



**ANNUAL WATER LICENCE REPORT 2019
NORMAN WELLS AIRPORT AIRSIDE
FORMER HYDROCARBON SOILS TREATMENT FACILITY
WATER LICENCE S17L8-003**

Submitted to:



Sahtu Land and Water Board

Box 1

Fort Good Hope, NT XOE OHO

Prepared by:

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Project Number: 190564

January 2020

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TABLE OF CONTENTS

1.	INTRODUCTION.....	1
2.	REPORTING REQUIREMENTS.....	1
2.1	UPDATES OR REVISIONS TO APPROVED PLANS	1
3.	2019 SUMMARY	2
3.1	WINTER 2019.....	2
3.1.1	2019 Drilling /Monitoring Well Installation/Sampling	2
3.1.2	Soil Disposal.....	3
3.2	SUMMER 2019	3
3.2.1	Water Management	3
3.2.2	Spreading of Treated Soil	4
3.2.3	Groundwater Sampling	4
3.3	FALL 2019	5
3.3.1	Groundwater Sampling	5
4.	GROUNDWATER FLOW.....	5
5.	SURVEILLANCE NETWORK PROGRAM REPORT	5
5.1	RESULTS	6
5.2	QA/QC PROCEDURES.....	9
5.3	GROUNDWATER QUALITY TRENDS 2017-2019	10
5.4	WATER QUALITY MANAGEMENT PROGRAM- DETAILS AND RESULTS	12
5.5	OTHER ITEMS.....	13
6.	SAMPLING AND ANALYSIS PLAN 2020	13
7.	CLOSURE.....	14
8.	REFERENCES.....	16



LIST OF TABLES

Table 1:	Summary of Updates and Revisions to Approved Plans	1
Table 2:	Summary of QA/QC Sampling	6
Table 3:	Monthly and Annual Quantities of Effluent Discharged From HSTF in 2019	7
Table 4:	Summary of SNP QA/QC Program	9
Table 5:	Summary of Water Quality Management Program Reporting Action Levels	13

LIST OF FIGURES

Figure 1:	S17L8-003 SNP Station Locations
Figure 2:	Groundwater Flow

LIST OF APPENDICES

Appendix A:	Water and Soil Chemistry Results 2019
Appendix B:	Site Photos 2019
Appendix C:	Figures
Appendix D:	Correspondence
Appendix E:	Borehole Log



1. INTRODUCTION

BluMetric Environmental Inc. (BluMetric™) was retained by Public Services and Procurement Canada (PSPC) on behalf of Transport Canada (TC) to prepare this Annual Water Licence Report for the operations of the Airside former Hydrocarbon Soils Treatment Facility (HSTF) within the former HSTF on the Norman Wells Airport property, in Norman Wells, Northwest Territories. This report is a requirement of the Type B Water Licence S17L8-003 obtained from the Sahtu Land and Water Board (SLWB) on December 5, 2017. The Water Licence S17L8-003 expires December 4, 2022. This report includes all work performed in relation to this project for the calendar year 2019.

BluMetric has supported the maintenance and sampling work that occurred at the facility in 2019 and provided contractor supervision for local contractor HRN Contracting who provides heavy equipment and operators to conduct work at the site. The work at the HSTF was completed on behalf of Transport Canada, the permittee and licensee.

2. REPORTING REQUIREMENTS

2.1 UPDATES OR REVISIONS TO APPROVED PLANS

Table 1 below outlines the plans submitted to and approved by the SLWB in 2019.

Table 1: Summary of Updates and Revisions to Approved Plans

Report	Date Submitted	Date Approved
Final Closure and Reclamation Plan v1.0	March 26, 2019	April 1, 2019

With the exception of the Closure and Reclamation Plan, no revisions or updates were made to the submitted plans past their approval dates. A final Closure and Reclamation Plan was submitted to the SLWB in March 2019. All the documents referred to above have been posted on the Sahtu Land and Water Board public registry.



3. 2019 SUMMARY

The following activities were undertaken in 2019 in accordance with the Water Licence:

3.1 WINTER 2019

3.1.1 2019 Drilling /Monitoring Well Installation/Sampling

On January 30, 2019 a deeper well (MW1-D) was drilled directly adjacent to MW1 to ensure that the water table would be screened during both wet and dry conditions so that the upgradient water quality was fully characterized during the annual groundwater monitoring activities.

HSTF activities including drilling and groundwater monitoring are currently governed under the following regulatory licences:

- Sahtu Land and Water Board (SLWB) Type B Water Licence S17L8-003; and
- Sahtu Land and Water Board Type A Land Use Permit (LUP) S17X-004.

Both the SLWB and the Government of the Northwest Territories (GNWT) lands inspector were informed of the planned site activities one week prior to commencement.

Drilling activities were undertaken in accordance with the SLWB Water Licence S17L8-003 and LUP S17X-004. The new monitoring well (labelled MW1-D) was constructed and installed by Clean Harbors/Gully Enterprises personnel under the direction of BluMetric on January 30, 2019. A Marl M 4CT tracked auger drill rig was used for the installation. Soil cuttings generated during the drilling activities were contained onsite for characterization sampling.

MW1-D was constructed using new 50 mm inside diameter flush threaded schedule 40 PVC pipe, and 10-slot well screen and was installed to a depth of 8.23 meters below ground surface (mbgs). MW1-D was completed as a stick-up and protected with a 4" steel casing. MW1-D was installed approximately 3 meters to the east of MW1. A borehole log for this well installation is included in Appendix E.

One characterization soil sample was collected during drilling for soil disposal purposes. The soil sample was submitted to ALS laboratories for analysis of the parameters outlined in the Treated Soil Criteria section of SLWB Water Licence S17L8-003. These parameters include metals, benzene, ethylbenzene, toluene and xylene (collectively known as BTEX), petroleum hydrocarbon fractions 1 through 4 (PHC F1-F4), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), phenols, total organic carbon (TOC) and per and



polyfluoroalkyl substances (PFAS). The soil sample was packed in a cooler with ice to keep it at approximately 4°C, pending shipment to ALS laboratories. Analytical results for these samples are provided in Table 9.

One groundwater sample was collected from MW1- D and submitted to ALS for laboratory analysis of the parameters outline in SLWB Water Licence S17L8-003. These parameters include total metals, BTEX, PHC F1-F4, extractable petroleum hydrocarbons (EPH), chemical oxygen demand (COD), total suspended solids (TSS) and pH.

3.1.2 Soil Disposal

Disposal of soil found to be above GNWT guidelines commenced on March 11 and was conducted by KBL Environmental Inc. who were responsible for loading soil bags approved for disposal for transport via the winter road. A total of 187 megabags of soil and two (2) roll-off bins containing the HSTF liner were mobilized for disposal in Alberta prior to the closure of the winter road in March 2019. The remaining 17 megabags were moved by KBL Environmental to their facility in Norman Wells for storage and eventual shipment by barge for disposal.

On March 16, 2019, BluMetric personnel performed a quality assurance/quality control (QA/QC) site inspection of the soil disposal activities at the site. Site activities observed during the inspection included the loading of soil bags onto trucks for demobilization via the winter road. Photos taken during the site inspection are presented in Appendix B (following the text).

The retention pond soil that had been removed during the sub-liner assessment in October 2018 was approved for use as re-grading material in March 2019 and was returned to the HSTF area as part of the soil shipping activities.

Pertinent approval correspondence received in 2019 has been included in Appendix D.

3.2 SUMMER 2019

3.2.1 Water Management

Following the retention pond discharge in early September, 2018, additional water that had accumulated in the retention pond was sampled on September 26 and October 9, 2018. Concentrations of aluminum, arsenic, iron and manganese were above the discharge requirements as outlined in the SLWB Water Licence S17L8-003. As a result of the elevated parameter concentrations, permission to discharge was not granted and the water was pumped into a holding tank awaiting disposal confirmation. Following discussions with the ENR and



SLWB, permission to discharge the stored retention pond water was granted by the ENR on March 12, 2019. Correspondence regarding this water discharge can be found in Appendix D.

Retention pond water contained in the off-site storage tanks was transported via vacuum truck to the discharge pad and discharge began on August 8, 2019. Discharge was overseen by BluMetric personnel. In order to minimize erosion and prevent ponding of water, a low discharge flow was set on the vacuum truck and the discharge pad was modified to reduce the velocity of discharge and minimize the potential for erosion. Due to the low flow rate discharge concluded on August 10, 2019. In total 50m³ of water was discharged.

The approximate GPS coordinates of the Discharge Pad are:

- 65.275564 N, -126.777233 W

3.2.2 Spreading of Treated Soil

On August 7, 2019, 49 megabags of treated soil which were approved for use on the site by the SLWB in 2018 were returned to the bermed area. This soil was evenly spread along the eastern fence of the former HSTF and roughly graded. This work was performed by HRN Contracting Ltd. and supervised by BluMetric personnel. Further grading work will be required in 2020 to complete the reclamation of the site.

3.2.3 Groundwater Sampling

All 4 monitoring wells were purged and sampled using low-flow sampling techniques between August 8 and 9, 2019. One duplicate sample (MW-DUP) was collected from monitoring well MW2. All samples collected were submitted for laboratory analysis for PHCs F1-F4, BTEX, metals, extractable petroleum hydrocarbons (EPH), perfluorooctane sulfonate (PFOS), chemical oxygen demand (COD), total suspended solids (TSS), and pH as listed in the SLWB Water Licence. Groundwater water quality parameters including turbidity, pH, conductivity, temperature, oxygen reduction potential (ORP), and dissolved oxygen were monitored during sampling (in situ) using a Horiba multi-parameter water quality instrument connected to a flow-through cell.

Samples were stored at a temperature less than 4°C in a cooler during shipment to the laboratory (ALS Laboratories) for chemical analyses. Hold times for samples conformed to the CCME Standards (CCME, 1993). Groundwater sampling is further discussed in Section 5.0.

Photos of the field activities have been provided in Appendix B. Laboratory results from the Summer 2019 sampling can be found in Tables 6A to 6D in appendix A.



3.3 FALL 2019

3.3.1 Groundwater Sampling

All 4 monitoring wells were purged and sampled using low-flow sampling techniques between October 12 and October 13, 2019. One duplicate sample (MW-DUP) was collected from monitoring well MW1-D. All samples collected were submitted for laboratory analysis for PHCs F1-F4, BTEX, metals, extractable petroleum hydrocarbons (EPH), perfluorooctane sulfonate (PFOS), chemical oxygen demand (COD), total suspended solids (TSS), and pH as listed in the SLWB Water Licence. Groundwater water quality parameters including turbidity, pH, conductivity, temperature, oxygen reduction potential (ORP), and dissolved oxygen were monitored during sampling (in situ) using a YSI 556 multi-parameter water quality instrument connected to a flow-through cell.

Samples were stored at a temperature less than 4°C in a cooler during shipment to the laboratory (ALS Laboratories) for chemical analyses. Hold times for samples conformed to the CCME Standards (CCME, 1993). Groundwater sampling is further discussed in Section 5.0.

Photos of the field activities have been provided in Appendix B. Laboratory results from the Fall 2019 sampling can be found in Tables 7A to 7D in appendix A.

4. GROUNDWATER FLOW

Groundwater flow was calculated using water levels collected in the Fall 2019 monitoring event. Groundwater flow was found to be to the southeast towards the Mackenzie River. Previous reports have inferred the background well was MW1. The calculated flow indicates that this is still this case and data collected from this well should be considered indicative of background conditions for the former HSTF.

A detailed illustration of groundwater flow at the former HSTF can be found in Figures 02.

5. SURVEILLANCE NETWORK PROGRAM REPORT

The Surveillance Network Program (SNP) corresponding to SLWB Water Licence S17L8-003 is comprised of four stations. The description, sampling frequency and location of each SNP station has been provided in **Table 2** below. It should be noted that In order to assess the effects of HSTF operations on groundwater quality, groundwater data from MW1 needed be examined in



contrast to data from MW2 and MW3. As MW1 was the only upgradient well at the HSTF, it is crucial to obtain data from this monitor for comparison purposes.

As a result, a decision was made to drill a new deeper well directly adjacent to MW1 to ensure that the water table would be screened during both wet and dry conditions and to ensure successful sample collection. This well was named MW1-D and was added to **Table 2** below (2019-1a). Another important point to note was the decommissioning of SNP Station 2017-1, which was removed during the decommissioning work at the HSTF in the fall of 2018. As such data will no longer be collected from this location.

Table 2: Summary of QA/QC Sampling

SNP Station ID	Description	Approximate Location	Sampling Frequency	Sampling Parameters
Decommissioned 2017-1	Monitors retention water in HSTF prior to discharge	N: 7240979.111 E: 603701.087	As required prior to discharge	pH, Metals, BTEX, PHC F1-F2, PAHs, Phenol, PCBs, PFAS, Ammonia, Nutrients
2017-2a	MW1- monitoring well located at the NW corner outside perimeter of the HSTF	N: 7241089. 144 E: 603706.630	Following spring freshet and prior to freeze-up	Field Parameters, Total Metals, BTEX, PHC F1-F4, EPH, COD, TSS, PFAS, pH
2017-2b	MW2- monitoring well located at the NW edge outside perimeter of the HSTF	N: 7240975.804 E: 603674.157		
2017-2c	MW3- monitoring well located at the S edge outside perimeter of the HSTF	N: 7240965.688 E: 603694.050		
2019-1a	MW1D - monitoring well located at the NW corner outside perimeter of the HSTF	N: 7241090. 150 E: 603706.630		

5.1 RESULTS

Tables 6 and 7 present the analytical results for the samples collected from SNP Stations 2017-2a, 2b, 2c and 2019-1a in 2019.



SNP Station 2017-1 (MW1)

No samples were collected from the 2017-1 in 2019 as it was decommissioned in 2018. Retention pond water that had been pumped out prior to the retention pond decommissioning was sampled and transported to offsite storage tanks in 2018. Approval to discharge was received in March 2019 following an evaluation of applicable discharge criteria. This remaining retention pond water was stored until August 9th 2019 when it was transported via vacuum trucks to the site and discharged on the approved discharge pad. **Table 3** below provides a summary of all water discharged from the HSTF in 2019.

Table 3: Monthly and Annual Quantities of Effluent Discharged From HSTF in 2019

Discharge Month	Discharge Date	Volume Discharged (m ³)	Discharge Location
August	9 th	50	Discharged to the environment from via an approved discharge pad outside of the east edge of the HSTF berm
Total Annual Discharge:		50m³	

SNP Station 2017-2a (MW1)

Groundwater sampling of MW1 was conducted on August 9 and on October 13 2019. The groundwater sample was submitted for laboratory analysis of total metals, BTEX, PHC F1-F4, EPH, COD, TSS, PFAS and pH and results were compared to the Federal Contaminated Sites Action Plan – Federal Interim Groundwater Quality Guidelines for Contaminated Sites (FIGWQGs), as outlined in the SLWB Water Licence S17L8-003 Annex A and the Water Quality Monitoring Program.

Results of the groundwater sample collected from MW1 were below the FIGWQGs for all parameters with the exception several metal parameters. Aluminum, copper, iron, selenium, uranium, and zinc exceeded criteria during both the spring and fall sampling events. Cadmium was found to exceed during the spring event only while molybdenum exceeded during the fall sampling round only. As MW1 was installed up gradient of the HSTF (and is therefore representative of background conditions), it is likely that the above mentioned exceedances are naturally elevated in the groundwater and not associated with HSTF activities.

SNP Station 2017-2b (MW2)

Groundwater sampling of MW2 was conducted on Aug 8 and on October 13, 2019. The groundwater sample was submitted for laboratory analysis of total metals, BTEX, PHC F1-F4, EPH, COD, TSS, PFAS and pH and results were compared to FIGWQGs, as outlined in the SLWB Water Licence S17L8-003 Annex A and the Water Quality Monitoring Program.



Results of the groundwater samples collected from MW2 were below the FIGWQGs for all parameters with the exception of several metal parameters. Aluminum, iron and uranium exceeded the FIGWQGs during the spring and fall sampling events. Copper exceeded criteria during the spring sampling round only. Iron and uranium were also found to exceed in the background well (SNP Station 2017-2a / MW1) which suggests that these parameters are naturally elevated in the groundwater and not associated with HSTF activities.

SNP Station 2017-2c (MW3)

Groundwater sampling of MW3 was conducted on August 9 and on October 13, 2019. The groundwater sample was submitted for laboratory analysis of total metals, BTEX, PHC F1-F4, EPH, COD, TSS, PFAS and pH and results were compared to FIGWQGs, as outlined in the SLWB Water Licence S17L8-003 Annex A and the Water Quality Monitoring Program.

Results of the groundwater samples collected from MW3 were below the FIGWQGs for all parameters with the exception of several metals parameters. Aluminum and iron exceeded the FIGWQGs during the spring and fall sampling events. Cadmium, copper and lead exceeded criteria during the spring round only. Aluminum, iron, cadmium, copper lead and uranium were also found to exceed in the background well (SNP Station 2017-2a / MW1) which suggests that these parameters are naturally elevated in the groundwater and not associated with HSTF activities.

SNP Station 2019-1a (MW1-D)

Groundwater sampling of MW1-D was conducted once on August 9 and again on October 13, 2019. The groundwater sample was submitted for laboratory analysis of total metals, BTEX, PHC F1-F4, EPH, COD, TSS, PFAS and pH and results were compared to FIGWQGs, as outlined in the SLWB Water Licence S17L8-003 Annex A and the Water Quality Monitoring Program.

Results of the groundwater samples collected from MW1-D were below the FIGWQGs for all parameters with the exception of several metal parameters. Iron exceeded criteria during both the spring and fall sampling events. Aluminum was found to exceed criteria only during the fall sampling event. As MW1-D was installed up gradient of the HSTF (and is therefore representative of background conditions), it is likely that the above mentioned exceedances are naturally elevated in the groundwater and not associated with HSTF activities.



5.2 QA/QC PROCEDURES

Rigorous chain of custody documentation was completed for accompaniment of each sample cooler for sign off by the shipper and the receiver. A summary of QA/QC samples collected for the SNP sampling in 2019 is provided in **Table 4** below.

Table 4: Summary of SNP QA/QC Program

Sampling Event	Number of Duplicate Samples Collected	Number of Trip Blank Samples Submitted	Number of Field Blank Samples Submitted
August Sampling Event	1	0	0
October Sampling Event	1	1	1

Blind duplicate samples were collected in unison with their corresponding sample locations and were submitted for analysis of the same parameters, with unique sample IDs.

Sampling precision is measured by calculating the relative percentage difference (RPD) for the duplicate samples. If the contaminant concentrations are greater than five times the laboratory reportable detection limit (MDL), an RPD is calculated. Concentration results less than five times the MDL become increasingly imprecise and RPDs are not calculated. The CCME recommends an acceptable RPD of 40% for water when the analytical values are significantly greater than the method detection limit (CCME, 2016).

The RPD is the difference between the duplicate results divided by the mean of the results, expressed as a percentage, calculated as follows:

$$RPD (\%) = [(DUP1 - DUP2) / (\frac{DUP1 + DUP2}{2})] \times 100$$

The field blank sample was submitted during the fall sampling event with the water samples for analysis of PFAS parameters to evaluate the potential for cross-contamination during the PFAS sample collection. Due to a laboratory error the supplied water was not verified PFAS free and as such the field blank and trip blank were not analyzed for PFAS to avoid potential false positives. The field blank and trip blank were analyzed for all other parameters (PHCs F1-F4, BTEX, total metals and general chemistry). The sealed trip blank and field blank were maintained on ice throughout the field program and were shipped back to the laboratories with the corresponding groundwater samples for analysis.



Additional QA/QC procedures were performed by ALS Laboratories, including method duplicates, blanks, spikes, and recoveries as part of their internal QA/QC protocol. Laboratory QA/QC results were reviewed as part of the overall QA/QC process for the analytical results and no issues were identified.

A review of the field duplicate analytical results was conducted and with the exception of pH in August 2019, all results were found to be acceptable, with calculated RPD values below 40% for groundwater. Although the pH results exceeded the acceptable RPD values the concentrations of the sample and duplicate are within the acceptable range for the FIGWQGs criteria (6.5-9.0) and as such, is not considered an area of concern.

Both the trip blank and field blank samples submitted in October 2019 were below reported laboratory detection limits for all parameters analyzed. This indicates that there was no interference with the samples in the field or during the shipping process.

The QA/QC evaluation indicates that the data should be considered reproducible and accurate; therefore the overall results should be considered representative of groundwater conditions at the site.

5.3 GROUNDWATER QUALITY TRENDS 2017-2019

PHC F1-F4 & BTEX

Over the course of the monitoring program there has been one hydrocarbon detection at the former HSTF. PHC F1 was detected in MW1 in June 2018. The detection was just above the laboratory detection limit and well below the FIGWQGs. As this detection was in the background well it is not believed to be related to HSTF activities.

BTEX and PHC F1-F4 concentrations appear to be consistently below detection limits at the former HSTF.

Summary tables of historic PHC F1-F4 concentrations can be found in Table 8C in Appendix A.

PFAS

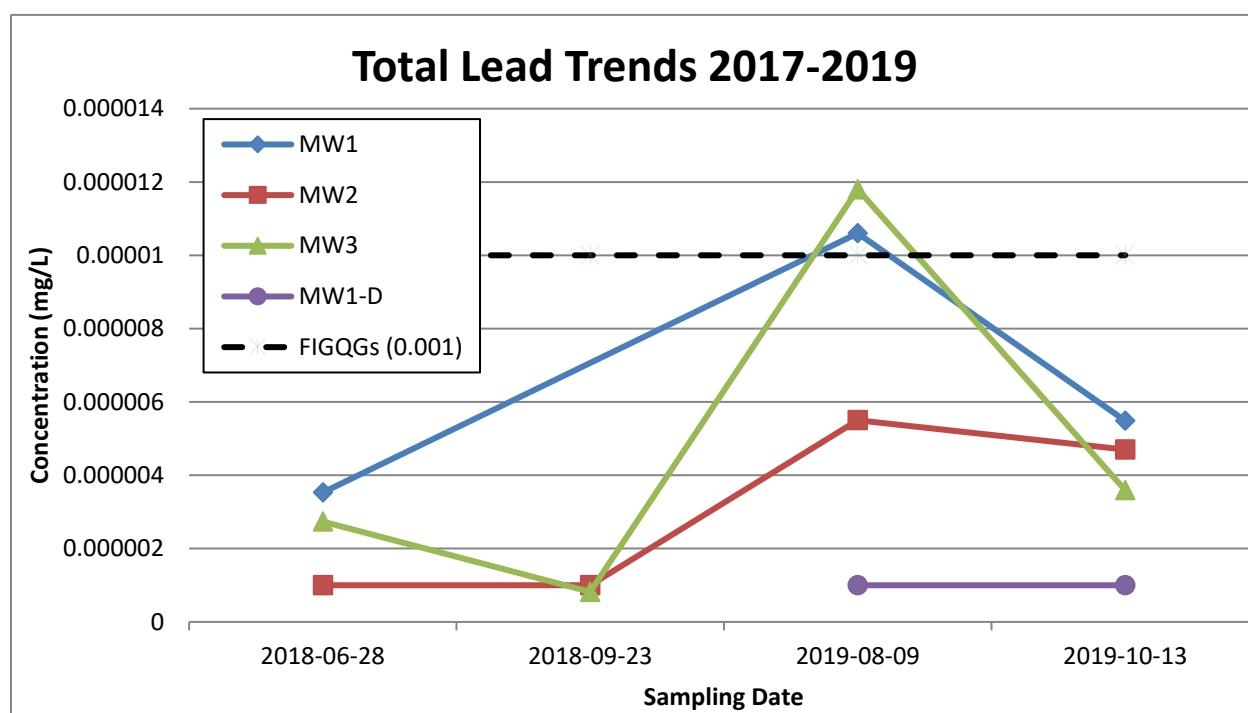
Over the course of the monitoring program there have been no PFAS detections at the former HSTF. All samples analyzed have been below the laboratory detection limit and subsequently well below the FIGWQGs.



PFOs/PFOA concentrations appear to be consistently below detection limits at the former HSTF. Summary tables of historic PFAS concentrations can be found in Table 8D in Appendix A.

Metals

Over the course of the monitoring program several different metals have exceeded the FIGWQGs at the former HSTF. Exceedances at this well include aluminum, cadmium, copper, iron, lead, molybdenum, selenium, uranium and zinc. Lead was an additive in fuel products, as such it can be considered an indicator of potential fuel contamination (the main contaminant of concern at the HSTF) therefore special consideration has been given to lead trend analysis over the other metal parameters. The graph below shows lead trends in the onsite wells since the monitoring program began in 2017.



Lead concentrations have been variable and do not appear to show any particular trend. Lead has exceeded criteria twice, both times in Aug of 2019 at MW1 and MW3. The latest sampling round (Oct 2019) found all lead concentrations to be below FIGWQGs. The background well, MW1, has had some of the highest lead concentrations since 2017. As such, it is likely that these exceedances are due to naturally elevated concentrations in the groundwater and not associated with HSTF activities.



All other historical metal exceedances in the SNP were also found to have the highest concentrations in the background well (MW1) with the exception of iron. This suggests that the metals concentrations may represent naturally elevated concentrations in groundwater.

A review of analytical data collected since 2017 for metals showed no apparent trend and as such have not been presented graphically in this report.

Summary tables of historic total metals concentrations can be found in Table 8B in Appendix A.

5.4 WATER QUALITY MANAGEMENT PROGRAM- DETAILS AND RESULTS

Action levels for groundwater management are outlined in the Water Quality Management Program and have been summarized below.

Groundwater

The three action levels for groundwater management are as follows:

- **Meets Applicable Groundwater Quality Criteria** – Groundwater quality meets the applicable criteria which suggests that groundwater quality has not been impacted by the HSTF – NO FURTHER ACTION REQUIRED
- **Exceeds Applicable Groundwater Quality Criteria but Concentrations are Less Than the Upgradient Groundwater Monitoring Well (MW1)** – Groundwater quality does not meet the applicable groundwater criteria but concentrations are less than or equal to those found in the upgradient monitoring well MW1 which suggests that groundwater quality has not been impacted by the HSTF – No Further Action Required
- **Exceeds Applicable Groundwater Quality Criteria but Concentrations are Greater Than the Upgradient Groundwater Monitoring Well (MW1)** – Groundwater quality does not meet the applicable groundwater criteria and concentrations are greater than those found in the upgradient monitoring well MW1 which suggests that groundwater quality has been impacted by the HSTF – Resample And Further Investigate Groundwater Quality If Criteria Continue To Be Exceeded

As detailed in the SNP Sampling Report above, groundwater samples collected in August and October, 2019 were found to exceed the applicable criteria for certain metals however concentrations in the upgradient well, MW1 were greater than concentrations found in the downgradient wells, MW2 and MW3. This suggests groundwater quality has not been impacted by the HSTF and no further action is required.



Table 5 below provides a summary of 2019 reporting action levels for surface water and groundwater management.

Table 5: Summary of Water Quality Management Program Reporting Action Levels

Media	Sampling Event	Reported Action Level	Action Taken
Surface Water	Sept. 26 & Oct. 9, 2018	Acceptable for Discharge	Water discharged from holding tank in August 2019
Groundwater	Aug. 8/9, 2019	Exceeds Applicable Groundwater Quality Criteria but Concentrations are Less Than the Upgradient Groundwater Monitoring Well (MW1)	No further action required
	Oct 13, 2019		

Further details relating to surface water and groundwater sampling including monitoring locations, frequency of monitoring events, chemical parameters tested and data analysis can be found above in Section 5.0, Surveillance Network Program Report.

5.5 OTHER ITEMS

Spills and Unauthorized Discharges

No spills or unauthorized discharges occurred at the Norman Wells HSTF in 2019.

Contravention Reports

No contravention reports were issued in regards to the Norman Wells HSTF in 2019.

6. SAMPLING AND ANALYSIS PLAN 2020

According to Water Licence S17L8-003, the following item will take place during the 2020 calendar year:

- SNP monitoring; SNP stations 2017-2a, 2b and 2c will be monitored followed the conditions outlined in Annex A- Surveillance Network Program.



As described in Section 2.6, groundwater sampling will occur as part of the SNP monitoring in 2020. Two rounds of sampling are planned, which will occur in the spring following the thaw and again in the fall prior to freeze up. These samples will be analyzed for all parameters specified within the SNP as part of the SLWB Water Licence. It should be noted that SNP Station 2017-1 has been decommissioned and will no longer be sampled under the SNP and the water licence will be amended to include the sampling of newly installed MW1-D as part of the SNP to provide additional upgradient data from the HSTF.

7. CLOSURE


The conclusions presented in this report represent our professional opinion and are based upon the work described in this report and any limiting conditions in the terms of reference, scope of work, or conditions noted herein. The findings presented in this report are based on conditions observed at the specified dates and locations, and on the analysis of samples for the specified parameters. Unless otherwise stated, the findings cannot be extended to previous or future site conditions, portions of the site that were not investigated directly, or types of analysis not performed.


BluMetric Environmental Inc. makes no warranty as to the accuracy or completeness of the information provided by others, or of conclusions and recommendations predicated on the accuracy of that information. Nothing in this report is intended to constitute or provide a legal opinion. BluMetric Environmental Inc. makes no representation as to compliance with environmental laws, rules, regulations, or policies established by regulatory agencies.

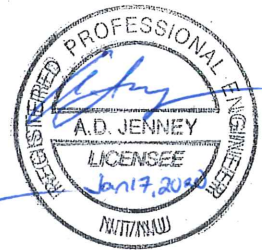


This report has been prepared for the Sahtu Land and Water Board on behalf of Public Services and Procurement Canada and Transport Canada. Any use a third party makes of this report, any reliance on the report, or decisions based upon the report, are the responsibility of those third parties unless authorization 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.

Respectfully submitted,
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Senior Project Engineer



8. REFERENCES

BluMetric Environmental Inc. March 2019. 2018 Annual Water Licence Report, Norman Wells Airport Airside Land Treatment Unit, Water Licence S17L8-003.

BluMetric Environmental Inc. March 2018. 2017 Annual Water Licence Report, Norman Wells Airport Airside Land Treatment Unit, Water Licence S17L8-003.

Government of Canada, May 2010 (Updated November 2012). Guidance Document on Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites, Federal Contaminated Sites Action Plan (FCSAP).

Sahtu Land and Water Board. Type B Water Licence S17L8-003. Issued December 5, 2017, to Transport Canada, Prairie and Northern Region- Environmental Services, Contaminated Sites.



APPENDIX A

Water and Soil Chemistry Results 2019



Table 6a: Groundwater Analytical Results - General Chemistry

Sample ID	MDL	Units	FIGWQGs ¹	MW1	MW1-D	MW2	MW3	MW-DUP (MW2)
Date Sampled				9-Aug-2019	8-Aug-2019	8-Aug-2019	9-Aug-2019	9-Aug-2019
ALS Sample ID				L2327336-2	L2327336-1	L2327336-3	L2327336-4	L2327336-4
Physical Tests								
pH	0.1	pH	6.5-9	8.01	7.91	7.8	7.74	7.74
Total Suspended Solids	3.0	mg/L	NV	24.6	3.6	21.8	67	67
Organics								
COD	20.00	mg/L	NV	44	<20	28	29	29

1 - Federal Interim Groundwater Quality Guidelines for Fine-Grained Soil and Commercial/Industrial Land Use (June 2016)

NV - No Value

MDL - Method Detection Limit

Table 6B: Groundwater Analytical Results - Total Metals

Sample ID	MDL	Units	FIGWQGs ¹	MW1	MW1-D	MW2	MW3	MW-DUP (MW2)
Date Sampled				9-Aug-2019	8-Aug-2019	8-Aug-2019	9-Aug-2019	8-Aug-2019
ALS Sample ID				L2327336-2	L2327336-1	L2327336-3	L2327336-4	L2327336-5
Aluminum (Al)-Total	0.0030	mg/L	0.1	0.813000	0.050700	0.394000	1.090000	0.392000
Antimony (Sb)-Total	0.00010	mg/L	2.0	0.002120	<0.00020	<0.00020	0.000240	<0.00020
Arsenic (As)-Total	0.00010	mg/L	0.005	0.004030	0.000200	0.001240	0.001800	0.001250
Barium (Ba)-Total	0.00010	mg/L	0.5	0.0868	0.0093	0.0486	0.1110	0.0477
Beryllium (Be)-Total	0.00010	mg/L	0.0053	<0.00020	<0.00020	<0.00020	<0.00010	<0.00020
Bismuth (Bi)-Total	0.000050	mg/L	NV	<0.00010	<0.00010	<0.00010	<0.000050	<0.00010
Boron (B)-Total	0.010	mg/L	1.5	0.158	0.912	0.059	0.061	0.061
Cadmium (Cd)-Total	0.0000050	mg/L	0.00009	0.000229	<0.000010	0.000088	0.000129	0.000077
Calcium (Ca)-Total	0.050	mg/L	NV	358	205	335	193	344
Cesium (Cs)-Total	0.000010	mg/L	NV	0.000128	0.000049	0.000066	0.000169	0.000065
Chromium (Cr)-Total	0.00010	mg/L	0.0089	0.000820	<0.00020	0.000630	0.001380	0.000560
Cobalt (Co)-Total	0.00010	mg/L	NV	0.004100	0.000210	0.001200	0.001730	0.001160
Copper (Cu)-Total	0.00050	mg/L	0.002	0.004900	<0.0010	0.002500	0.003600	0.002400
Iron (Fe)-Total	0.010	mg/L	0.3	0.753000	0.426000	0.910000	1.820000	0.916000
Lead (Pb)-Total	0.000050	mg/L	0.001	0.001060	<0.00010	0.000550	0.001180	0.000540
Lithium (Li)-Total	0.0010	mg/L	NV	0.070400	0.147000	0.012400	0.014200	0.012600
Magnesium (Mg)-Total	0.0050	mg/L	NV	141.0	192.0	166.0	96.6	162.0
Manganese (Mn)-Total	0.00010	mg/L	NV	0.19	0.20	1.01	1.09	1.01
Mercury (Hg)-Total	0.0000050	mg/L	0.000026	<0.0000050	<0.0000050	<0.0000050	<0.000010	<0.000010
Molybdenum (Mo)-Total	0.000050	mg/L	0.073	0.03310	<0.00010	0.00166	0.00182	0.00158
Nickel (Ni)-Total	0.00050	mg/L	0.025	0.02100	<0.0010	0.00450	0.00703	0.00460
Phosphorus (P)-Total	0.050	mg/L	NV	0.160000	<0.10	<0.10	0.097000	<0.10
Potassium (K)-Total	0.050	mg/L	NV	6.560000	9.590000	1.980000	2.240000	2.000000
Rubidium (Rb)-Total	0.00020	mg/L	NV	0.005500	0.006490	0.002100	0.003810	0.002050
Selenium (Se)-Total	0.000050	mg/L	0.001	0.008370	<0.00010	0.000240	0.000317	0.000350
Silicon (Si)-Total	0.10	mg/L	NV	15.70	3.27	5.81	7.31	5.71
Silver (Ag)-Total	0.000010	mg/L	0.00025	0.000036	<0.000020	0.000029	0.000028	0.000035
Sodium (Na)-Total	0.050	mg/L	NV	311.0	433.0	74.1	24.0	72.1
Strontium (Sr)-Total	0.00020	mg/L	NV	1.060	4.290	0.645	0.496	0.637
Sulfur (S)-Total	0.50	mg/L	NV	390.0	528.0	441.0	172.0	446.0
Tellurium (Te)-Total	0.00020	mg/L	NV	<0.00040	0.000420	<0.00040	<0.00020	<0.00040
Thallium (Tl)-Total	0.000010	mg/L	0.0008	0.000096	<0.000020	0.000044	0.000038	0.000040
Thorium (Th)-Total	0.00010	mg/L	NV	0.001410	<0.00020	0.000380	0.000730	0.000350
Tin (Sn)-Total	0.00010	mg/L	NV	0.001710	<0.00020	<0.00020	0.000110	<0.00020
Titanium (Ti)-Total	0.00030	mg/L	0.1	0.012500	<0.00060	0.006220	0.014000	0.006290
Tungsten (W)-Total	0.00010	mg/L	NV	0.005970	<0.00020	<0.00020	<0.00010	<0.00020
Uranium (U)-Total	0.000010	mg/L	0.015	0.071400	0.000068	0.018600	0.012700	0.018700
Vanadium (V)-Total	0.00050	mg/L	0.1	0.002600	<0.0010	0.001400	0.003220	0.001400
Zinc (Zn)-Total	0.0030	mg/L	0.01	0.014700	<0.0060	<0.0060	0.009100	<0.0060
Zirconium (Zr)-Total	0.000200	mg/L	NV	0.003130	0.000740	0.000520	0.000670	0.000550

1 - Federal Interim Groundwater Quality Guidelines for Fine-Grained Soil and Commercial/Industrial Land Use (June 2016)

NV - No Value

MDL - Method Detection Limit

Table 6C: Groundwater Analytical Results - BTEX and PHC

Sample ID	MDL	Units	FIGWQGs ¹	MW1	MW1-D	MW2	MW3	MW-DUP (MW2)
Date Sampled				9-Aug-2019	8-Aug-2019	8-Aug-2019	9-Aug-2019	8-Aug-2019
ALS Sample ID				L2327336-2	L2327336-1	L2327336-3	L2327336-4	L2327336-5
Volatile Organic Compounds								
Benzene	0.00050	mg/L	19	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Ethylbenzene	0.00050	mg/L	150	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Methyl t-butyl ether (MTBE)	0.00050	mg/L	NV	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Styrene	0.00050	mg/L	0.072	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Toluene	0.00045	mg/L	240	<0.00045	<0.00045	<0.00045	<0.00045	<0.00045
ortho-Xylene	0.00050	mg/L	NV	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
meta- & para-Xylene	0.00050	mg/L	NV	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Xylenes	0.00075	mg/L	74	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075
Hydrocarbons								
EPH10-19	0.25	mg/L	NV	<0.25	<0.25	<0.25	<0.25	<0.25
EPH19-32	0.25	mg/L	NV	<0.25	<0.25	<0.25	<0.25	<0.25
TEH10-30	0.25	mg/L	NV	<0.25	<0.25	<0.25	<0.25	<0.25
F1 (C6-C10)	0.10	mg/L	9.9	<0.10	<0.10	<0.10	<0.10	<0.10
F2 (C10-C16)	0.30	mg/L	3.1	<0.30	<0.30	<0.30	<0.30	<0.30
F3 (C16-C34)	0.30	mg/L	NV	<0.30	<0.30	<0.30	<0.30	<0.30
F4 (C34-C50)	0.30	mg/L	NV	<0.30	<0.30	<0.30	<0.30	<0.30

1 - Federal Interim Groundwater Quality Guidelines for Fine-Grained Soil and Commercial/Industrial Land Use (June 2016)

NV - No Value

MDL - Method Detection Limit

n/a - Not Analyzed

Table 6D : Groundwater Analytical Results - Per and Polyfluoroalkyl Substances

Sample ID	MDL	Units	FIGWQGs ¹	MW1	MW1-D	MW2	MW3	MW-DUP (MW2)
Date Sampled				9-Aug-2019	8-Aug-2019	8-Aug-2019	9-Aug-2019	8-Aug-2019
Maxxam Sample ID				-	-	-	-	-
ALS Sample ID				L2327336-2	L2327336-1	L2327336-3	L2327336-4	L2327336-5
Perfluorobutanoic Acid	0.0055	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorobutane Sulfonate (PFBS)	0.0054	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorodecane Sulfonate	0.006	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluoroheptanoic Acid (PFHpA)	0.0074	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluoroheptane sulfonate ug/L	0.008	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorohexanoic Acid (PFHxA)	0.0035	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorohexane Sulfonate (PFHxS)	0.0056	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorononanoic Acid (PFNA)	0.0087	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluoropentanoic Acid (PFPeA)	0.0075	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorotetradecanoic Acid	0.0027	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorotridecanoic Acid	0.0038	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluoroundecanoic Acid (PFUnA)	0.0025	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorodecanoic Acid (PFDA) ug/L	0.0061	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorododecanoic Acid (PFDoA)	0.005	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorooctanoic acid (PFOA)	0.010	ug/L	NV	<0.010	<0.010	<0.010	<0.010	<0.010
Perfluorooctane Sulfonic Acid (PFOS)	0.010	ug/L	68 ^a	<0.010	<0.010	<0.010	<0.010	<0.010

1 - Federal Interim Groundwater Quality Guidelines for Fine-Grained Soil and Commercial/Industrial Land Use (June 2016)

a - Federal Groundwater Quality Guideline - Final (February, 2017)

NV - No Value

MDL - Method Detection Limit

n/a- Not Analyzed

Table 7A - Groundwater Analytical Results - General Chemistry

Sample ID	MDL	Units	FIGWQGs ¹	MW1	MW1-D	MW2	MW3	MW-DUP (MW1-D)
Date Sampled				13-Oct-2019	13-Oct-2019	13-Oct-2019	13-Oct-2019	13-Oct-2019
ALS Sample ID				L2365039-1	L2365039-2	L2365039-3	L2365039-4	L2365039-5
Physical Tests								
pH	0.1	pH	6.5-9	7.76	7.81	7.73	7.73	7.76
Total Suspended Solids	3.0	mg/L	NV	19.7	7.7	28.7	20.1	7.9
Organics								
COD	20.00	mg/L	NV	41	<20	24	30	<20

1 - Federal Interim Groundwater Quality Guidelines for Fine-Grained Soil and Commercial/Industrial Land Use (June 2016)

NV - No Value

MDL - Method Detection Limit

Table 7B - Groundwater Analytical Results - Total Metals

Sample ID	MDL	Units	FIGWQGs ¹	MW1	MW1-D	MW2	MW3	MW-DUP (MW1-D)
Date Sampled				13-Oct-2019	13-Oct-2019	13-Oct-2019	13-Oct-2019	13-Oct-2019
ALS Sample ID				L2365039-1	L2365039-2	L2365039-3	L2365039-4	L2365039-5
Aluminum (Al)-Total	0.0030	mg/L	0.1	0.426	0.122	0.388	0.486	0.116
Antimony (Sb)-Total	0.00010	mg/L	2.0	0.00144	<0.00020	<0.00020	0.00015	<0.00020
Arsenic (As)-Total	0.00010	mg/L	0.005	0.00318	0.00046	0.00081	0.00121	0.00040
Barium (Ba)-Total	0.00010	mg/L	0.5	0.0449	0.0108	0.0393	0.0774	0.0103
Beryllium (Be)-Total	0.00010	mg/L	0.0053	<0.00010	<0.00020	<0.00020	<0.00010	<0.00020
Bismuth (Bi)-Total	0.000050	mg/L	NV	<0.000050	<0.00010	<0.00010	<0.000050	<0.00010
Boron (B)-Total	0.010	mg/L	1.5	0.100	1.02	0.082	0.078	1.11
Cadmium (Cd)-Total	0.0000050	mg/L	0.00009	<0.00024	<0.00001	0.000034	0.000070	<0.000010
Calcium (Ca)-Total	0.050	mg/L	NV	187	244	303	227	249
Cesium (Cs)-Total	0.000010	mg/L	NV	0.000108	0.000053	0.000047	0.000054	0.000051
Chromium (Cr)-Total	0.00010	mg/L	0.0089	0.00064	0.00032	0.00079	0.00076	0.00043
Cobalt (Co)-Total	0.00010	mg/L	NV	0.00195	0.00035	0.00049	0.00081	0.00033
Copper (Cu)-Total	0.00050	mg/L	0.002	0.00273	<0.0010	0.00160	0.00186	<0.0010
Iron (Fe)-Total	0.010	mg/L	0.3	0.463	0.716	0.674	0.613	0.674
Lead (Pb)-Total	0.000050	mg/L	0.001	0.000549	<0.00010	0.00047	0.000359	<0.00010
Lithium (Li)-Total	0.0010	mg/L	NV	0.0453	0.165	0.019	0.021	0.167
Magnesium (Mg)-Total	0.0050	mg/L	NV	81.4	238.0	164.0	107.0	239.0
Manganese (Mn)-Total	0.00010	mg/L	NV	0.11	0.26	0.22	0.58	0.26
Mercury (Hg)-Total	0.0000050	mg/L	0.000026	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	0.000050	mg/L	0.073	0.10500	<0.00010	0.00106	0.00114	<0.00010
Nickel (Ni)-Total	0.00050	mg/L	0.025	0.01080	0.00100	0.00270	0.00420	<0.0010
Phosphorus (P)-Total	0.050	mg/L	NV	0.074000	<0.10	<0.10	0.051000	<0.10
Potassium (K)-Total	0.050	mg/L	NV	4.89	12.2	2.65	2.18	11.9
Rubidium (Rb)-Total	0.00020	mg/L	NV	0.003840	0.006960	0.001730	0.002330	0.006710
Selenium (Se)-Total	0.000050	mg/L	0.001	0.00418	<0.00010	0.000250	0.000197	<0.00010
Silicon (Si)-Total	0.10	mg/L	NV	9.06	3.39	6.06	6.43	3.36
Silver (Ag)-Total	0.000010	mg/L	0.00025	0.000010	<0.000020	<0.000020	0.000011	<0.000020
Sodium (Na)-Total	0.050	mg/L	NV	264.0	473.0	83.2	29.4	473.0
Strontium (Sr)-Total	0.00020	mg/L	NV	0.569	5.10	0.74	0.578	5.06
Sulfur (S)-Total	0.50	mg/L	NV	239.0	566.0	390.0	206.0	579.0
Tellurium (Te)-Total	0.00020	mg/L	NV	<0.00020	0.00057	<0.00040	<0.00020	0.00046
Thallium (Tl)-Total	0.000010	mg/L	0.0008	0.000052	<0.000020	0.000035	0.000021	<0.000020
Thorium (Th)-Total	0.00010	mg/L	NV	0.000510	<0.00020	0.000410	0.000280	<0.00020
Tin (Sn)-Total	0.00010	mg/L	NV	0.000840	<0.00020	<0.00020	<0.00010	<0.00020
Titanium (Ti)-Total	0.00030	mg/L	0.1	0.006320	<0.0018	<0.0060	<0.0096	<0.0012
Tungsten (W)-Total	0.00010	mg/L	NV	0.003710	<0.00020	<0.00020	<0.00010	<0.00020
Uranium (U)-Total	0.000010	mg/L	0.015	0.0456	0.000128	0.0191	0.0131	0.00009
Vanadium (V)-Total	0.00050	mg/L	0.1	0.00217	<0.0010	0.0010	0.00199	<0.0010
Zinc (Zn)-Total	0.0030	mg/L	0.01	0.0103	<0.0060	<0.0060	0.0036	<0.0060
Zirconium (Zr)-Total	0.000200	mg/L	NV	0.00136	0.00077	0.00045	0.00057	0.00077

1 - Federal Interim Groundwater Quality Guidelines for Fine-Grained Soil and Commercial/Industrial Land Use (June 2016)

NV - No Value

MDL - Method Detection Limit

Value - Method Detection Limit exceeds applicable criterion due to dilution**Value** - Exceeds applicable criterion

Table 7C - Groundwater Analytical Results - BTEX and PHC

Sample ID	MDL	Units	FIGWQGs ¹	MW1	MW1-D	MW2	MW3	MW-DUP (MW1-D)
Date Sampled				13-Oct-2019	13-Oct-2019	13-Oct-2019	13-Oct-2019	13-Oct-2019
ALS Sample ID				L2365039-1	L2365039-2	L2365039-3	L2365039-4	L2365039-5
Volatile Organic Compounds								
Benzene	0.00050	mg/L	19	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Ethylbenzene	0.00050	mg/L	150	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Methyl t-butyl ether (MTBE)	0.00050	mg/L	NV	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Styrene	0.00050	mg/L	0.072	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Toluene	0.00045	mg/L	240	<0.00045	<0.00045	<0.00045	<0.00045	<0.00045
ortho-Xylene	0.00050	mg/L	NV	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
meta- & para-Xylene	0.00050	mg/L	NV	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Xylenes	0.00075	mg/L	74	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075
Hydrocarbons								
EPH10-19	0.25	mg/L	NV	<0.25	<0.25	<0.25	<0.25	<0.25
EPH19-32	0.25	mg/L	NV	<0.25	<0.25	<0.25	<0.25	<0.25
TEH10-30	0.25	mg/L	NV	<0.25	<0.25	<0.25	<0.25	<0.25
F1 (C6-C10)	0.10	mg/L	9.9	<0.10	<0.10	<0.10	<0.10	<0.10
F2 (C10-C16)	0.30	mg/L	3.1	<0.30	<0.30	<0.30	<0.30	<0.30
F3 (C16-C34)	0.30	mg/L	NV	<0.30	<0.30	<0.30	<0.30	<0.30
F4 (C34-C50)	0.30	mg/L	NV	<0.30	<0.30	<0.30	<0.30	<0.30

1 - Federal Interim Groundwater Quality Guidelines for Fine-Grained Soil and Commercial/Industrial Land Use (June 2016)

NV - No Value

MDL - Method Detection Limit

n/a - Not Analyzed

Table 7D - Groundwater Analytical Results - Per and Polyfluoroalkyl Substances

Sample ID	MDL	Units	FIGWQGs ¹	MW1	MW1-D	MW2	MW3	MW-DUP (MW1-D)
Date Sampled				13-Oct-2019	13-Oct-2019	13-Oct-2019	13-Oct-2019	13-Oct-2019
Maxxam Sample ID				-	-	-	-	-
ALS Sample ID				L2365039-1	L2365039-2	L2365039-3	L2365039-4	L2365039-5
Perfluorobutanoic Acid	0.0055	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorobutane Sulfonate (PFBS)	0.0054	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorodecane Sulfonate	0.006	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluoroheptanoic Acid (PFHpA)	0.0074	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluoroheptane sulfonate ug/L	0.008	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorohexanoic Acid (PFHxA)	0.0035	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorohexane Sulfonate (PFHxS)	0.0056	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorononanoic Acid (PFNA)	0.0087	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluoropentanoic Acid (PFPeA)	0.0075	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorotetradecanoic Acid	0.0027	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorotridecanoic Acid	0.0038	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluoroundecanoic Acid (PFUnA)	0.0025	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorodecanoic Acid (PFDA) ug/L	0.0061	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorododecanoic Acid (PFDoA)	0.005	ug/L	NV	n/a	n/a	n/a	n/a	n/a
Perfluorooctanoic acid (PFOA)	0.010	ug/L	NV	<0.010	<0.010	<0.010	<0.010	<0.010
Perfluorooctane Sulfonic Acid (PFOS)	0.010	ug/L	68 ^a	<0.010	<0.010	<0.010	<0.010	<0.010

1 - Federal Interim Groundwater Quality Guidelines for Fine-Grained Soil and Commercial/Industrial Land Use (June 2016)

a - Federal Groundwater Quality Guideline - Final (February, 2017)

NV - No Value

MDL - Method Detection Limit

n/a- Not Analyzed

Table 8A - Groundwater Analytical Results - General Chemistry

Sample ID	MDL	Units	FIGWQGs¹	MW1	MW1	MW1	MW2	MW2	MW2	MW-DUP (MW2)	MW2	MW3	DUP (MW3)
Date Sampled				28-Jun-2018	9-Aug-2019	13-Oct-2019	28-Jun-2018	23-Sep-2018	8-Aug-2019	8-Aug-2019	13-Oct-2019	23-Sep-2018	23-Sep-2018
ALS Sample ID				L2123987-1	L2327336-2	L2365039-1	L2123987-2	L2169980-3	L2327336-3	L2327336-4	L2365039-3	L2169980-2	L2169980-1
Physical Tests													
pH	0.1	pH	6.5-9	7.59	8.01	7.76	7.44	8.05	7.8	7.74	7.73	8.11	7.96
Total Suspended Solids	3.0	mg/L	NV	30.2	24.6	19.7	9.8	11.7	21.8	67	28.7	6.7	11.1
Organics													
COD	20.00	mg/L	NV	75	44	41	<20	<20	28	29	24	<20	<20

1 - Federal Interim Groundwater Quality Guidelines for Fine-Grained Soil and
Commercail/Industrial Land Use (June 2016)

NV - No Value
MDL - Method Detection Limit

Table 8A - Groundwater Analytical Results - General Chemistry

Sample ID	MDL	Units	FIGWQGs ¹	MW3	MW3-DUP	MW3	MW3	MW1-D	MW1-D	MW1-D	MW-DUP (MW1-D)
Date Sampled				28-Jun-2018	28-Jun-2018	9-Aug-2019	13-Oct-2019	31-Jan-2019	8-Aug-2019	13-Oct-2019	13-Oct-2019
ALS Sample ID				L2123987-3	L2123987-4	L2327336-4	L2365039-4	L2227652-2	L2327336-1	L2365039-2	L2365039-5
Physical Tests											
pH	0.1	pH	6.5-9	7.55	7.68	7.74	7.73	7.7	7.91	7.81	7.76
Total Suspended Solids	3.0	mg/L	NV	43.4	18.4	67	20.1	14500	3.6	7.7	7.9
Organics											
COD	20.00	mg/L	NV	28	23	29	30	396	<20	<20	<20

1 - Federal Interim Groundwater Quality Guidelines for Fine-Grained Soil and
Commercail/Industrial Land Use (June 2016)

NV - No Value
MDL - Method Detection Limit

Table 8B - Groundwater Analytical Results - Metals

Sample ID	MDL	Units	FIGWQGs¹	MW1	MW1	MW1	MW2	MW2	MW2	MW-DUP (MW2)	MW2	MW3	MW3-DUP	MW3	DUP (MW3)	MW3	MW3
Date Sampled				28-Jun-2018	9-Aug-2019	13-Oct-2019	28-Jun-2018	23-Sep-2018	8-Aug-2019	8-Aug-2019	13-Oct-2019	28-Jun-2018	28-Jun-2018	23-Sep-2018	23-Sep-2018	9-Aug-2019	13-Oct-2019
ALS Sample ID				L2123987-1	L2327336-2	L2365039-1	L2123987-2	L2169980-3	L2327336-3	L2327336-5	L2365039-3	L2123987-3	L2123987-4	L2169980-2	L2169980-1	L2327336-4	L2365039-4
Aluminum (Al)-Total	0.0030	mg/L	0.1	0.358000	0.813000	0.426000	0.044400	0.056300	0.394000	0.392000	0.388000	0.278000	0.276000	0.045900	0.045800	1.090000	0.486000
Antimony (Sb)-Total	0.00010	mg/L	2.0	0.001050	0.002120	0.001440	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.000250	0.000240	0.000190	0.000210	0.000240	0.000150
Arsenic (As)-Total	0.00010	mg/L	0.005	0.002800	0.004030	0.003180	0.000420	0.001040	0.001240	0.001250	0.000810	0.001490	0.001490	0.001500	0.001510	0.001800	0.001210
Barium (Ba)-Total	0.00010	mg/L	0.5	0.035900	0.086800	0.044900	0.024300	0.019500	0.048600	0.047700	0.039300	0.049900	0.050700	0.047600	0.050200	0.111000	0.077400
Beryllium (Be)-Total	0.00010	mg/L	0.0053	<0.00010	<0.00020	<0.00010	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Bismuth (Bi)-Total	0.000050	mg/L	NV	<0.000050	<0.00010	<0.000050	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Total	0.010	mg/L	1.5	0.097000	0.158000	0.100000	0.104000	0.120000	0.059000	0.061000	0.082000	0.053000	0.052000	0.118000	0.120000	0.061000	0.078000
Cadmium (Cd)-Total	0.0000050	mg/L	0.00009	0.000383	0.000229	<0.00024	0.000079	0.000073	0.000088	0.000077	0.000034	0.000076	0.000076	0.000043	0.000061	0.000129	0.000070
Calcium (Ca)-Total	0.050	mg/L	NV	129.000000	358.000000	187.000000	354.000000	377.000000	335.000000	344.000000	303.000000	128.000000	128.000000	189.000000	194.000000	193.000000	227.000000
Cesium (Cs)-Total	0.000010	mg/L	NV	0.000044	0.000128	0.000108	<0.000020	<0.000020	0.000066	0.000065	0.000047	0.000048	0.000048	<0.000010	<0.000010	0.000169	0.000054
Chromium (Cr)-Total	0.00010	mg/L	0.0089	0.000360	0.000820	0.000640	<0.00020	<0.00020	0.000630	0.000560	0.000790	0.000480	0.000530	0.000110	<0.00010	0.001380	0.000760
Cobalt (Co)-Total	0.00010	mg/L	NV	0.008640	0.004100	0.001950	0.000490	0.001090	0.001200	0.001160	0.000490	0.001500	0.001520	0.001110	0.001120	0.001730	0.000810
Copper (Cu)-Total	0.00050	mg/L	0.002	0.003690	0.004900	0.002730	<0.0010	<0.0010	0.002500	0.002400	0.001600	0.001820	0.001800	0.001040	0.001080	0.003600	0.001860
Iron (Fe)-Total	0.010	mg/L	0.3	0.383000	0.753000	0.463000	0.079000	0.261000	0.910000	0.916000	0.674000	0.537000	0.525000	0.159000	0.160000	1.820000	0.613000
Lead (Pb)-Total	0.000050	mg/L	0.001	0.0004	0.0011	0.0005	<0.00010	<0.00010	0.0006	0.0005	0.0005	0.0003	0.0003	0.0001	0.0001	0.0012	0.0004
Lithium (Li)-Total	0.0010	mg/L	NV	0.025300	0.070400	0.045300	0.029100	0.032000	0.012400	0.012600	0.019000	0.009700	0.009700	0.023800	0.024100	0.014200	0.021000
Magnesium (Mg)-Total	0.0050	mg/L	NV	45.200000	141.000000	81.400000	188.000000	184.000000	166.000000	162.000000	164.000000	62.300000	63.100000	93.000000	94.400000	96.600000	107.000000
Manganese (Mn)-Total	0.00010	mg/L	NV	0.865000	0.190000	0.110000	0.112000	0.296000	1.010000	1.010000	0.220000	0.123000	0.125000	0.206000	0.202000	1.090000	0.580000
Mercury (Hg)-Total	0.0000050	mg/L	0.000026	0.000008	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.000010	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.000010	<0.0000050
Molybdenum (Mo)-Total	0.000050	mg/L	0.073	0.018200	0.033100	0.105000	0.001060	0.001280	0.001660	0.001580	0.001060	0.001770	0.001780	0.001350	0.001440	0.001820	0.001140
Nickel (Ni)-Total	0.00050	mg/L	0.025	0.019400	0.021000	0.010800	0.002700	0.003200	0.004500	0.004600	0.002700	0.005260	0.005310	0.004130	0.004070	0.007030	0.004200
Phosphorus (P)-Total	0.050	mg/L	NV	0.052000	0.160000	0.074000	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050	<0.050	<0.050	0.055000	0.097000	0.051000
Potassium (K)-Total	0.050	mg/L	NV	4.320000	6.560000	4.890000	4.520000	4.920000	1.980000	2.000000	2.650000	1.400000	1.430000	2.100000	2.100000	2.240000	2.180000
Rubidium (Rb)-Total	0.00020	mg/L	NV	0.002720	0.005500	0.003840	0.000740	0.001020	0.002100	0.002050	0.001730	0.001390	0.001450	0.001570	0.001570	0.003810	0.002330
Selenium (Se)-Total	0.000050	mg/L	0.001	0.002030	0.008370	0.004180	0.000170	0.000160	0.000240	0.000350	0.000250	0.000303	0.000338	0.000265	0.000272	0.000317	0.000197
Silicon (Si)-Total	0.10	mg/L	NV	5.960000	15.700000	9.060000	5.780000	6.460000	5.810000	5.710000	6.060000	4.910000	4.940000	5.530000	5.640000	7.310000	6.430000
Silver (Ag)-Total	0.000250	mg/L	0.00025	0.000017	0.000036	0.000010	<0.000020	<0.000020	0.000029	0.000035	<0.000020	0.000035	<0.000010	<0.000010	<0.000010	0.000028	0.000011
Sodium (Na)-Total	0.050	mg/L	NV	143.000000	311.000000	264.000000	106.000000	110.000000	74.100000	72.100000	83.200000	18.700000	18.800000	31.300000	31.300000	24.000000	29.400000
Strontium (Sr)-Total	0.00020	mg/L	NV	0.353000	1.060000	0.569000	0.901000	0.922000	0.645000	0.637000	0.740000	0.314000	0.312000	0.537000	0.559000	0.496000	0.578000
Sulfur (S)-Total	0.50	mg/L	NV	185.000000	390.000000	239.000000	510.000000	479.000000	441.000000	446.000000	390.000000	105.000000	104.000000	196.000000	200.000000	172.000000	206.000000
Tellurium (Te)-Total	0.00020	mg/L	NV	<0.00020	<0.00040	<0.00020	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Total	0.000010	mg/L	0.0008	0.000061	0.000096	0.000052	0.000035	0.000034	0.000044	0.000040	0.000035	0.000024	0.000023	0.000019	0.000019	0.000038	0.000021
Thorium (Th)-Total	0.00010	mg/L	NV	0.000200	0.001410	0.000510	<0.00020	<0.00020	0.000380	0.000350	0.000410	<0.00010	<0.00010	<0.00010	<0.00010	0.000730	0.000280
Tin (Sn)-Total	0.00010	mg/L	NV	0.001220	0.001710	0.000840	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010	0.000100	0.000110	<0.00010
Titanium (Ti)-Total	0.00030	mg/L	0.1	0.006320	0.012500	0.006320	<0.00090	<0.00090	0.006220	0.006290	<0.0060	0.003940	<0.0060	<0.0012	<0.00060	0.014000	<0.0096
Tungsten (W)-Total	0.00010	mg/L	NV	0.001350	0.005970	0.003710	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Uranium (U)-Total	0.000010	mg/L	0.015	0.026100	0.071400	0.045600	0.023400	0.022500	0.018600	0.018700	0.019100	0.010800	0.010700	0.014000	0.013500	0.012700	0.013100
Vanadium (V)-Total	0.00050	mg/L	0.1	0.001040	0.002600	0.002170	<0.0010	<0.0010	0.001400	0.001400	0.001000	0.001520	0.001460	0.000820	0.000810	0.003220	0.001990
Zinc (Zn)-Total	0.0030	mg/L	0.01	0.003900	0.014700	0.010300	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	0.003900	0.003700	<0.0030	<0.0030	0.009100	0.003600
Zirconium (Zr)-Total	0.000060	mg/L	NV	0.000552	0.003130	0.001360	0.000220	0.000240	0.000520	0.000550	0.000450	0.000382	0.000383	0.000282	0.000300	0.000670	0.000570

1 - Federal Interim Groundwater Quality Guidelines for
Fine-Grained Soil and Commercial/Industrial Land Use
(June 2016)
NV - No Value
MDL - Method Detection Limit

Table 8B - Groundwater Analytical Results - Metals

Sample ID	MDL	Units	FIGWQGs ¹	MW1-D	MW1-D	MW-DUP (MW1-D)
Date Sampled				8-Aug-2019	13-Oct-2019	13-Oct-2019
ALS Sample ID				L2327336-1	L2365039-2	L2365039-5
Aluminum (Al)-Total	0.0030	mg/L	0.1	0.050700	0.122000	0.116000
Antimony (Sb)-Total	0.00010	mg/L	2.0	<0.00020	<0.00020	<0.00020
Arsenic (As)-Total	0.00010	mg/L	0.005	0.000200	0.000460	0.000400
Barium (Ba)-Total	0.00010	mg/L	0.5	0.009300	0.010800	0.010300
Beryllium (Be)-Total	0.00010	mg/L	0.0053	<0.00020	<0.00020	<0.00020
Bismuth (Bi)-Total	0.000050	mg/L	NV	<0.00010	<0.00010	<0.00010
Boron (B)-Total	0.010	mg/L	1.5	0.912000	1.020000	1.110000
Cadmium (Cd)-Total	0.0000050	mg/L	0.00009	<0.000010	<0.00001	<0.000010
Calcium (Ca)-Total	0.050	mg/L	NV	205.000000	244.000000	249.000000
Cesium (Cs)-Total	0.000010	mg/L	NV	0.000049	0.000053	0.000051
Chromium (Cr)-Total	0.00010	mg/L	0.0089	<0.00020	0.000320	0.000430
Cobalt (Co)-Total	0.00010	mg/L	NV	0.000210	0.000350	0.000330
Copper (Cu)-Total	0.00050	mg/L	0.002	<0.0010	<0.0010	<0.0010
Iron (Fe)-Total	0.010	mg/L	0.3	0.426000	0.716000	0.674000
Lead (Pb)-Total	0.000050	mg/L	0.001	<0.00010	<0.00010	<0.00010
Lithium (Li)-Total	0.0010	mg/L	NV	0.147000	0.165000	0.167000
Magnesium (Mg)-Total	0.0050	mg/L	NV	192.000000	238.000000	239.000000
Manganese (Mn)-Total	0.00010	mg/L	NV	0.200000	0.260000	0.260000
Mercury (Hg)-Total	0.0000050	mg/L	0.000026	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	0.000050	mg/L	0.073	<0.00010	<0.00010	<0.00010
Nickel (Ni)-Total	0.00050	mg/L	0.025	<0.0010	0.001000	<0.0010
Phosphorus (P)-Total	0.050	mg/L	NV	<0.10	<0.10	<0.10
Potassium (K)-Total	0.050	mg/L	NV	9.590000	12.200000	11.900000
Rubidium (Rb)-Total	0.00020	mg/L	NV	0.006490	0.006960	0.006710
Selenium (Se)-Total	0.000050	mg/L	0.001	<0.00010	<0.00010	<0.00010
Silicon (Si)-Total	0.10	mg/L	NV	3.270000	3.390000	3.360000
Silver (Ag)-Total	0.000250	mg/L	0.00025	<0.000020	<0.000020	<0.000020
Sodium (Na)-Total	0.050	mg/L	NV	433.000000	473.000000	473.000000
Strontium (Sr)-Total	0.00020	mg/L	NV	4.290000	5.100000	5.060000
Sulfur (S)-Total	0.50	mg/L	NV	528.000000	566.000000	579.000000
Tellurium (Te)-Total	0.00020	mg/L	NV	0.000420	0.000570	0.000460
Thallium (Tl)-Total	0.000010	mg/L	0.0008	<0.000020	<0.000020	<0.000020
Thorium (Th)-Total	0.00010	mg/L	NV	<0.00020	<0.00020	<0.00020
Tin (Sn)-Total	0.00010	mg/L	NV	<0.00020	<0.00020	<0.00020
Titanium (Ti)-Total	0.00030	mg/L	0.1	<0.00060	<0.0018	<0.0012
Tungsten (W)-Total	0.00010	mg/L	NV	<0.00020	<0.00020	<0.00020
Uranium (U)-Total	0.000010	mg/L	0.015	0.000068	0.000128	0.000090
Vanadium (V)-Total	0.00050	mg/L	0.1	<0.0010	<0.0010	<0.0010
Zinc (Zn)-Total	0.0030	mg/L	0.01	<0.0060	<0.0060	<0.0060
Zirconium (Zr)-Total	0.000060	mg/L	NV	0.000740	0.000770	0.000770

1 - Federal Interim Groundwater Quality Guidelines for
Fine-Grained Soil and Commercial/Industrial Land Use
(June 2016)
NV - No Value
MDL - Method Detection Limit

Table 8C - Groundwater Analytical Results - BTEX and PHC

Sample ID	MDL	Units	FIGWQGs¹	MW1	MW1	MW1	MW2	MW2	MW2	MW-DUP (MW2)	MW2	MW3	MW3-DUP	MW3	DUP (MW3)	MW3	MW3	MW1-D	MW1-D	MW-DUP (MW1-D)			
Date Sampled				28-Jun-2018	9-Aug-2019	13-Oct-2019	28-Jun-2018	23-Sep-2018	8-Aug-2019	8-Aug-2019	13-Oct-2019	28-Jun-2018	28-Jun-2018	23-Sep-2018	23-Sep-2018	9-Aug-2019	13-Oct-2019	8-Aug-2019	13-Oct-2019	13-Oct-2019			
ALS Sample ID				L2123987-1	L2327336-2	L2365039-1	L2123987-2	L2169980-3	L2327336-3	L2327336-5	L2365039-3	L2123987-3	L2123987-4	L2169980-2	L2169980-1	L2327336-4	L2365039-4	L2327336-1	L2365039-2	L2365039-5			
Volatile Organic Compounds																							
Benzene	0.00050	mg/L	19	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050			
Ethylbenzene	0.00050	mg/L	150	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050			
Toluene	0.00045	mg/L	240	<0.00045	<0.00045	<0.00045	<0.00045	<0.00045	<0.00045	<0.00045	<0.00045	<0.00045	<0.00045	<0.00045	<0.00045	<0.00045	<0.00045	<0.00045	<0.00045	<0.00045			
Xylenes	0.00075	mg/L	74	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075			
Hydrocarbons																							
EPH10-19	0.25	mg/L	NV	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25			
EPH19-32	0.25	mg/L	NV	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25			
F1-BTEX	0.10	mg/L	NV	1.19	<0.10	<0.25	<0.10	<0.10	<0.10	<0.10	<0.25	<0.10	<0.10	<0.10	<0.10	<0.10	<0.25	<0.10	<0.25	<0.25			
TEH10-30	0.25	mg/L	NV	<0.25	<0.25	<0.10	<0.25	<0.25	<0.25	<0.25	<0.10	<0.25	<0.25	<0.25	<0.25	<0.25	<0.10	<0.25	<0.10	<0.10			
F1 (C6-C10)	0.10	mg/L	9.9	1.19	<0.10	<0.30	<0.10	<0.10	<0.10	<0.10	<0.30	<0.10	<0.10	<0.10	<0.10	<0.10	<0.30	<0.10	<0.30	<0.30			
F2 (C10-C16)	0.30	mg/L	3.1	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30			
F3 (C16-C34)	0.30	mg/L	NV	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30			
F4 (C34-C50)	0.30	mg/L	NV	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30			

1 - Federal Interim Groundwater Quality Guidelines for Fine-Grained Soil and Commercail/Industrial Land Use (June 2016)
NV - No Value
MDL - Method Detection Limit
N/A - Not Analyzed

Table 8D - Groundwater Analytical Results - Per and Polyfluoroalkyl Substances

Sample ID	MDL	Units	FIGWQGs ¹	MW1	MW1	MW1	MW2	MW2	MW2	MW-DUP (MW2)	MW2	MW3	MW3-DUP	MW3	DUP (MW3)	MW3	MW3	MW1-D	MW1-D	MW-DUP (MW1-D)
Date Sampled				27-Jun-2018	9-Aug-2019	13-Oct-2019	27-Jun-2018	23-Sep-2018	8-Aug-2019	8-Aug-2019	13-Oct-2019	27-Jun-2018	27-Jun-2018	23-Sep-2018	23-Sep-2018	9-Aug-2019	13-Oct-2019	8-Aug-2019	13-Oct-2019	13-Oct-2019
Maxxam Sample ID				HCP259	-	-	HCP260	-	-	-	-	HCP261	HCP262	-	-	-	-	-	-	-
ALS Sample ID				-	L2327336-2	L2365039-1	-	L2169980-3	L2327336-3	L2327336-5	L2365039-3	-	-	L2169980-2	L2169980-1	L2327336-4	L2365039-4	L2327336-1	L2365039-2	L2365039-5
Perfluorooctanoic acid (PFOA)	0.0033	ug/L	NV	<0.0033	<0.010	<0.010	<0.0033	<0.010	<0.010	<0.010	<0.010	<0.0033	<0.0033	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Perfluorooctane Sulfonic Acid (PFOS)	0.0060	ug/L	68 ^a	<0.0060	<0.010	<0.010	<0.0060	<0.010	<0.010	<0.010	<0.010	<0.0060	<0.0060	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

1 - Federal Interim Groundwater Quality Guidelines for Fine-Grained Soil and Commercail/Industrial Land Use (June 2016)
a - Federal Groundwater Quality Guideline - Final (February, 2017)
NV - No Value
MDL - Method Detection Limit
n/a- Not Analyzed

Table 9A - Soil - Metals

Sample ID	LDL	Units	CCME CSQGs ¹	GNWT CSR ²	Water Licence Criteria ³	MW1-D
Date Sampled						30-Jan-2019
ALS Sample ID						L2227652-1
pH						
pH	0.1	%	6-8	6-8	6-9	8.67
Metals						
Antimony (Sb)	0.1	mg/kg	40	40	40	0.22
Arsenic (As)	0.1	mg/kg	12	12	120	8.46
Barium (Ba)	0.5	mg/kg	2000	2000	2000	203
Beryllium (Be)	0.1	mg/kg	8	8	8	0.66
Cadmium (Cd)	0.02	mg/kg	22	22	22	0.059
Chromium (Cr)	0.5	mg/kg	87	87	87	35.6
Cobalt (Co)	0.1	mg/kg	300	300	300	17.4
Copper (Cu)	0.5	mg/kg	91	91	91	20.9
Lead (Pb)	0.5	mg/kg	260	260	260	10.4
Mercury (Hg)	0.005	mg/kg	24	24	24	0.0422
Molybdenum (Mo)	0.1	mg/kg	40	40	40	0.36
Nickel (Ni)	0.5	mg/kg	89	50	89	50.9
Selenium (Se)	0.2	mg/kg	2.9	3.9	3.9	<0.20
Silver (Ag)	0.1	mg/kg	40	40	40	<0.10
Thallium (Tl)	0.05	mg/kg	1	1	1	0.109
Tin (Sn)	2	mg/kg	300	300	100	<2.0
Uranium (U)	0.05	mg/kg	33	NV	300	0.442
Vanadium (V)	0.2	mg/kg	130	130	130	46.3
Zinc (Zn)	2	mg/kg	410	360	360	119

Notes:

10	Exceeds CCME Guidelines
10	Exceeds GNWT Guidelines
10	Exceeds Water Licence Criteria

1 - Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, Fine-Grained Soils, Commercial Land Use, Canadian Council for Ministers of the Environment (1999, updated 2016)

2 - Environmental Guideline for Contaminated Site Remediation, Table A7 Criteria, Commercial Land Use, Government of Northwest Territories (November 2003)

3 - Sahtu Land and Water Board Type B Water Licence S17L8-003

mg/kg - Milligrams Per Kilogram

NV - No Value

LDL - Lowest Detection Limit

Table 9B - Soil - BTEX and PHCs

Sample ID	LDL	Units	CCME CSQGs ¹ / CWS ²	GNWT CSR ³	Water Licence Criteria ⁴	MW1-D
Date Sampled						30-Jan-2019
ALS Sample ID						L2227652-1
BTEX						
Benzene	0.005	mg/kg	0.0068	5	5	<0.0050
Ethylbenzene	0.01	mg/kg	0.018	20	20	<0.010
Styrene	0.05	mg/kg	50	50	NV	<0.050
Toluene	0.05	mg/kg	0.8	0.8	0.8	<0.050
Xylenes	0.1	mg/kg	2.4	17	20	<0.10
Hydrocarbons						
F1 (C6-C10)	10	mg/kg	320	660	660	<10
F2 (C10-C16)	20	mg/kg	260	1500	1500	203
F3 (C16-C34)	20	mg/kg	2500	2500	2500	933
F4 (C34-C50)	20	mg/kg	6600	6600	6600	467

Notes:

10	Exceeds CCME Guidelines
10	Exceeds GNWT Guidelines
10	Exceeds Water Licence Criteria

1 - Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, Fine-Grained Soils, Commercial Land Use, Canadian Council for Ministers of the Environment (CCME 1999, updated 2016)

2 - Canada Wide Standards for Petroleum Hydrocarbons in Soil, Tier 1 Levels, Fine-Grained Surface Soils (<1.5 mbgs), Commercial Land Use, CCME (2008)

3 - Environmental Guideline for Contaminated Site Remediation, Tier 1 Levels, Fine Grained Surface Soils (<1.5mbgs) & Table A7 Criteria, Commercial Land Use, Government of Northwest Territories (November 2003)

4 - Sahtu Land and Water Board Type B Water Licence S17L8-003

mg/kg - Milligrams Per Kilogram

mbgs - Meters Below Ground Surface

NV - No Value

LDL - Lowest Detection Limit

Table 9C - Soil - PAHs

Sample ID	LDL	Units	CCME CSQGs ¹	GNWT CSR ²	Water Licence Criteria ³	MW1-D
Date Sampled						30-Jan-2019
ALS Sample ID						L2227652-1
Benz(a)anthracene	0.010	mg/kg	10 ^{a,d}	10	10	<0.010
Benzo(a)pyrene	0.010	mg/kg	1.4 ^a	0.7	0.7	<0.010
Benzo(b+j)fluoranthene	0.010	mg/kg	10 ^a	10	10	<0.010
Benzo(k)fluoranthene	0.010	mg/kg	10 ^{a,d}	10	10	<0.010
Dibenz(a,h)anthracene	0.0050	mg/kg	10 ^{a,d}	10	10	<0.0050
Indeno(1,2,3-c,d)pyrene	0.010	mg/kg	10 ^{a,d}	10	10	<0.010
Naphthalene	0.010	mg/kg	0.013 ^{a,b}	22	22	<0.010
Phenanthrene	0.010	mg/kg	0.046 ^{a,b}	50	50	0.049
Pyrene	0.010	mg/kg	100 ^{a,d}	100	100	<0.010

Notes:

10	Exceeds CCME Guidelines
10	Exceeds GNWT Guidelines
10	Exceeds Water Licence Criteria

1 - Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, Fine-Grained Soils, Commercial Land Use, Canadian Council for Ministers of the Environment (CCME 1999, updated 2016)

2 - Environmental Guideline for Contaminated Site Remediation, Table A7 Criteria, Commercial Land Use, Government of Northwest Territories (November 2003)

3 - Sahtu Land and Water Board Type B Water Licence S17L8-003

mg/kg - Milligrams Per Kilogram

mbgs - Meters Below Ground Surface

NV - No Value

LDL - Lowest Detection Limit

a - Soil Quality Guideline for the protection of environmental health for non-carcinogenic effects of PAHs.

b - Based on Freshwater Life Protection

c - Based on Soil Contact Guideline Value

d - CCME Interm Soil Quality Criteria 1991

e - Benzo(a)pyrene Total Potency Equivalents (B[a]P TPE) calculated based on CCME guidance for the protection of human health from carcinogenic effects based on an incremental lifetime cancer risk of 1 in 5,000,000

Table 9D - Soil - PCBs

Sample ID	LDL	Units	CCME CSQGs ¹	GNWT CSR ²	Water Licence Criteria ³	MW1-D
Date Sampled						30-Jan-2019
ALS Sample ID						L2227652-1
Total Polychlorinated Biphenyls	0.050	mg/kg	33	33	33	<0.050

Notes:

10	Exceeds CCME Guidelines
10	Exceeds GNWT Guidelines
10	Exceeds Water Licence Criteria

1 - Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, Fine-Grained Soils, Commercial Land Use, Canadian Council for Ministers of the Environment (CCME 1999, updated 2016)

2 - Environmental Guideline for Contaminated Site Remediation, Table A7 Criteria, Commercial Land Use, Government of Northwest Territories (November 2003)

3 - Sahtu Land and Water Board Type B Water Licence S17L8-003

mg/kg - Milligrams Per Kilogram

mbgs - Meters Below Ground Surface

NV - No Value

LDL - Lowest Detection Limit

Table 9E - Soil - Phenols

Sample ID	LDL	Units	CCME CSQGs ¹	GNWT CSR ²	Water Licence Criteria ³	MW1-D
Date Sampled						30-Jan-2019
ALS Sample ID						L2227652-1
Phenolic Compounds						
Phenols (4AAP)	0.10	mg/kg	3.8	3.8	4	<0.10

Notes:

10	Exceeds CCME Guidelines
10	Exceeds GNWT Guidelines
10	Exceeds Water Licence Criteria

1 - Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, Fine-Grained Soils, Commercial Land Use, Canadian Council for Ministers of the Environment (CCME 1999, updated 2016)

2 - Environmental Guideline for Contaminated Site Remediation, Table A7 Criteria, Commercial Land Use, Government of Northwest Territories (November 2003)

3 - Sahtu Land and Water Board Type B Water Licence S17L8-003

mg/kg - Milligrams Per Kilogram

mbgs - Meters Below Ground Surface

NV - No Value

LDL - Lowest Detection Limit

Table 9F - Soil - PFOS

Sample ID	LDL	Units	CCME CSQGs ¹	GNWT CSR ²	Water Licence Criteria ³	MW1-D
Date Sampled						30-Jan-2019
ALS Sample ID						L2227652-1
Perfluorinated Compounds (Soil)						
Perfluorooctane sulfonic acid (PFOS)	0.50	ug/kg	NV	NV	NV	<0.50
Perfluorooctanoic acid (PFOA)	0.10	ug/kg	NV	NV	0.14	<0.10

Notes:

10	Exceeds CCME Guidelines
10	Exceeds GNWT Guidelines
10	Exceeds Water Licence Criteria

1 - Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, Fine-Grained Soils, Commercial Land Use, Canadian Council for Ministers of the Environment (1999, updated 2016)

2 - Environmental Guideline for Contaminated Site Remediation, Table A7 Criteria, Commercial Land Use, Government of Northwest Territories (November 2003)

3 - Sahtu Land and Water Board Type B Water Licence S17L8-003

mg/kg - Milligrams Per Kilogram

NV - No Value

LDL - Lowest Detection Limit

APPENDIX B

Site Photos 2019





Photo 1: Drilling of MW1-D
January 29, 2019



Photo 2: MW1-D (left) adjacent to MW1 (right)
January 30, 2019



Photo 3: Installation of MW1-D
January 30, 2019



Photo 4: Staging and loading of contaminated soil bags.
March 16, 2019



Photo 5: Short road from former contaminated soil bag storage area
to staging and loading area.
March 16, 2019



Photo 6: Compliant soil bag storage area.
March 16, 2019



Photo 7: Roll-off dumpster with sump soil – located off site.
March 16, 2019



Photo 8: View of LTU facing east.
August 8, 2019



Photo 9: Compliant bagged soil emptied and ready for spreading.
August 8, 2019



Photo 10: Emptying of compliant soil bags.
August 8, 2019



Photo 11: Sampling of groundwater MW-2.
August 8, 2019



Photo 12: Discharge of sump water on pad.
August 8, 2019



Photo 13: Spreading of bagged soil along east side of LTU.
August 8, 2019



Photo 14: Sampling of groundwater at MW-3.
August 9, 2019



Photo 15: View of soil spread along east side facing north.
August 8, 2019



Photo 16: View of LTU facing west
October 13, 2019



Photo 17: Sump Discharge Area
October 13, 2019



Photo 18: Purge water tote
October 13, 2019



Photo 19: View of LTU facing northwest
October 13, 2019



Photo 20: Monitoring Well MW1
October 13, 2019



Photo 21: Sampling MW1-D
October 13, 2019



Photo 22: Monitoring Well MW2
October 13, 2019



Photo 23: Monitoring Well MW3
October 13, 2019

APPENDIX C

Figures



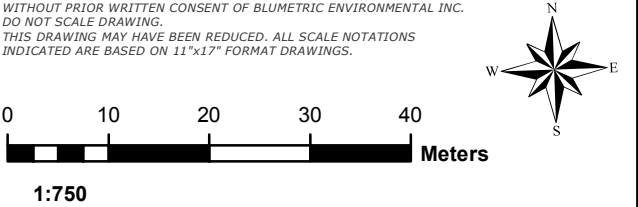


LEGEND

- Monitoring Well
- Former Sump Outline
- Land Farm Outline

1				
REV.	DESCRIPTION	YY/MM/DD	BY	CHK

REFERENCES
PROPRIETARY INFORMATION MAY NOT BE REPRODUCED OR DIVULGED WITHOUT PRIOR WRITTEN CONSENT OF BLUMETRIC ENVIRONMENTAL INC. DO NOT SCALE DRAWING.
THIS DRAWING MAY HAVE BEEN REDUCED. ALL SCALE NOTATIONS INDICATED ARE BASED ON 11"x17" FORMAT DRAWINGS.



CLIENT
Public Services and Procurement Canada

PROJECT
2019 Norman Wells LTU Water Management and Maintenance

TITLE
SLWB Water Licence S17L8-003 SNP Station Locations

4916 49th Street,
PO Box 11086
Yellowknife, NT, X1A 1P3
TEL: (867) 873-3500
FAX: (867) 873-3499
Email: info@blumetric.ca
Web: http://www.blumetric.ca

PROJECT # 190564		DATE September 05, 2019	
DRAWN GM	CHECKED LB	FIGURE 01	REV 0



LEGEND

- Monitoring Wells
- Groundwater Flow Direction
- Groundwater Contours (20 cm)
- Former Land Treatment Unit Sump Outline
- Former Land Treatment Unit Outline

1				
REV.	DESCRIPTION	YY/MM/DD	BY	CHK

REFERENCES

PROPRIETARY INFORMATION MAY NOT BE REPRODUCED OR DIVULGED WITHOUT PRIOR WRITTEN CONSENT OF BLUMETRIC ENVIRONMENTAL INC. DO NOT SCALE DRAWING.

THIS DRAWING MAY HAVE BEEN REDUCED. ALL SCALE NOTATIONS INDICATED ARE BASED ON 11"x17" FORMAT DRAWINGS.

0 10 20 30 40 Meters

1:750

CLIENT

Public Services and Procurement Canada

PROJECT

2019 Norman Wells LTU Water Management and Maintenance

TITLE

Groundwater Flow Direction

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PO Box 11086
Yellowknife, NT, X1A 1P3
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FAX: (867) 873-3499
Email: info@blumetric.ca
Web: <http://www.blumetric.ca>

PROJECT # 190564		DATE December 11, 2019		
DRAWN AL	CHECKED AB	FIGURE 02	REV 0	

APPENDIX D

Correspondence



From: Erin Goose <Erin_Goose@gov.nt.ca>
Sent: March 12, 2019 5:56 PM
To: Andrea Jenney
Cc: Laurel McDonald
Subject: Conditional approval for water discharge LTU Transport Canada

Hello Andrea,

I have spoken to our water experts within ENR and we have come to an agreement that you are able to release the discharge of water this one time. There will need to be an amendment to the Water License #S17L8-003 for future waste management/disposal that will outline the criteria for this type of exceedences. Please use this as an approval letter for the discharge of water.

Have a great day,

Erin

Mársi | Kinanāskomitin | Thank you | Merci | Hą́ı' | Quana | Qujannamiik | Quyanainni | Máhsı | Máhsı | Mahsi

Erin Goose
Water Resource Officer, Sahtu
Department of Environment and Natural Resources
Government of the Northwest Territories
2nd Floor , Northern Cartrols Building
P.O. Box 130
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APPENDIX E

Borehole Log





Project No.: 180501
Client: PSPC
Report: Norman Wells LTU
Site Address: Norman Wells Airport
 NWT

BOREHOLE ID: MW1-D

Elevation Ground: Not Surveyed
 TOP: Not Surveyed

SUBSURFACE PROFILE				SAMPLE								WELL COMPLETION		
Depth (m)	Symbol	Description	Depth (m) / Elev. (m a.s.l.)	Sample ID	Type	Blow Counts	Recovery (%)	Lab Analysis	Headspace Vapour Level PID (ppm)				Construction	Notes
									10	100	1000	10000		
-1														
0			Ground Surface	0.00										Steel casing, jplug
														Void space between PVC and steel casing
0		Fill Sand & gravel, light brown, dry, light PHC odour												
1														Bentonite
1.52			1.52											
2		Silty Sand Brown, dry, light PHC odour		MW 1-D										
2.74			2.74											
3		Sandy Silt Brownish grey, dry, light PHC odour												GW = 3.07 mbg
3.35			3.35											
4		Silty Sand Trace gravel, brown, dry, no PHC odour												2" PVC riser pipe
5														
5.18			5.18											
6		Sandy Silt Light brown, damp, no PHC odour												
6.71			6.71											#2 Silica sand
7		Silt Trace sand & clay, dark grey, saturated, no PHC odour												
7.62			7.62											2" Slot 10 PVC pipe
8		Clayey Silt Light grey, saturated, no PHC odour												
9														Slough
9.14			9.14											
		End of borehole at 9.14 m												
10		Well Completion Details: Screened interval from 6.71 m to 8.23 m below surface Elevation at top of pipe (TOP) = Not Surveyed												
11		Groundwater Information: Depth to groundwater from TOP = 4.050 m ()												
Drill Date: January 30, 2019 Drilled By: Clean Harbors Drilling Method: Solid Stem Auger Hole Diameter: 0.1524 m (OD)					Notes: GRAB SAMPLE					Sheet 1 of 1				
Logged By: AB Checked By: EB														

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