolved	0.001	0.1				0.001900
Arsenic -Total	0.0001	0.005	0.005120			0.004310
Iron -Total	0.01	0.3	0.811000	2.480000	2.460000	2.170000
Iron -Dissolved	0.01	0.3				0.029000
Manganese -Total	0.0001	0.05	0.452000	1.160000	1.180000	1.040000
Manganese -Dissolved	0.0001	0.05				0.954000

Notes:

- All units are in mg/L
- Water licence criteria from Type B Water Licence S17L8-003 & Type A Land Use Permit S17X-004
- **Red** indicates concentration exceeds criteria
- *only parameters exceeding the water license criteria are presented in the table

BACKGROUND WATER QUALITY

The elevated concentrations of aluminum, iron, arsenic and manganese are likely the result of the local geological conditions, rather than the anthropogenic activities occurring at the LTU. If the LTU was contributing to these concentrations, then elevated levels of petroleum related compounds that are known to be present at the LTU would be expected.

Background Surface Water Quality

Long-term monitoring programs have measured water quality parameters within the Mackenzie River at Norman Wells since the 1960s. A recent study evaluated the water quality of the area with respect to metals and physical variables¹. The 90th percentile concentration of aluminum, iron and manganese were above CCME guidelines for the protection of drinking water and/or aquatic life. The study suggested that high suspended sediment loads were contributing to increased total (mostly particulate) trace metals.

¹ Lumb et al., 2006. Application of CCME Water Quality Index to Monitor Water Quality: A Case of the Mackenzie River Basin, Canada. Environmental Monitoring and Assessment. 113:411-429

The sump water concentrations were compared to surface water concentrations that have been measured within the Mackenzie River in Norman Wells from the years 2000 to 2018. The background data set was obtained from the Government of Canada². The results are presented in Table 2.

Table 2: Aluminum, Iron, Arsenic, and Manganese Concentrations in Sump Water Compared to the MacKenzie River in Norman Wells.

	Water Licence Criteria	Background Surface Water (MacKenzie River)		Sump Water	
		Average	95 th Percentile	Min	Max
Aluminum	0.1	1.1124	3.5690	0.2910	0.8400
Arsenic	0.005	0.0011	0.0030	0.0043	0.0051
Iron	0.3	2.6153	9.5420	0.8110	2.4800
Manganese	0.05	0.0622	0.2160	0.4520	1.1800

Notes:

- All units are in mg/L; total metal concentrations are presented.
- Water licence criteria from Type B Water Licence S17L8-003 & Type A Land Use Permit S17X-004
- The background data set was obtained from the Government of Canada² and represents surface water data from the Mackenzie River in Norman Wells collected between the years 2000 and 2018.
- **Red** indicates concentration exceeds criteria
- **Shaded** indicates sump concentration exceeds 95th percentile background concentration)

Similar to the sump water results, the concentrations of aluminum, iron and manganese from the Mackenzie River in Norman Wells are above the water licence criteria. The sump water concentrations for aluminum and iron are below the background concentrations in the Mackenzie River, whereas the sump water concentrations for arsenic and manganese were above.

Overall, the background water quality data from the Mackenzie River show that concentrations of aluminum, iron and manganese in the area are naturally elevated above the water licence criteria as a result of high suspended sediments.

Background Groundwater Quality

BluMetric has monitored groundwater concentrations upgradient and downgradient from the LTU to assess the impact of the LTU on groundwater quality. The results are presented in Table 3.

² Government of Canada, 2018. Lower MacKenzie River Basin Long-term Water Quality Monitoring Data – Canada’s North. Accessed online at: <https://open.canada.ca/data/en/dataset/0177c195-13a8-4078-aa85-80b17e9e2cfe> [accessed in December 2018]

Table 3: Analytical Results for Aluminum, Iron, Arsenic, and Manganese in Groundwater Upgradient (at MW1) and Downgradient (at MW2 and MW3) of the LTU

Sample ID	Water License Criteria	MW1	MW2	MW3	DUP (MW3)	MW2	MW3	DUP (MW3)
Date Sampled		28/06/2018				23/09/2018*		
Aluminum	0.1	0.358	0.0444	0.278	0.276	0.0458	0.0459	0.0563
Arsenic	0.005	0.0028	0.00042	0.00149	0.00149	0.00151	0.0015	0.00104
Iron	0.3	0.383	0.079	0.537	0.525	0.160	0.159	0.261
Manganese	0.05	0.865	0.112	0.123	0.125	0.202	0.206	0.296

Notes:

- All units are in mg/L; total metal concentrations are presented.
- Water licence criteria from Type B Water Licence S17L8-003 & Type A Land Use Permit S17X-004
- **Red** indicates concentration exceeds criteria
- *MW1 was not sampled in September 2018 as the well was dry

The groundwater results in June 2018 show that aluminum, iron and manganese were elevated above the water licence criteria both upgradient (MW1) and downgradient (MW2 and MW3) from the LTU. Further, the aluminum, arsenic and manganese concentrations in the upgradient well (MW1) were higher than the concentrations measured in the downgradient wells (MW2 and MW3). No groundwater results are available for the upgradient well in September 2018 as the well was dry at the time of sampling.

Overall, the groundwater results show that concentrations of aluminum, iron and manganese in the area are above the water licence criteria both upgradient and downgradient of the LTU. Similar to the background surface water quality data in the Mackenzie River, the groundwater results support that these metals are naturally elevated in the area.

BASIS FOR CURRENT WATER LICENCE CRITERIA

The water licence criteria for the LTU are adopted from either the Health Canada *Canadian Drinking Water Quality Guidelines* (HC CDWQG) or the CCME *Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life* (CCME CWQG), as summarized in Table 4.

Table 4: Basis for Aluminum, Iron, Arsenic, and Manganese Water Licence Criteria

Parameter	Water License Criteria	HC CDWQG	CCME CWQG	Notes:
Aluminum	0.1	<0.1	0.1	HC CDWQG based on an OG that applies to treatment plants using Al-based coagulants. No MAC provided. CCME CWQG based on a pH ≥ 6.5 (as has been measured in sump water)
Arsenic	0.005	0.010	0.005	HC CDWQG based on MAC.
Iron	0.3	≤ 0.3	0.3	HC CDWQG based on AO related to taste and staining of laundry and plumbing fixtures. No MAC available as no evidence exists of dietary iron toxicity in the general population.
Manganese	0.05	≤ 0.05	No Value	HC CDWQG based on AO related to taste and staining of laundry and plumbing fixtures. No MAC available as it

Notes:

- All units are in mg/L
- Water licence criteria from Type B Water Licence S17L8-003 & Type A Land Use Permit S17X-004
- **Red** indicates the guideline adopted for the water licence criteria
- OG = operational guideline
- AO = aesthetic objective
- MAC = maximum acceptable concentration for the protection of human health from drinking water

Basis and Applicability of Water Licence Criteria for Aluminum

The water licence criterion for aluminum is based on both the HC CDWQG and the CCME CWQG (as they have equal values). The HC CDWQ for aluminum is derived from an operational guideline that applies to water treatment plants using Al-based coagulants. Waste water treatment operations will not be applicable to sump water discharged into the environment. HC does not provide water guidelines for the protection of human health as aluminum is considered innocuous. As a result, the aluminum criteria for the sump water should be based on the protection of aquatic life.

Basis and Applicability of Water Licence Criteria for Arsenic

The water licence criterion for arsenic is based on the CCME CWQG. HC CDWQGs based on the protection of human health have been developed for arsenic; however, the maximum concentration of arsenic measured in sump water (0.00521 mg/L) did not exceed the health based guideline. As a result, the arsenic criterion for the sump water should be based on the protection of aquatic life.

Basis and Applicability of Water Licence Criteria for Iron

The water licence criterion for iron is based on both the HC CDWQG and the CCME CWQG (as they have equal values). The HC CDWQ for iron is derived from an aesthetic objective related to taste and staining of laundry and plumbing fixtures. These aesthetic concerns will not be applicable to sump water discharged into the environment.

HC does not provide water guidelines for the protection of human health as there is no evidence of dietary iron toxicity in the general population. As a result, the iron criterion for the sump water should be based on the protection of aquatic life.

Basis and Applicability of Water Licence Criteria for Manganese

The water licence criterion for manganese is based on both the HC CDWQG. The HC CDWQ for manganese is derived from an aesthetic objective related to taste and staining of laundry and plumbing fixtures. These aesthetic concerns will not be applicable to sump water discharged into the environment. HC does not provide water guidelines for the protection of human health as manganese is considered to be naturally occurring from erosion and weathering of rocks and minerals. Similarly, CCME does not provide guidelines for the protection of aquatic life for manganese. As a result, the elevated manganese concentrations in sump water that would be discharged into the environment is not considered an area of environmental concern.

RECOMMENDED CRITERIA FOR THE DISCHARGE OF SUMP WATER INTO THE ENVIRONMENT

It is BluMetric's understanding that TC wishes to discharge the collected sump water directly to the ground using a low flow technique to minimize potential for erosion as has been done in the past. If the sump water is to be discharged into the environment in this matter, then the criteria for aluminum, arsenic and iron should be based on the following:

1. Criteria that protects freshwater aquatic life rather than human health. As discussed above, there are no human health based guidelines for aluminum and iron as they are generally innocuous. Although arsenic has drinking water quality guidelines protective of human health, the maximum concentration of arsenic measured in sump water does not exceed this value. This leaves the potential exposure of sump water to aquatic receptors as the only remaining concern.
2. Criteria based on groundwater quality rather than surface water quality. The intent is for the sump water to be discharged onto the ground and not directly into a surface water body. In this situation, the attenuation of metals, with respect to sorption-desorption and dispersion, will occur as they are transported through the aquifer. If aquatic receptors are exposed to any metals attributed to the sump water, the concentrations will be much lower than what was originally measured in the sump water. Groundwater quality criteria are more applicable as it can account for these factors.

As discussed in the section above, there is no human health or environmental based guidelines available for manganese as it naturally occurring from erosion and weathering of rocks and minerals. No further criteria need to be developed for manganese to support the discharge of sump water into the environment.

There are currently no CCME Canadian Environmental Quality Guidelines (CEQG) for groundwater. The Federal Interim Groundwater Quality Guidelines (FIGQGs) are intended to be used as an interim measure until CEQG for groundwater are available³. The FIGQGs were developed based on a critical review and evaluation of existing approaches used by other jurisdictions in Canada. The FIGQGs for the protection of aquatic life were derived based on adoption of the CCME CWQGs.

For inorganic substances, the CCME CWQGs are applied directly to groundwater as an initial screening (or Tier 1) level of assessment, without accounting for any attenuation due to the lateral separation distance between the point of measurement and the surface water body. If concentrations exceed the FIGQGs for the protection of aquatic life, then Tier 2 guidelines can be developed to account for lateral separation distances using the adjustment factors provided in Section B.3 of the FIGQG guidance document³. The Tier 2 guidelines are derived by multiplying the Tier 1 FIGQG for the protection of aquatic life (represented by the CCME CWQGs for metals) by adjustment factors, identified in the table below, corresponding to the distance to the nearest surface water body. The FIGQGs for aluminum, arsenic, iron and manganese adjusted for various distances to surface water bodies is presented in Table 5.

³ Federal Contaminated Sites Action Plan (FCSAP), 2016. Guidance Document on Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites (Version 4), June 2016.

Table 5: Adjusted FIGQGs for the Protection of Freshwater Aquatic Life Based on Various Lateral Separation Distances to Surface Water

	Maximum Sump Water Concentration	FIGQG for the Protection of Freshwater Aquatic Life						
		<50 m (no AF)	50 -74 m (1.9x AF)	75 -99 m (2.75x AF)	100 -149 m (3.6x AF)	150 -199 m (5.4x AF)	200 -249 m (7.1x AF)	300 -349 m (8.9x AF)
Total Concentrations								
Al	0.8400	0.1	0.19	0.275	0.36	0.54	0.71	0.89
As	0.0051	0.005	0.0095	0.01375	0.018	0.027	0.0355	0.0445
Fe	2.4800	0.3	0.57	0.825	1.08	1.62	2.13	2.67
Dissolved Concentrations*								
Al	0.0019	0.1	0.19	0.275	0.36	0.54	0.71	0.89
Fe	0.0290	0.3	0.57	0.825	1.08	1.62	2.13	2.67

Notes:

- All values in mg/L
- AF – adjustment factor based on lateral separation distance between the point of measurement and the surface water body
- **Red** indicates maximum sump water concentration exceeds guideline
- *Dissolved concentrations of arsenic were not measured.
- Manganese is not presented in the table as no guideline is available

The discharge area proposed for the sump water is located 340 m from the Mackenzie River, the closest downgradient aquatic environment. The maximum sump water concentration of total aluminum, total arsenic and total iron are below the FIGQGs for the protection of aquatic life adjusted for this distance. A comparison of total metal concentrations measured in the sump water to the adjusted FIGQGs is a highly conservative assessment. Groundwater guidelines, including the FIGQGs, are usually applied to dissolved metals concentrations³ as it is the dissolved concentrations that would be subject to groundwater transport. Therefore, once the sump water is discharged into the ground it is expected that only the dissolved phase would have the potential to reach downgradient water bodies. All of the dissolved concentrations measured in the sump water do not exceed the unadjusted guidelines applicable to separation distances <50 m.

Any ponds, streams or drainage ditches located closer than the Mackenzie River are expected to be ephemeral or freeze completely during the winter months; therefore, they are not expected to support an aquatic environment that may be of concern. As discussed above, there likely is no concern for the discharge of sump water into the ground, regardless of distances to water bodies, when you consider dissolved concentrations.

Overall, the discharge of the sump water to the ground is unlikely to result in undue risk given that the measured concentrations do not exceed drinking water guidelines protective of human health or groundwater quality guidelines protective of downgradient aquatic receptors.

CONCLUSIONS

It is the objective of Transport Canada (TC) to discharge the sump water collected from the Norman Wells Airside LTU into the environment. Concentrations of aluminum, iron, arsenic and manganese in the sump water have recently been measured above TC's Sahtu Land and Water Board Type B Water Licence S17L8-003; however, these elevated parameters are likely natural and their discharge into the environment is not expected to result in undue risk to human health or ecological receptors.

Background water quality data in the Mackenzie River and groundwater results around the LTU were evaluated and the results support that the elevated metal concentrations measured in the sump are likely due to the local geology rather than the activities occurring at the LTU.

The applicability of the water licence criteria was also evaluated in consideration of the site-specific exposure scenario where sump water is discharged directly to the ground adjacent to the LTU. Revised criteria were recommended based on the Health Canada Canadian Drinking Water Quality Guidelines (HC CDWQGs) for the protection of human health and the Federal Interim Groundwater Quality Guidelines (FIGQGs) for the protection of aquatic life.

The discharge of sump water onto the ground, rather than into a surface water body, will result in a decrease in metal concentrations as the sump water is transported through the aquifer. The FIGQGs for the protection of aquatic life can account for this as they provide guidelines adjusted for the distance between the point of measurement (e.g., the sump discharge location) and the nearest aquatic environment. The discharge area proposed for the sump water is located 340 m from the Mackenzie River, the closest downgradient aquatic environment. It is also important to note that the FIGQGs are meant to be applied to dissolved metal concentrations, as it is the dissolved concentrations that would be subject to groundwater transport. The CCME Canadian Water Quality Guidelines (CWQGs) for the protection of aquatic life, used to develop the water licence criteria, do not account for these factors.

The evaluation of the water licence criteria and the recommended revised criteria support that the discharge of the sump water onto the ground would not be considered an area of environmental concern, as discussed for each parameter below:

Aluminum

The water licence criterion for aluminum is based on the HC CDWQG to preserve wastewater treatment operations and the CCME CWQG. HC CDWQGs for the protection of human health are not provided as aluminum is considered innocuous. As a result, the aluminum criterion for the sump water should be based on the FIGQGs to protect downgradient aquatic receptors.

The total aluminum concentrations in sump water do not exceed the FIGQGs adjusted for a separation distance greater than 300 m between the discharge point and the downgradient receiving environment. The dissolved concentrations do not exceed the unadjusted FIGQGs applicable to separation distances less than 50 m. The aluminum concentrations in the sump water are therefore considered acceptable if discharged to the ground.

Arsenic

The water licence criterion for arsenic is based on the CCME CWQG. A HC CDWQG for arsenic that protects human health is available; however, the maximum concentration of arsenic measured in sump water did not exceed this value. As a result, the arsenic criterion for the sump water should be based on the FIGQGs to protect downgradient aquatic receptors. The total arsenic concentrations in sump water do not exceed the FIGQGs adjusted for a separation distance greater than 50 m between the discharge point and the downgradient receiving environment. The arsenic concentrations in the sump water are therefore considered acceptable if discharged to the ground.

Iron

The water licence criterion for iron is based on the HC CDWQG related to taste and staining of laundry and plumbing fixtures and the CCME CWQGs. HC CDWQGs for the protection of human health are not provided as there is no evidence of dietary iron toxicity in the general population. As a result, the iron criterion for the sump water should be based on the FIGQGs to protect downgradient aquatic receptors. The total iron concentrations in sump water do not exceed the FIGQGs adjusted for a separation distance greater than 300 m between the discharge point and downgradient receiving environment. The dissolved concentrations do not exceed the unadjusted FIGQGs applicable to separation distances <50 m. The iron concentrations in the sump water are therefore considered acceptable if discharged to the ground.

Manganese

The water licence criteria for manganese is based on the HC CDWQG related to taste and staining of laundry and plumbing fixtures. HC CDWQGs for the protection of human health are not provided as manganese is considered to be naturally occurring from erosion and weathering of rocks and minerals. Similarly, there are no water quality guidelines for the protection of aquatic life for manganese. The manganese concentrations in the sump water are therefore considered acceptable regardless of how it is discharged.

RECOMMENDATIONS

The discharge of the sump water to the ground is unlikely to result in undue risk given that the measured concentrations do not exceed drinking water guidelines protective of human health or groundwater quality guidelines protective of downgradient aquatic receptors. Therefore, it is recommended that the sump water is discharged into a seep pit during thawed ground conditions.

BluMetric welcomes any questions regarding the rationale presented in this memo and formally requests permission to proceed with the discharge of the tanked water in Spring 2019 once the ground is no longer frozen.

CLOSURE

The information presented within this memo has been prepared for Public Services and Procurement Canada and Transport Canada. Any use a third party makes of this report, any reliance on the report, or decisions based upon the report, are the responsibility of those third parties unless authorization is received from BluMetric Environmental Inc. in writing. BluMetric Environmental Inc. accepts no responsibility for any loss or damages suffered by any unauthorized third party as a result of decisions made or actions taken based on this report.

If you have any questions please do not hesitate to contact the undersigned.

Respectfully submitted,
BluMetric Environmental Inc.



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