Locating Contamination Plumes near Mount Mckay Waste Disposal Site

Submitted By:

Submitted To:

Faculty of Applied Sciences and Technology

Humber College

Discipline: Civil Engineering - Environmental Engineering

Date Submitted: 17 April, 2023

Abstract

Safe and healthy environment conditions should be accessible to all the people for their good health and well-being, also it is the vital part of a strong community. There are lots of reports for monitoring wells surrounding the waste disposal site close to Mount McKay (Thunder Bay, Ontario) which includes testing and records of concentration of different substances. But, the missing part of these reports are the analysis section which could specify the location and movement of the contamination plume. The aerial (visual) presentation of the contaminants is missing in the reports. Concentration of the substance greater than the standards is considered to be a contaminant. But these standards have become stringent over the years and also these standards are also the commercial ones. This waste disposal site is bounded by Fort William First Nation (FWFN) land and Kaministiquia River. Contour mapping of the contaminants lead to detection of the location of the contamination plume. Verifying most recent residential standards leads to appropriate analysis of the report. The alarming issue is that contaminants are displacing towards the Fort William First Nation community (East/ North East) and also, some towards the Kaministiquia River (North-West).

Table of Contents

List of Illustrations

1. Introduction

This report describes further analysis of the 2017 Water Quality Assessment from Oshki-Aki LP includes the steps taken and conclusion. The 2017 report is the water quality assessments for the monitoring wells in Thunder Bay near a waste disposal site. The residents of Fort Williams First Nations Community in Thunder Bay are facing symptoms of Leukemia due to which they are also facing various complications. This is a matter of concern as these problems are occurring due to the contamination of soil and groundwater.

There has been a Pulp and Paper Mill since 1924. The mill started off as a groundwood mill. A sulphite mill was installed in 1936 after a newspaper mill was built in 1927. A kraft mill was built in 1966, and a second one was built in 1976. With the kraft mill recovery system, used sulphite liquors from the sulphite mill are recovered.The following processes are included in the mill's list of manufactured goods: kraft pulping, pulp bleaching, groundwood pulping, sulphite pulping, and papermaking. Presently, it is owned by Avenor Inc. Since 1973, landfilling has been place. Before that, the location served as a quarry, when over 500,000 yd3 of rock were extracted (Jagger Hims Limited and Willms & Shier, 1993). The waste disposal site (landfilling) is located northeast of the Fort Williams First Nations Community. This removal was now being filled with waste without any environmental precautions being taken. Three Certificates of Approval for the landfill were issued between 1973 to 1980 but no conditions of approval were imposed at any time. The emissions and the bark and ash dump from the mill have led to an important environmental concern. (Bosgoed Project Consultants Ltd., 1996)

The impact of the Avenor Inc. Pulp and Paper Mill on air quality and the company's long-term operation of a waste disposal site near First Nation territories were two significant environmental concerns raised by the First Nation. The mill lies across Highway 61B from the community, in the northeast. A bark and ash waste disposal facility run by the mill is located next to the community. The dumping site is situated at the northern edge of the Fort William First Nation Reserve, at the foot of Mount McKay. The Reserve borders the majority of the site. The 11-hectare lot is right next to its westem boundary (purchased in 1994 by Avenor from the City of Thunder Bay). This parcel does not form part of the waste disposal site. The Department of National Defense Rifle Range is adjacent to this site. Access to the landfill is via Highway 61B. (Bosgoed Project Consultants Ltd., 1996)

Figure 1: Waste Disposal Site

The FWFN community has been exposed to Leukemia by means of contamination from soil and groundwater. Other than the Fort Williams First Nations

Reserve community being affected, there is a water body (Kaministiquia River) close by as well.

The analysis of this report will be centered on mapping and standards of the contaminants of the 2017 Water Quality Assessment report as it lacks an aerial (visual) portrayal of the pollutants. Contaminants are defined as substances that have higher concentrations of the standards. So, there is a need to redefine the contaminants as the standards might be changed a bit.

2. Methodology

2.1. Software Used:

- Google Earth Pro version 7.3.2
- Microsoft Excel 2303
- Golden Software Surfer 25.1.229

2.2. Collecting the data and Verifying the Standards:

This 2017 Oshki-Aki LP Water Assessment report has concentration of different substances, all these concentrations were recorded in the Microsoft Excel. The standards written in the report were verified with most recently updated standards of the substances from the Canadian Council of Ministers of the Environment (CCME) guidelines for residential standards. And then these new standards were compared with the concentrations of the substances (in the report) and the contaminants were found.

2.3. Aerial Photograph and Digitizing Monitoring Wells

First of all, Google Earth Pro was used to export the aerial photograph for the reference of the area around the Mount Mckay Waste Disposal Site where the monitoring wells were situated. A snapshot of the aerial picture of the area was taken along with the four corner coordinates for the reference. Then, the approximate coordinates of the monitoring wells were estimated in Google Earth Pro to digitize them and the coordinates were recorded.

Figure 2: Aerial Photograph with Digitized Monitoring Wells

2.4. Setting the Base Map

Now, in the Golden Software Surfer, the snapshot taken was used as a Base Map in order to make the analysis of the report. The four corner coordinates of the Base Map were entered in order to make the correct reference of the base map (snapshot). In this way, this simple snapshot was converted into a Base Map.

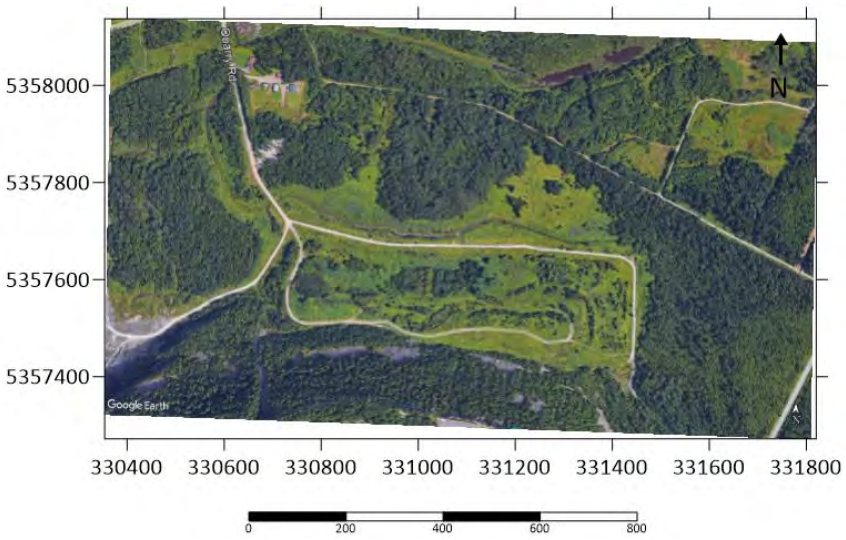

Figure 3: Base Map

2.5. Producing Concentration Maps

The concentration of the different substances recorded in these monitoring wells from the 2017 Oshki-Aki LP Water Assessment Report were duplicated into the Microsoft Excel. A different Excel sheet was made for different substances, for different types of Monitoring Wells and different time of the year. For e.g., Aluminum Shallow, Aluminum Deep, Iron Shallow, DOC Shallow May, DOC Shallow September, etc. The three columns in these Excels were X and Y coordinates are the Easting and Northings for monitoring wells and the Z coordinate depicts the concentration of the substance and the fourth column included the monitoring well number. These excel sheets were saved in the csv format for easier decoding by the Surfer application.

In the Surfer software, after the creation of the base map this data was used to produce the contour and post maps to depict the high and low concentration in the area on the map. The color scale was adjusted in a way for each substance that only the areas where the concentration is higher than the standards (contaminant) is shown in color. The Color Scale style used was Rainbow where Red was the highest color and purple the lowest, but the lowest depends on the standard. White with gradient of Grey was used below the point of the standard in the color scale which shows no color on the map depicting area under no danger (area not under concern).

3. Results and Analysis

The Figure 4 below shows the location of all the monitoring wells near the Mount Mckay Waste Disposal Site. The monitoring wells MW 11 R and MW 12 are the wells which in the bark dump, but the MW 12 does not have any data in the report as it is damaged and not repaired. So, all the information regarding the contamination of the bark dump is given by MW 11 R and other monitoring wells then further tell the movement of the contamination plume during the years.

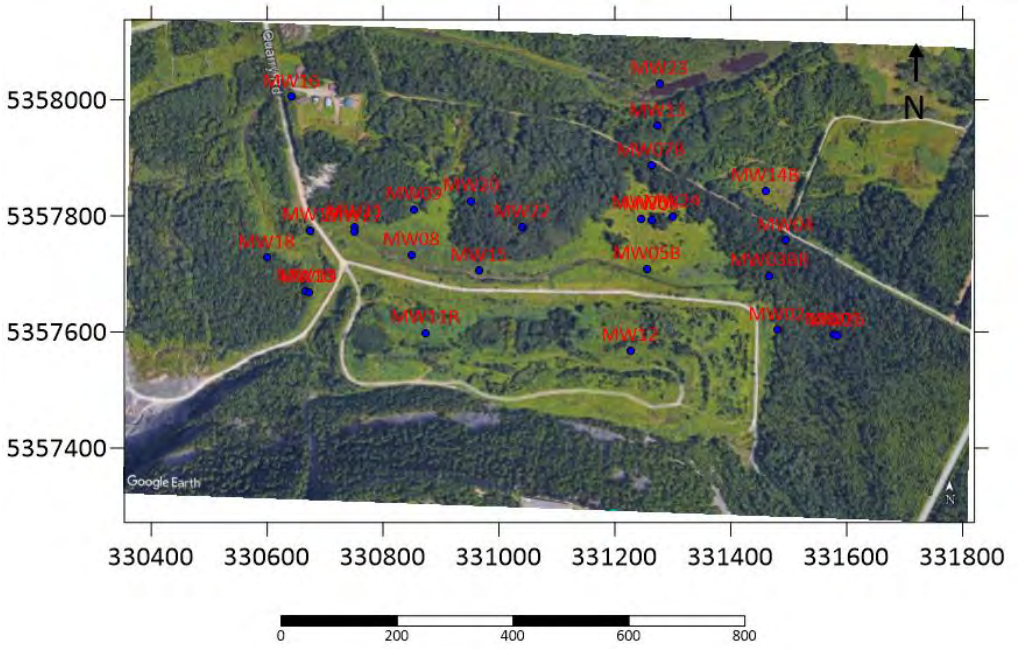

Figure 4: Monitoring Wells near the Mt. Mckay Waste Disposal Site

3.1. Shallow Groundwater

The monitoring wells in the Upper Overburden Zone which has shallow groundwater are listed in the Table 1 below along with their respective depths.

Shallow	
Upper Overburden Zone	
MW	Depth (m)
MW01	22.5
MW02	21.5
MW03BR	15
MW04	22.5
MW05B	No Log
MW06	17.5
MW07B	No Log
MW08	16.5
MW09	20
MW10	27.5
MW11R	85
MW14B	30
MW16	22
MW17	20
MW18	22
MW22	22
MW23	22
MW25	27

Table 1: Shallow Monitoring Wells with Depths

Tables 2 and 3 include the ODWS (Ontario Drinking Water Standards), RUG criteria standards from MOECC and residential standards from CCME standards. All these standards are compared to the concentrations of substances in all 18 monitoring wells in the **shallow groundwater**. The ones in red are the greater than the most recent standard available which makes it a contaminant. In the shallow groundwater, Total Dissolved Solids, Dissolved Organic Carbon, Phenol, Ammonia, Total Phosphorus, Chloride, Aluminum, Arsenic, Barium, Iron and Manganese are the contaminants.

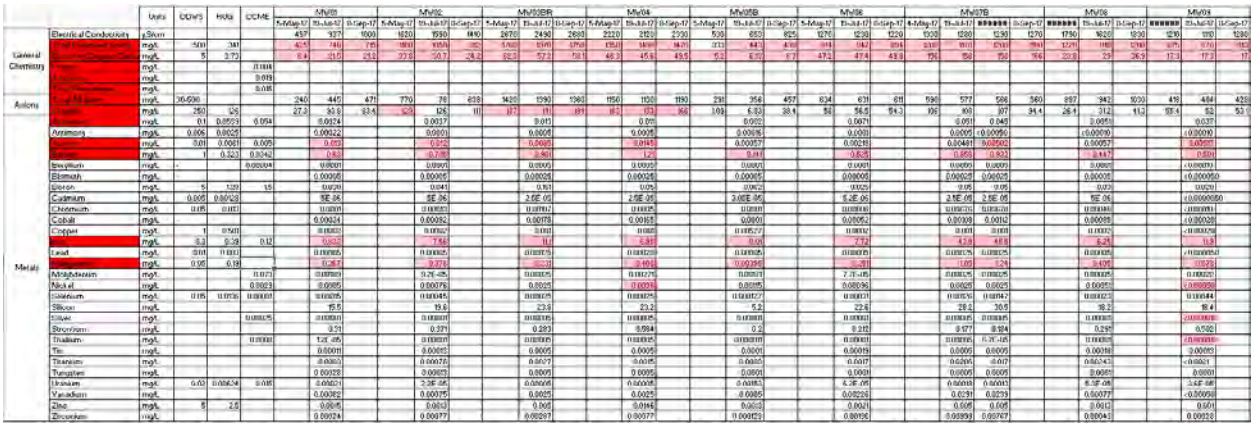

Table 2: Concentration of Substances in Shallow Groundwater

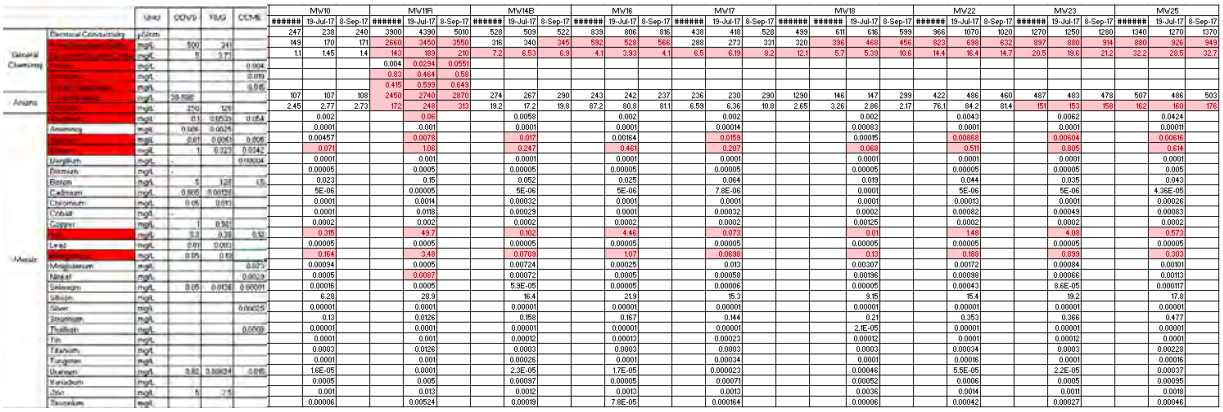

Table 3: Concentration of Substances in Shallow Groundwater contd.

3.1.1. Aluminum

Aluminum was tested only on 19 July, 2017 (Figure 5). In the Upper Overburden Zone, contamination due to Aluminum is high in the waste disposal site concentrated at MW 11R. This contamination moves towards the North – East side concentrated at MW 7. This contamination also moves towards the North – West direction concentrated at MW 9.

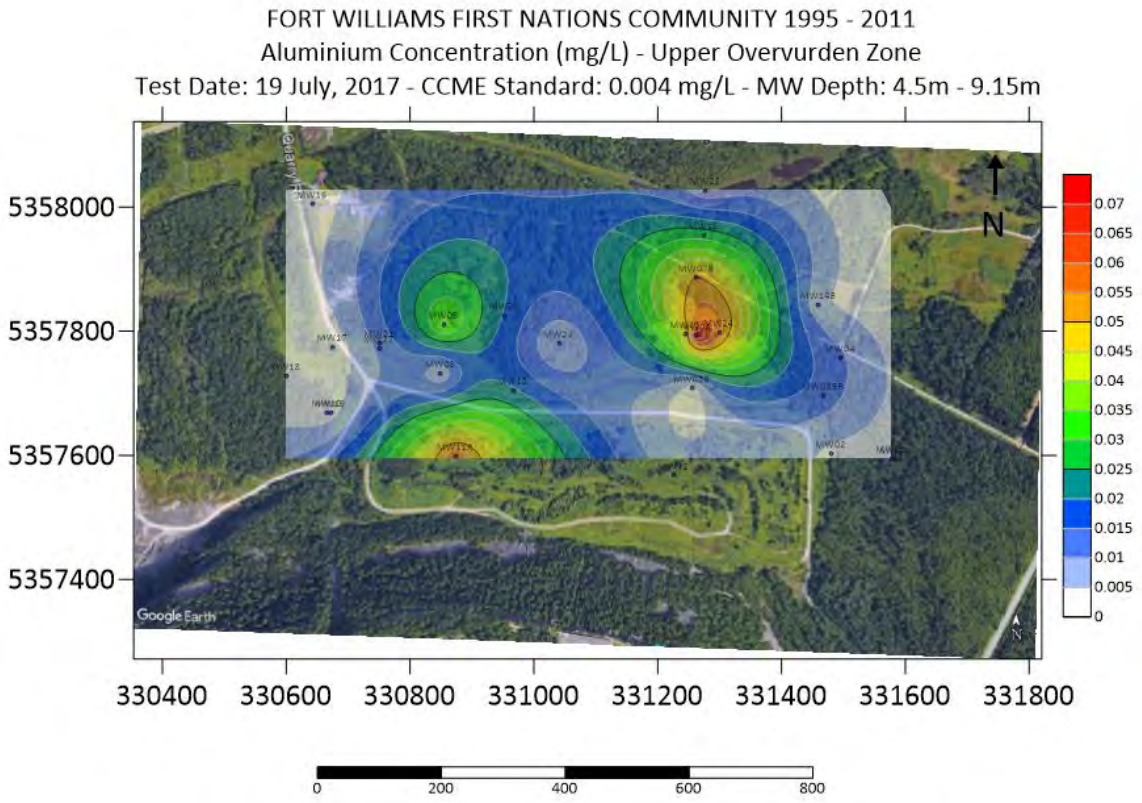

Figure 5: Aluminum in Shallow Groundwater

3.1.2. Arsenic

Arsenic was tested only on 19 July, 2017 (Figure 6). The contamination due to Arsenic is high towards the east side concentrated at MW 14. There is also contamination in waste disposal site also towards the North – East direction. This contamination also oved towards the towards the North – West direction concentrated at MW 17.

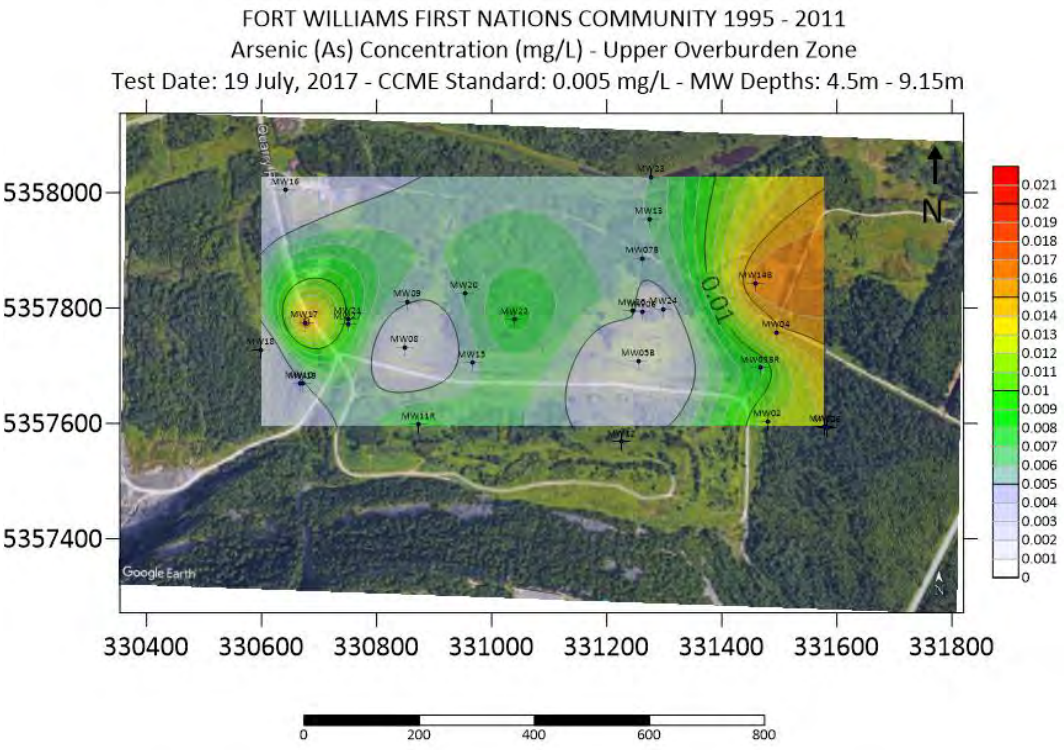

Figure 6: Arsenic in Shallow Groundwater

3.1.3. Barium

Barium is tested only on 19 July, 2017 (Figure 7). In the Upper Overburden Zone, contamination due to Barium is high in the waste disposal site concentrated at MW 11R. This contamination moves towards the North – East side concentrated at MW 7. This contamination also moves towards the East direction concentrated at MW 4. The contamination has also spread toward North – West direction.

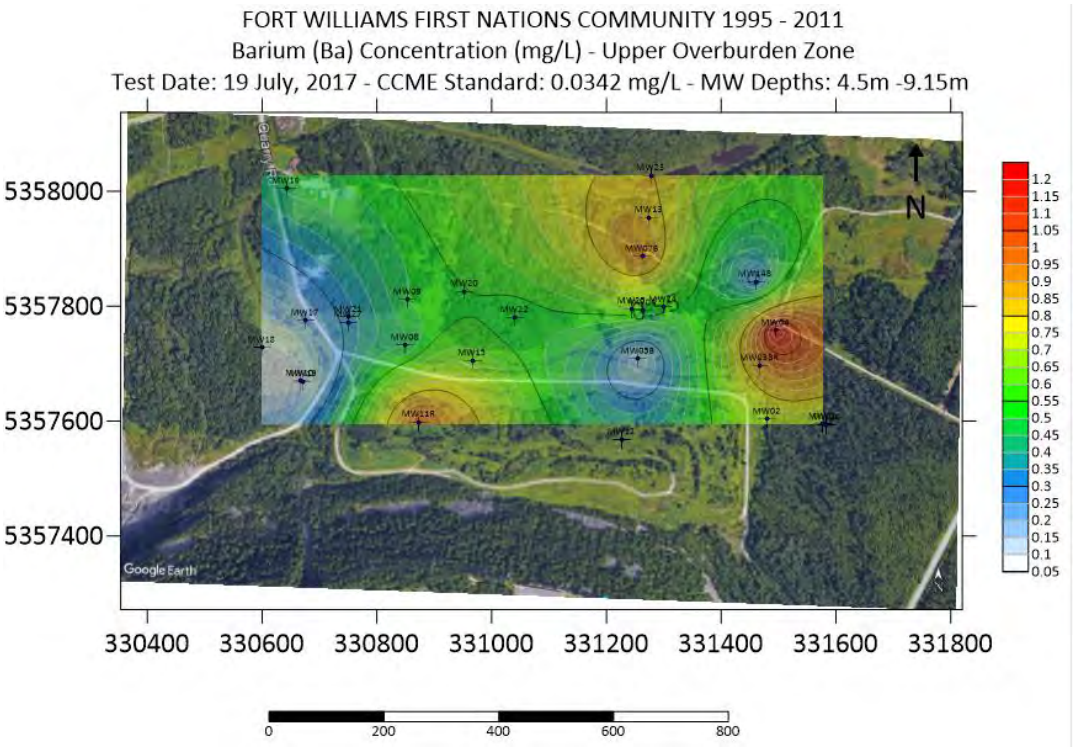

Figure 7: Barium in Shallow Groundwater

3.1.4. Chloride

The Chloride was tested three times during the year: 4-5 May, 19 July and 8 September. The contamination due to Chloride during the whole year (May – Figure 8, July – Figure 9 and September – Figure 10) is at the Waste Disposal Site, this contamination has moved towards the North – East and also towards the East direction concentrated at MW 3 BR. Rest of the area is not under concern (below the standard). On comparison of all three maps (May, July and September) the concentration in the MW 11R (bark dump) has increased from May to July then from July to September.

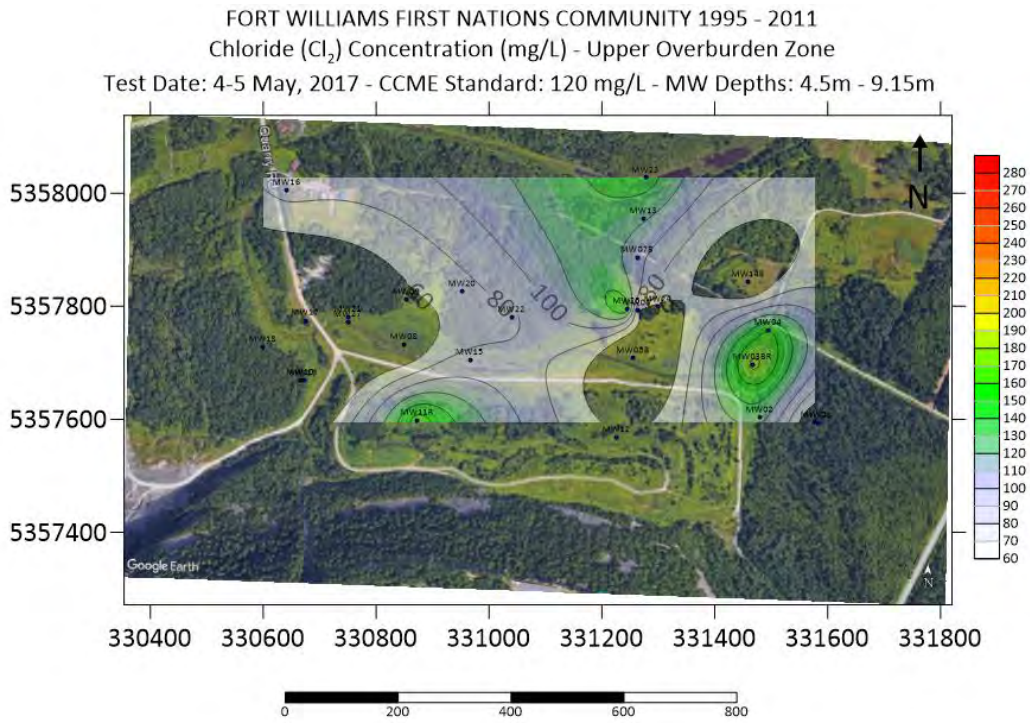

Figure 8: Chloride in Shallow Groundwater (May)

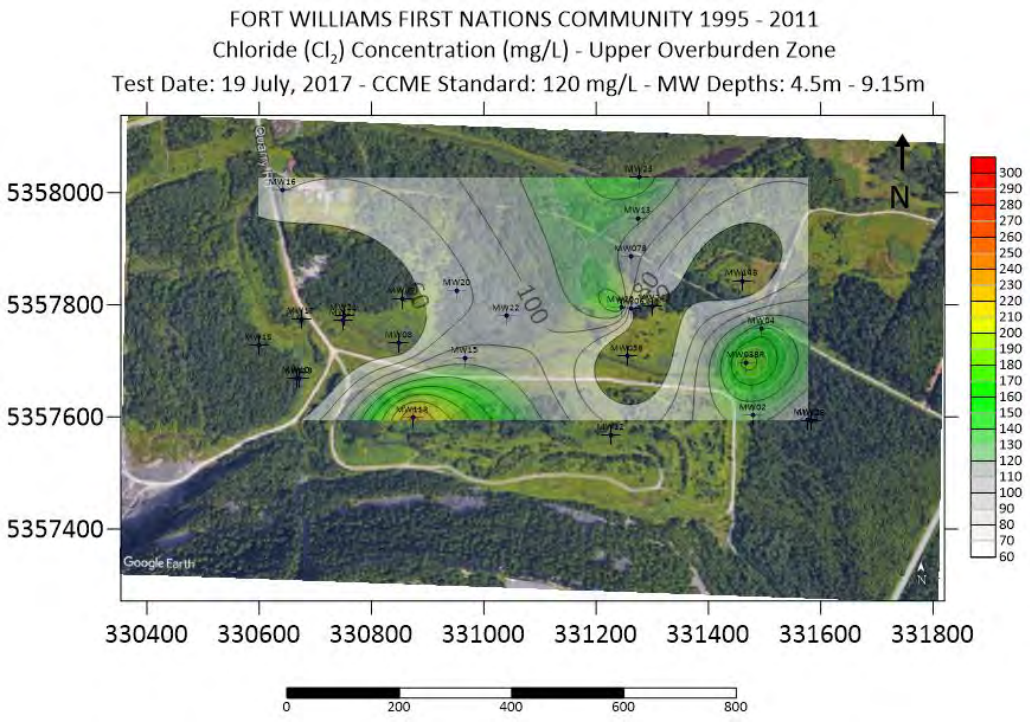

Figure 9: Chloride in Shallow Groundwater (July)

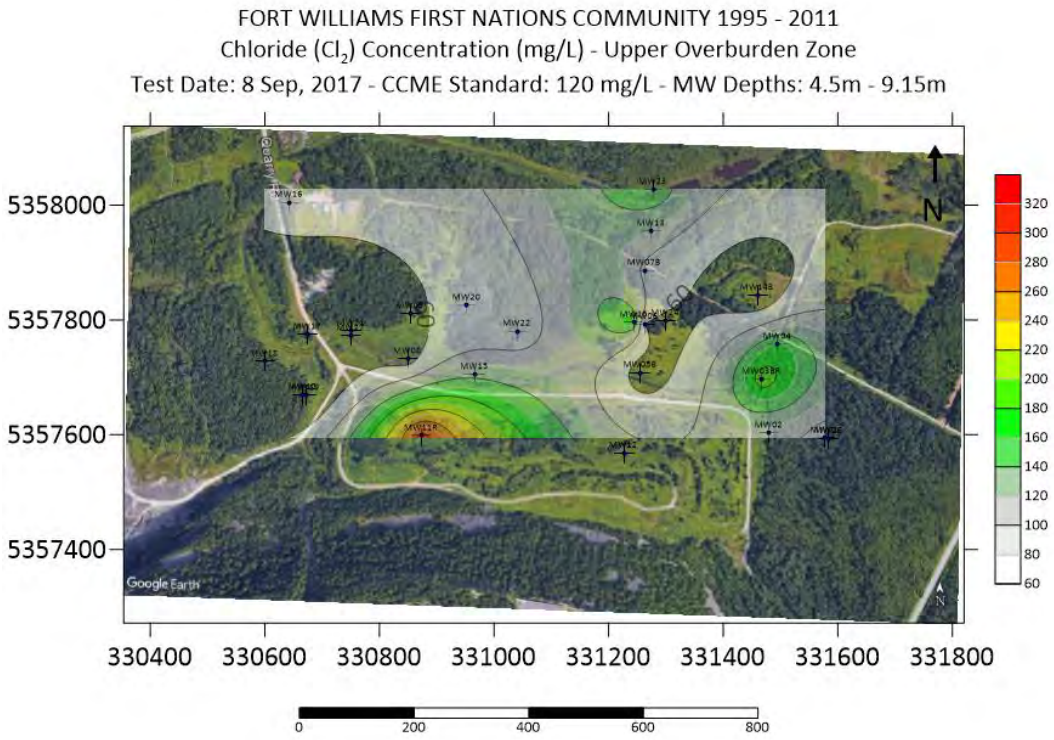

Figure 10: Chloride in Shallow Groundwater (September)

3.1.5. Dissolved Organic Carbon

Dissolved Organic Carbon was tested three times during the year: 4-5 May, 19 July and 8 September. The contamination due to Dissolved Organic Carbon during the whole year (May – Figure 11, July – Figure 12 and September – Figure 13) is around the Waste Disposal Site concentrated at MW 11 R, this contamination has moved towards the North – East direction, high at MW 7 B and also slight contamination towards the East direction at MW 3 BR. Rest of the area is not under concern (below the standard). On comparison of all three maps (May, July and September) the concentration in the MW 11R (bark dump) has slightly increased from May to July then from July to September.

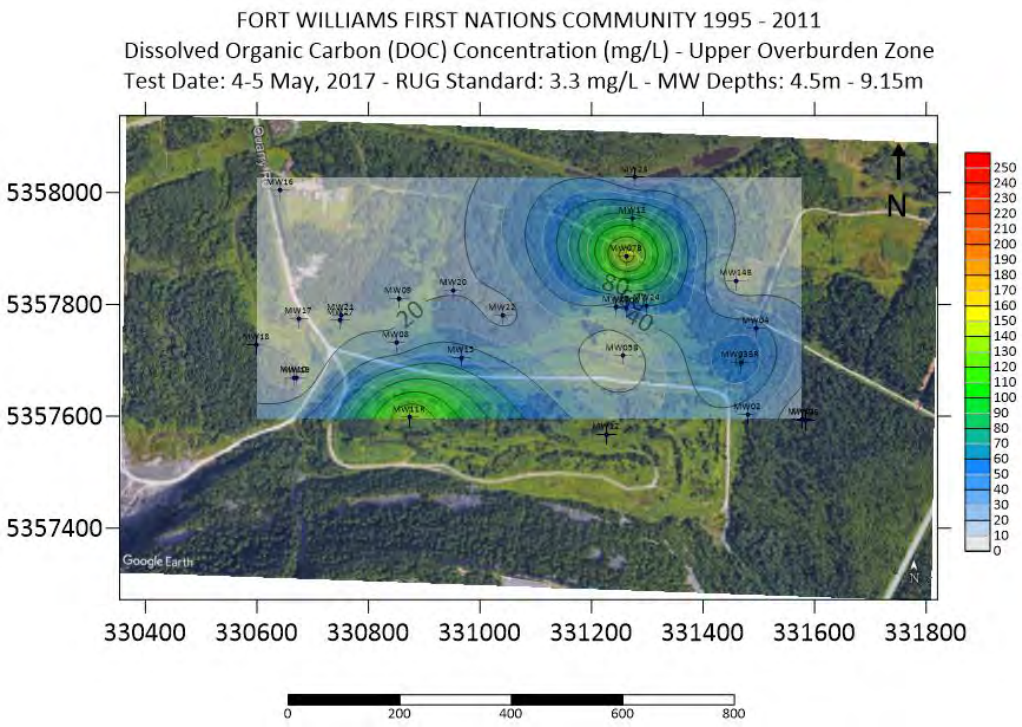

Figure 11: Dissolved Organic Carbon in Shallow Groundwater (May)

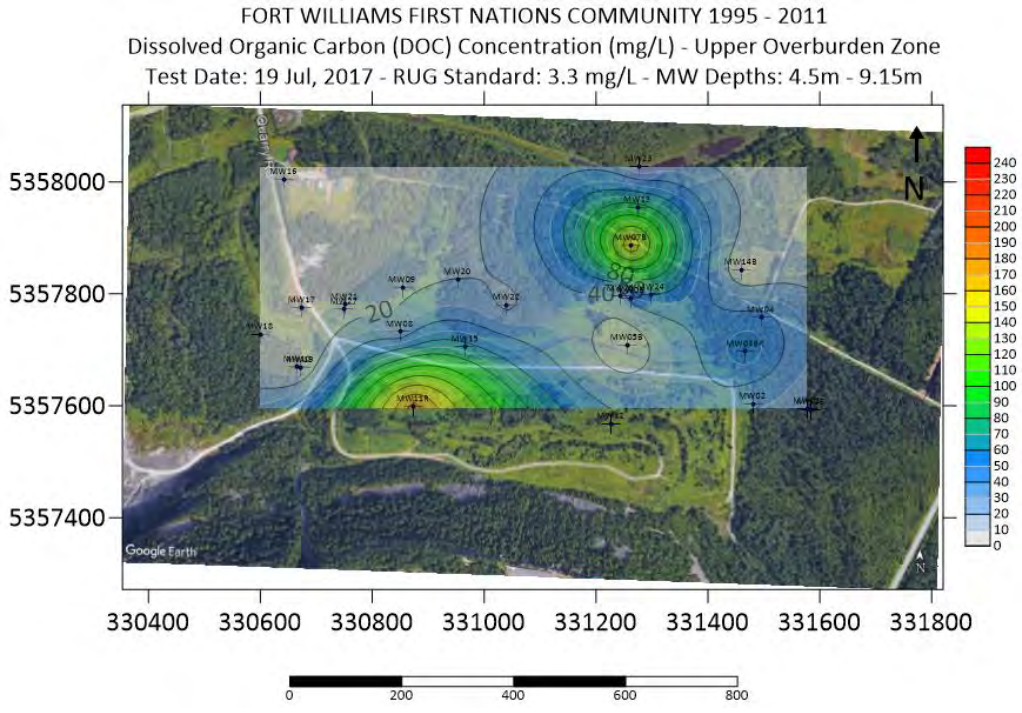

Figure 12: Dissolved Organic Carbon in Shallow Groundwater (July)

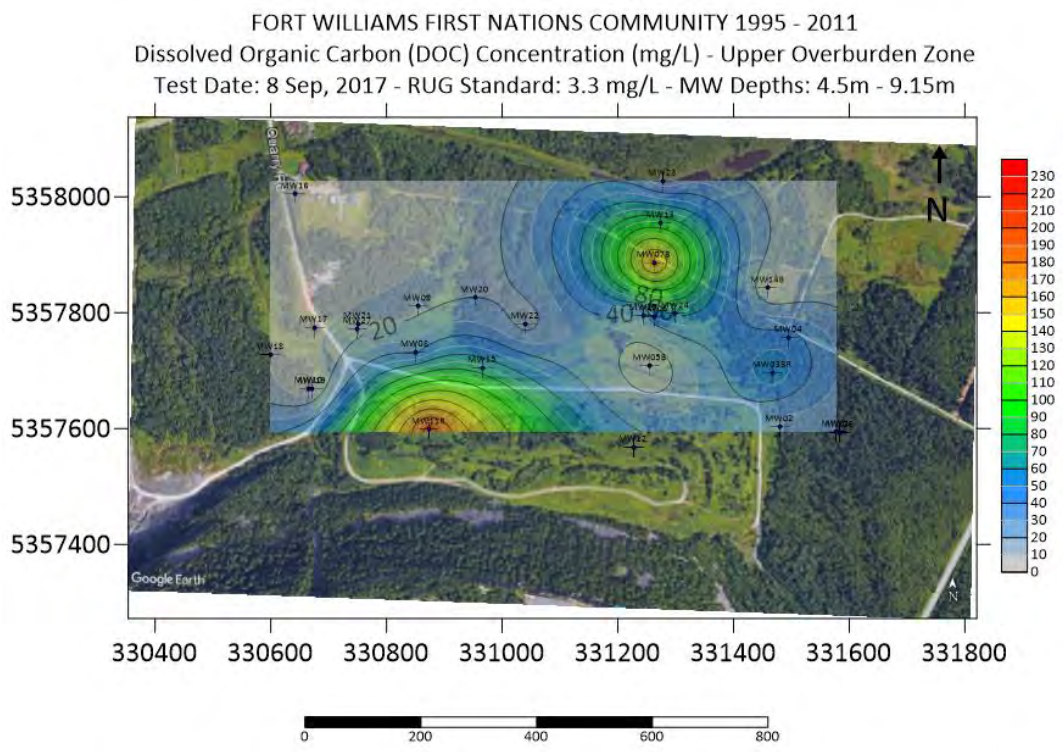

Figure 13: Dissolved Organic Carbon in Shallow Groundwater (September)

3.1.6. Iron

Iron is tested only on 19 July, 2017 (Figure 14). In the Upper Overburden Zone, contamination due to Iron is high in the waste disposal site concentrated at MW 11 R. This contamination moves towards the North – East side concentrated at MW 7 B. This contamination also moves towards the East direction, slightly high at MW 3 BR. The contamination has also spread toward North – West direction, slightly high at MW .

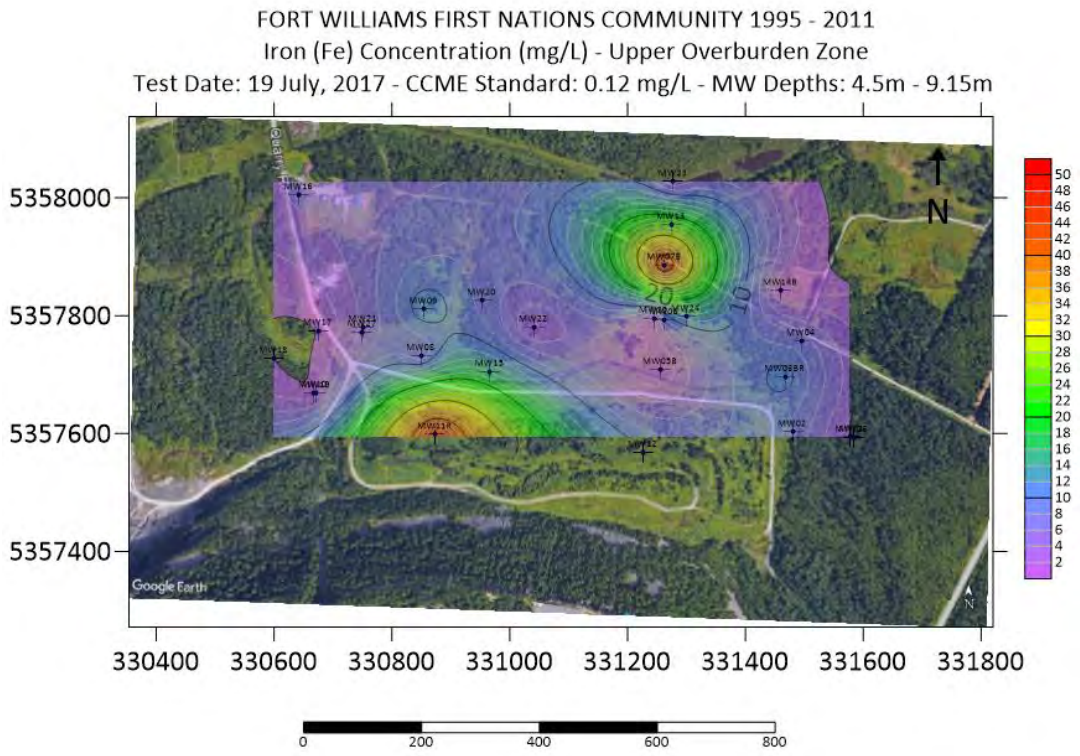

Figure 14: Iron in Shallow Groundwater

3.1.7. Manganese

Manganese is tested only on 19 July, 2017 (Figure 15). In the Upper Overburden Zone, contamination due to Manganese is high in the waste disposal site concentrated at MW 11 R. This contamination moves towards the North – East side concentrated at MW 7 B and MW 13. This contamination also moves towards the East direction. The contamination has also spread toward North – West direction.

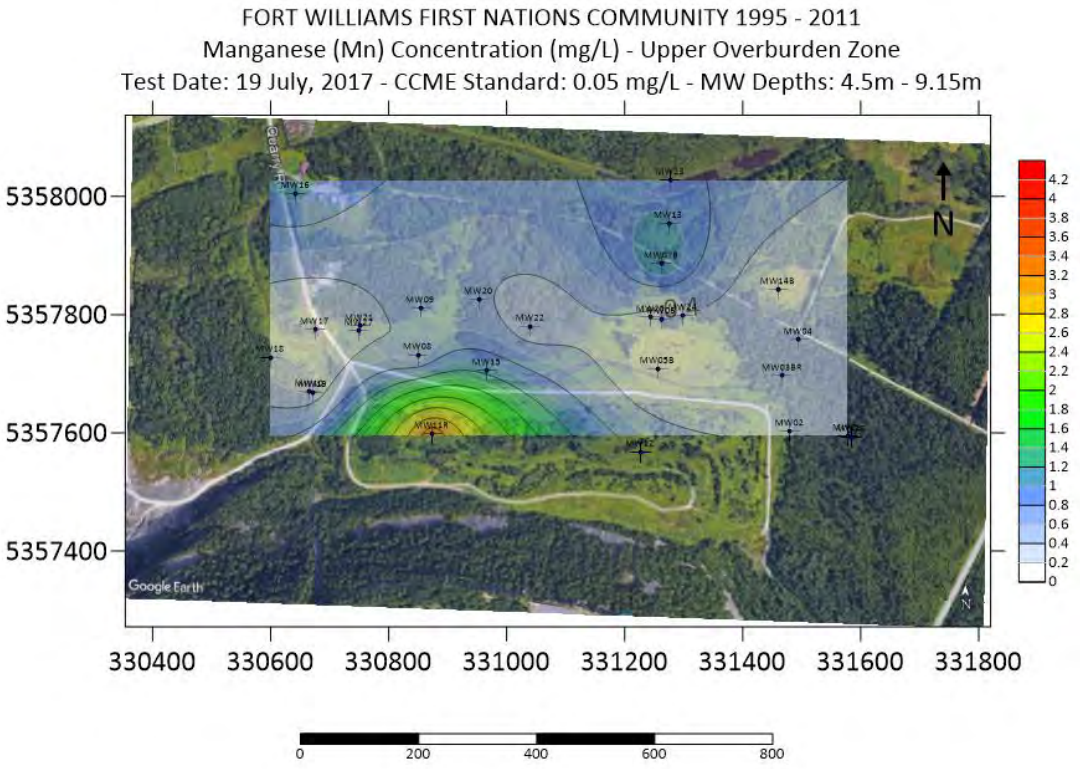

Figure 15: Manganese in Shallow Groundwater

3.1.8. Total Dissolved Solids

Total Dissolved Solids was tested three times during the year: 4-5 May, 19 July and 8 September. The contamination due to Total Dissolved Solids during the whole year (May – Figure 16, July – Figure 17 and September – Figure 18) is around the Waste Disposal Site concentrated at MW 11 R, this contamination has moved towards the North – East direction, high at MW 7 B and also slight contamination towards the East direction at MW 3 BR. On comparison of all three maps (May, July and September) the concentration in the MW 11R (bark dump) has slightly increased from May to July then from July to September.

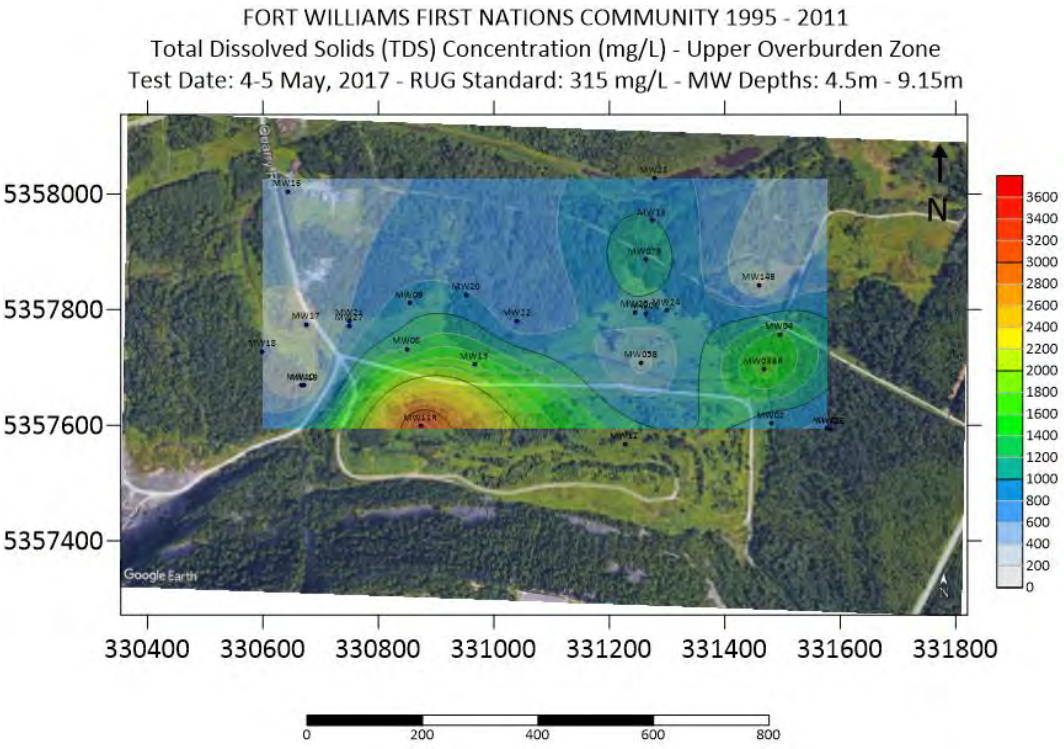

Figure 16: Total Dissolved Solids in Shallow Groundwater (May)

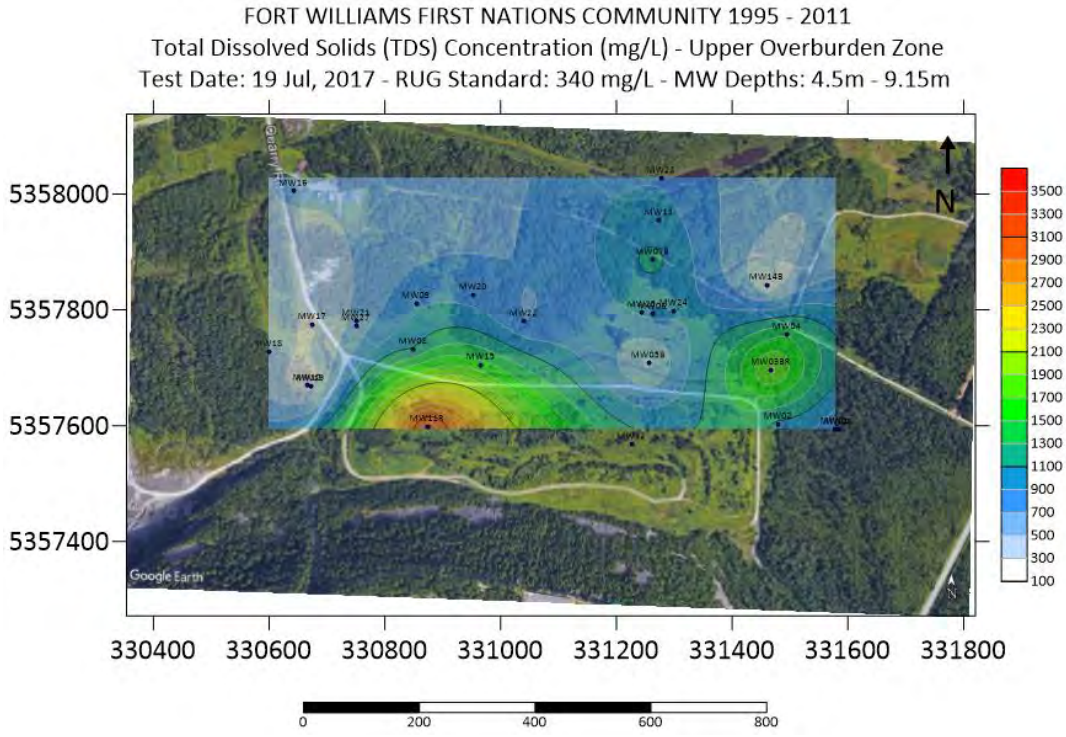

Figure 17: Total Dissolved Solids in Shallow Groundwater (July)

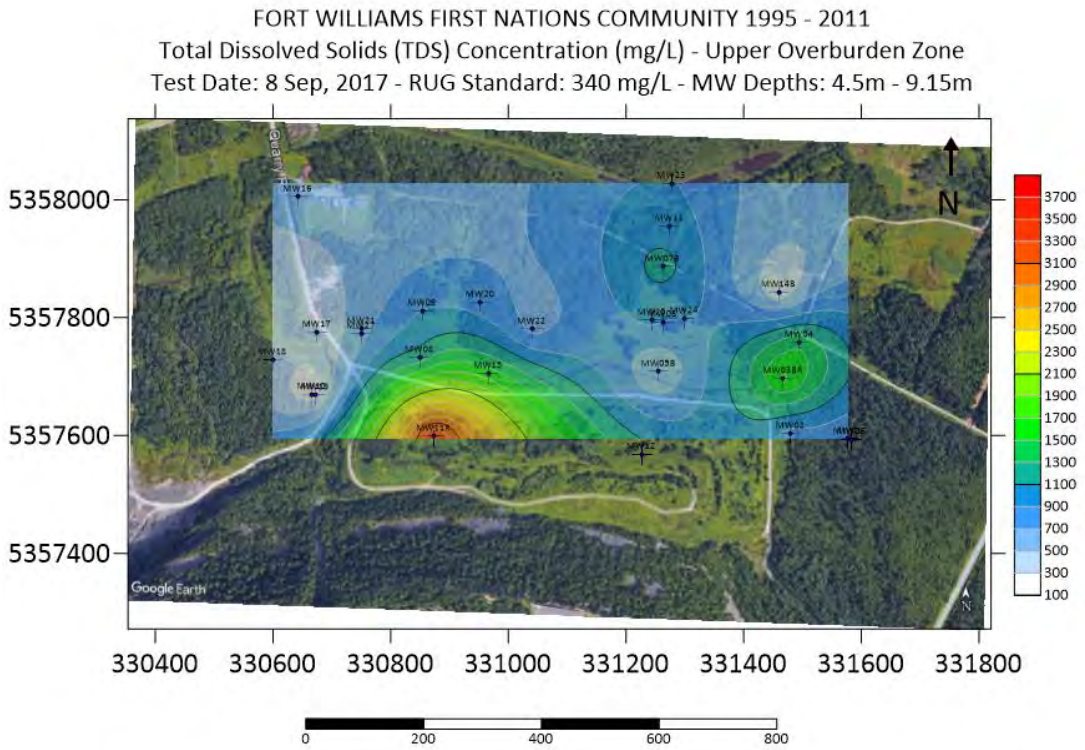

Figure 18: Total Dissolved Solids in Shallow Groundwater (September)

3.1.9 Ammonia, Phosphorus and Phenol

Ammonia, Phosphorus and Phenol all were tested three times during the year (in May July and September) but it was only tested for one monitoring well. MW 11 R. So due to inadequate data in the report which was not tested, the maps for Ammonia, Phosphorus and Phenols showing their respective contamination plumes were not possible. Though, it can be seen in the Table 4 below that all the concentrations for Ammonia, Phosphorus and Phenol are higher than the standard during the whole year in the MW 11 R.

	CCME	MW11R		
		5-May-17	19-Jul-17	8-Sep-17
Phenol	0.004	0.004	0.0294	0.0551
Ammonia	0.019	0.83	0.464	0.58
Total Phosphorus	0.015	0.415	0.599	0.649

Table 4: Ammonia, Phosphorus and Phenol in MW 11 R

3.2. Deep Groundwater

The monitoring wells in the Lower Overburden Zone and Bedrock Zone which has deep groundwater are listed in the Table 5 below along with their respective depths.

	Deep	
	MW	**Depth (m)**
Lower Overburdon Zone	MW03A	62.5
	MW05A	87.3
	MW07A	103
	MW21	155
Bedrock Zone	MW13	135
	MW14A	130
	MW15	130
	MW19	165
	MW20	220
	MW24	132
	MW26	124
	MW27	205

Table 5: Deep Monitoring Wells with Depths

Tables 6 and 7 include the ODWS (Ontario Drinking Water Standards), RUG criteria standards from MOECC and residential standards from CCME standards. All these are compared to the concentrations of substances in different monitoring wells in the **deep groundwater**. The ones in red are the greater than the most recent standard

available which makes it a contaminant. In the shallow groundwater, Total Dissolved Solids, Dissolved Organic Carbon, Chloride, Aluminum, Arsenic, Barium, Iron and Manganese are the contaminants.

		Units	ODWS	RUG	CCME	MW03A			MW05A			MW07A			MW13			MW14A			MW15		
						4-May-17	19-Jul-17	8-Sep-17	4-May-17	19-Jul-17	8-Sep-17	5-May-17	19-Jul-17	8-Sep-17	4-May-17	19-Jul-17	8-Sep-17	4-May-17	19-Jul-17	8-Sep-17	4-May-17	19-Jul-17	8-Sep-17
General Chemistry	Electrical Conductivity					552	530	542	1320	1270	1160	253	249	243	711	666	667	1170	1060	996	813	802	792
	Total Dissolved Solids	mg/L	500	315		304	426	435	702	849	729	501	311	601	381	370	374	700	670	610	456	501	479
	Dissolved Organic Carbon	mg/L	5	3.25		16	22.3	17.7	13.5	12.4	11.7	3.3	3.96	4.3	3.3	3.94	4	3.1	3.18	3.7	8.2	7.96	8
Anion	Chloride	mg/L	250	126		4.14	4.6	3.61	135	156	115	1.44	1.48	1.27	157	151	151	298	274	252	32.4	33.9	33.5
Metals	Alumnium	mg/L	0.1	0.0539	0.004		0.0036			0.0026			0.0325			0.0023			0.002			0.0024	
	Antimony	mg/L	0.006	0.0025			0.00018			0.0001			0.00011			0.0001			0.0001			0.0001	
	Arsenic	mg/L	0.01	0.0061	0.005		0.022			0.00314			0.00984			0.00113			0.00025			0.00232	
	Barium	mg/L	1	0.323	0.112		0.106			0.954			0.0309			0.19			1.84			1.13	
	Beryllium	mg/L	-		0.00004		0.0001			0.0001			0.0001			0.0001			0.0001			0.0001	
	Bismuth	mg/L	-				0.00005			0.00005			0.00005			0.00005			0.00005			0.00005	
	Boron	mg/L	5	1.28	1.5		0.067			0.233			0.122			0.199			0.277			0.224	
	Cadmium	mg/L	0.005	0.00128			3.2E-05			0.000005			1.37E-05			0.00021			4.2E-05			5E-06	
	Chromium	mg/L	0.05	0.013			0.0001			0.00041			0.0001			0.0001			0.0001			0.00017	
	Cobalt	mg/L	-				0.00033			0.00018			0.0001			0.00014			0.0001			0.00014	
	Copper	mg/L	1	0.501			0.00099			0.0002			0.00442			0.0002			0.0002			0.0002	
	Iron	mg/L	0.3	0.169			0.031			0.228			0.01			0.013			0.102			0.959	
	Lead	mg/L	0.01	0.00291			8.1E-05			0.00005			0.00005			0.00005			0.00005			0.00005	
	Manganese	mg/L	0.05	0.0293			0.0574			0.101			0.00601			0.0153			0.0288			0.158	
	Molybdenum	mg/L			0.073		0.0323			0.00245			0.0231			0.118			0.047			0.00173	
	Nickel	mg/L			0.0029		0.00152			0.0005			0.00071			0.0005			0.0005			0.0005	
	Selenium	mg/L	0.05	0.0136	0.00001		0.00019			0.000916			0.000055			0.00042			0.00029			0.0005	
	Silicon	mg/L					8.61			12.9			5.4			6.39			8.2			16.1	
	Silver	mg/L			0.00025		0.00001			0.00001			0.00001			0.00001			0.00001			0.00001	
	Strontium	mg/L					0.156			1.4			0.056			0.392			1.21			0.917	
	Thallium	mg/L			0.0008		0.00001			0.00001			0.00001			0.00001			0.00001			0.00001	
	Tin	mg/L					0.00011			0.0001			0.00014			0.00012			0.0001			0.00012	
	Titanium	mg/L					0.00037			0.00033			0.0009			0.0003			0.0003			0.0003	
	Tungsten	mg/L					0.00041			0.00036			0.00062			0.00063			0.00046			0.00012	
	Uranium	mg/L	0.02	0.00624	0.015		0.00024			0.00001			0.00112			2.8E-05			0.00001			0.00001	
	Vanadium	mg/L					0.00334			0.00128			0.00172			0.0005			0.0005			0.00067	
	Zinc	mg/L	5	2.5			0.0013			0.0019			0.001			0.0027			0.0018			0.001	
	Zirconium	mg/L					0.00048			0.00141			0.000077			0.00006			0.00006			0.00061	

Table 6:Concentration of Substances in Deep Groundwater

		Units	ODWS	RUG	CCME	MW19			MW20			MW21			MW24			MW26			MW27		
						4-May-17	19-Jul-17	8-Sep-17	4-May-17	19-Jul-17	8-Sep-17	4-May-17	19-Jul-17	8-Sep-17	4-May-17	19-Jul-17	8-Sep-17	4-May-17	19-Jul-17	8-Sep-17	4-May-17	19-Jul-17	8-Sep-17
General Chemistry	Electrical Conductivity					199	196	197	307	293	296	234	333	339	419	419	423	997	1030	1090	386	261	256
	Total Dissolved Solids	mg/L	500	315		98	129	133	196	183	190	141	213	222	247	252	258	562	647	741	206	171	150
	Dissolved Organic Carbon	mg/L	5	3.25		1.1	2.48	1	5.1	2.85	2.8	10.4	9.15	9.1	4.5	3.92	3.6	2.9	2.85	2.4	3.2	1.56	1.8
Anion	Chloride	mg/L	250	126		2.13	2.33	1.94	23.4	22.2	22	5.99	7.62	7.06	47	52.7	56.4	249	273	297	6.88	13.6	14.5
Metals	Alumnium	mg/L	0.1	0.0539	0.004		0.002			0.002			0.002			0.0049			0.0021			0.002	
	Antimony	mg/L	0.006	0.0025			0.0001			0.0001			0.00011			0.0001			0.0001			0.0001	
	Arsenic	mg/L	0.01	0.0061	0.005		0.00025			0.00054			0.0358			0.00231			0.00033			0.0001	
	Barium	mg/L	1	0.323	0.112		0.198			0.485			0.0264			0.404			1.18			0.15	
	Beryllium	mg/L	-		0.00004		0.0001			0.0001			0.0001			0.0001			0.0001			0.0001	
	Bismuth	mg/L	-				0.00005			0.00005			0.00005			0.00005			0.00005			0.00005	
	Boron	mg/L	5	1.28	1.5		0.015			0.164			0.062			0.279			0.229			0.151	
	Cadmium	mg/L	0.005	0.00128			5E-06			5E-06			1.36E-05			5E-06			4.2E-05			5E-06	
	Chromium	mg/L	0.05	0.013			0.0001			0.0001			0.0001			0.0001			0.0001			0.0001	
	Cobalt	mg/L	-				0.0001			0.0001			0.00012			0.0001			0.0001			0.0001	
	Copper	mg/L	1	0.501			0.0002			0.0002			0.0002			0.0002			0.0002			0.0002	
	Iron	mg/L	0.3	0.169			0.025			0.071			0.122			0.033			0.456			1.03	
	Lead	mg/L	0.01	0.00291			0.00005			0.00005			0.00005			0.00005			0.00005			0.00005	
	Manganese	mg/L	0.05	0.0293			0.00759			0.00881			0.142			0.0172			0.106			0.0484	
	Molybdenum	mg/L			0.073		0.00117			0.00115			0.032			0.00924			0.0446			0.00078	
	Nickel	mg/L			0.0029		0.0005			0.0005			0.00072			0.0005			0.0005			0.0005	
	Selenium	mg/L	0.05	0.0136	0.00001		0.00025			0.00027			0.000067			0.00032			0.0004			0.00284	
	Silicon	mg/L					5.32			7.39			7.45			7.52			6.83			6.08	
	Silver	mg/L			0.00025		0.00001			0.00001			0.00001			0.00001			0.00001			0.00001	
	Strontium	mg/L					0.152			0.377			0.0888			0.402			0.882			0.253	
	Thallium	mg/L			0.0008		0.00001			0.00001			0.00001			0.00001			0.00001			0.00001	
	Tin	mg/L					0.00012			0.00015			0.00041			0.00013			0.0001			0.00015	
	Titanium	mg/L					0.0003			0.0003			0.00042			0.0003			0.0003			0.0003	
	Tungsten	mg/L					0.0001			0.00042			0.00052			0.00106			0.00091			0.00031	
	Uranium	mg/L	0.02	0.00624	0.015		1.6E-05			0.00001			0.000037			0.00001			0.00001			0.00001	
	Vanadium	mg/L					0.0005			0.0005			0.0005			0.0005			0.0005			0.0005	
	Zinc	mg/L	5	2.5			0.0017			0.001			0.0013			0.001			0.0017			0.001	
	Zirconium	mg/L					0.00006			6E-06			0.000162			0.00006			0.00006			0.00006	

Table 7: Concentration of Substances in Deep Groundwater contd.

3.2.1 Aluminum

Aluminum was tested only on 19 July, 2017 (Figure 19). In the Deep Groundwater, contamination due to Aluminum is highly concentrated at MW 7 A.

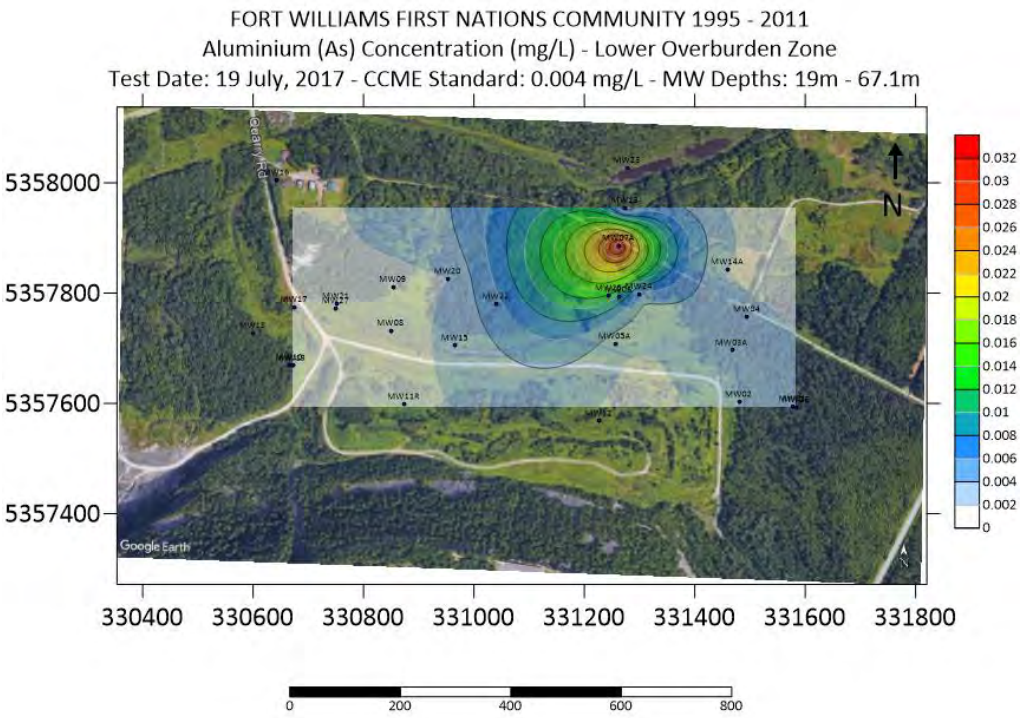

Figure 19: Aluminum in Deep Groundwater

3.2.2. Arsenic

Arsenic was tested only on 19 July, 2017 (Figure 20). In the Deep Groundwater, contamination due to Arsenic is high towards the North – West direction at MW 24This contamination also slightly concentrated at MW 3 A.

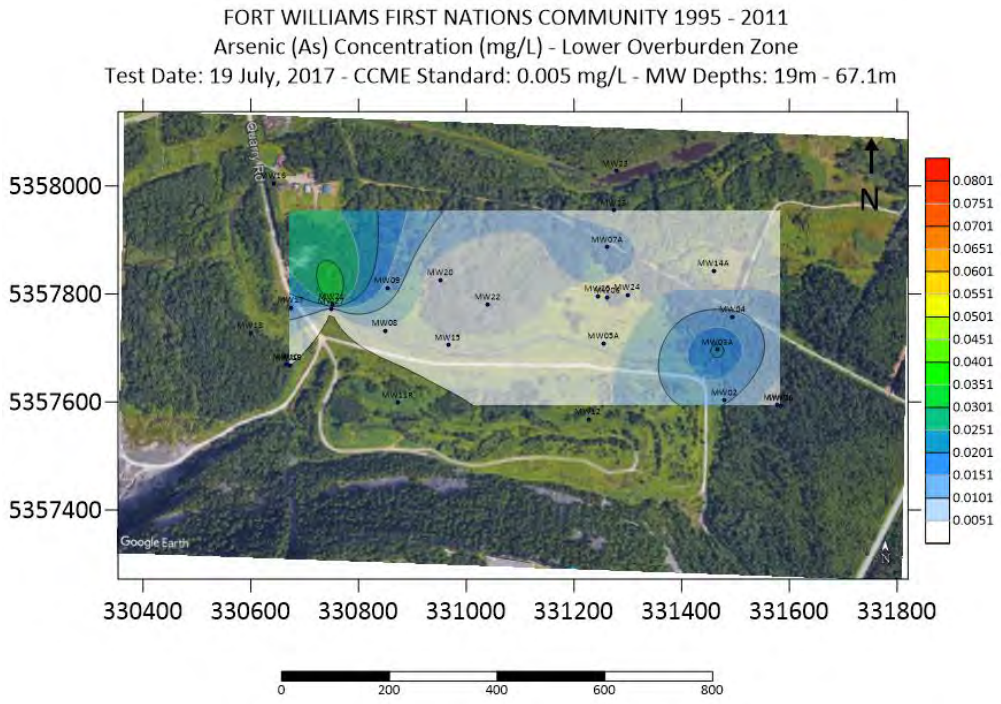

Figure 20: Arsenic in Deep Groundwater

3.2.3. Barium

Barium was tested only on 19 July, 2017 (Figure 21). In the Deep Groundwater, contamination due to Barium is highly concentrated towards the North – East direction at MW 14A. This contamination also slightly concentrated at MW 15.

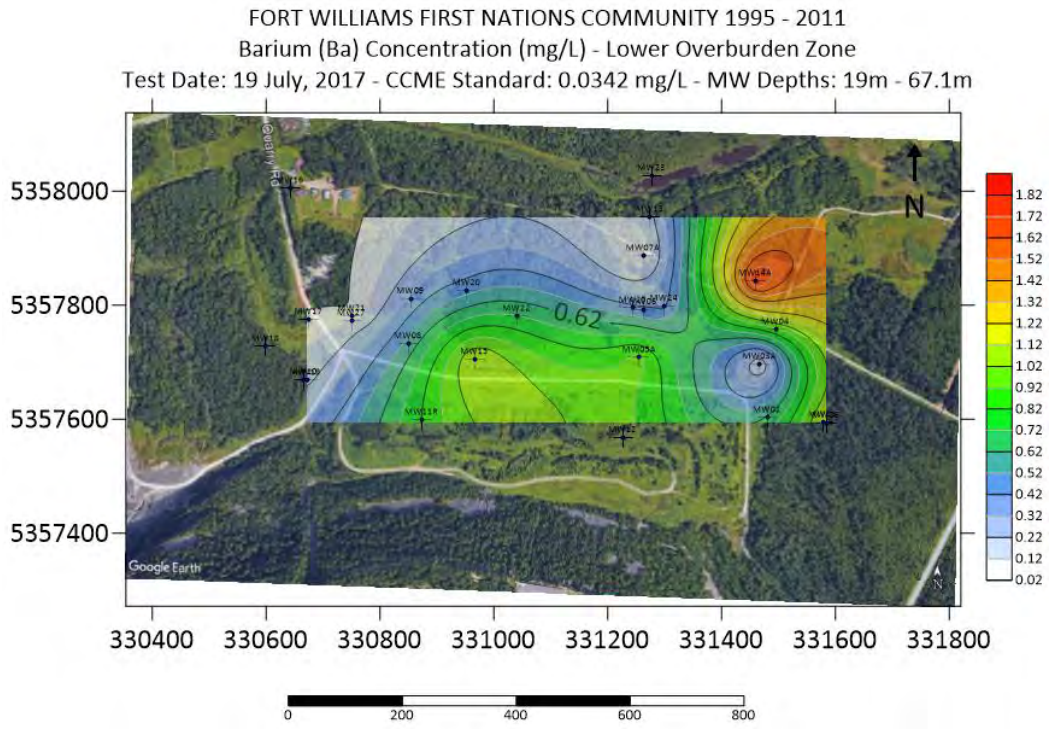

Figure 21: Barium in Deep Groundwater

3.2.4. Chloride

The Chloride was tested three times during the year: 4-5 May, 19 July and 8 September. The contamination due to Chloride during the whole year (May – Figure 22, July – Figure 23 and September – Figure 24) is in the North – East direction at MW 14 A Rest of the area is not under concern (below the standard). On comparison of all three maps (May, July and September) the concentration in the MW 11R (bark dump) has slightly decreased from May to July then from July to September. It could be a big assumption that the contamination has shifted more towards North-East.

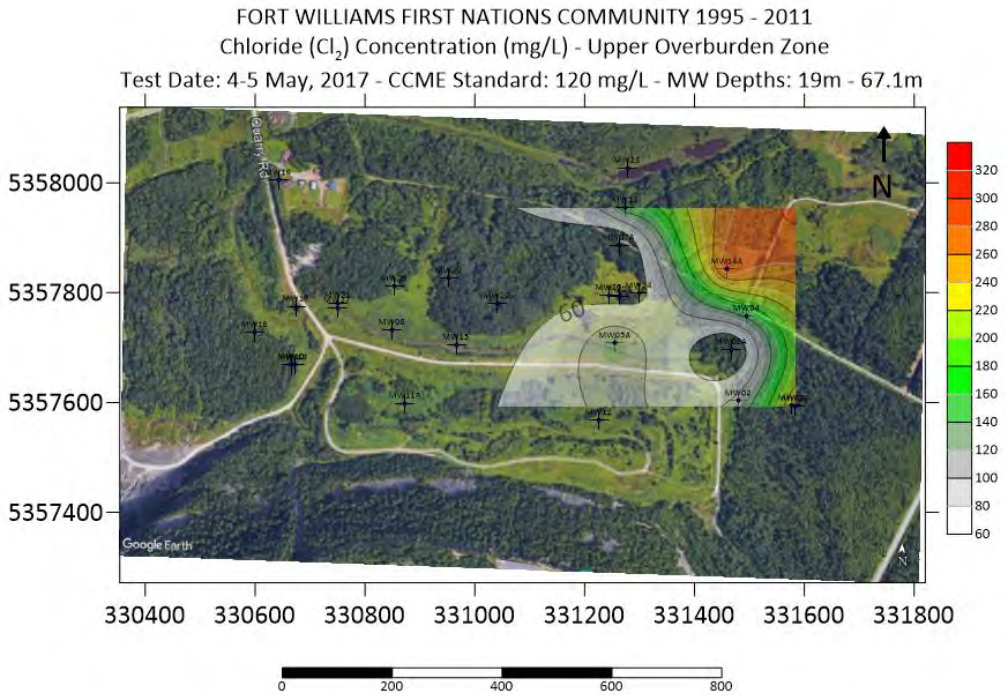

Figure 22: Chloride in Deep Groundwater (May)

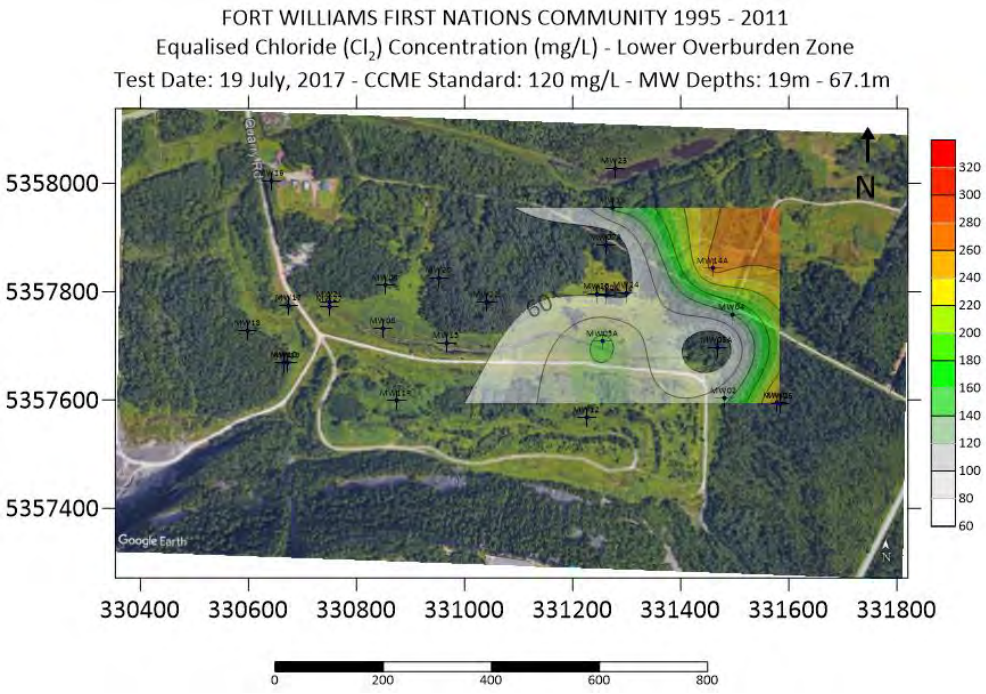

Figure 23: Chloride in Deep Groundwater (July)

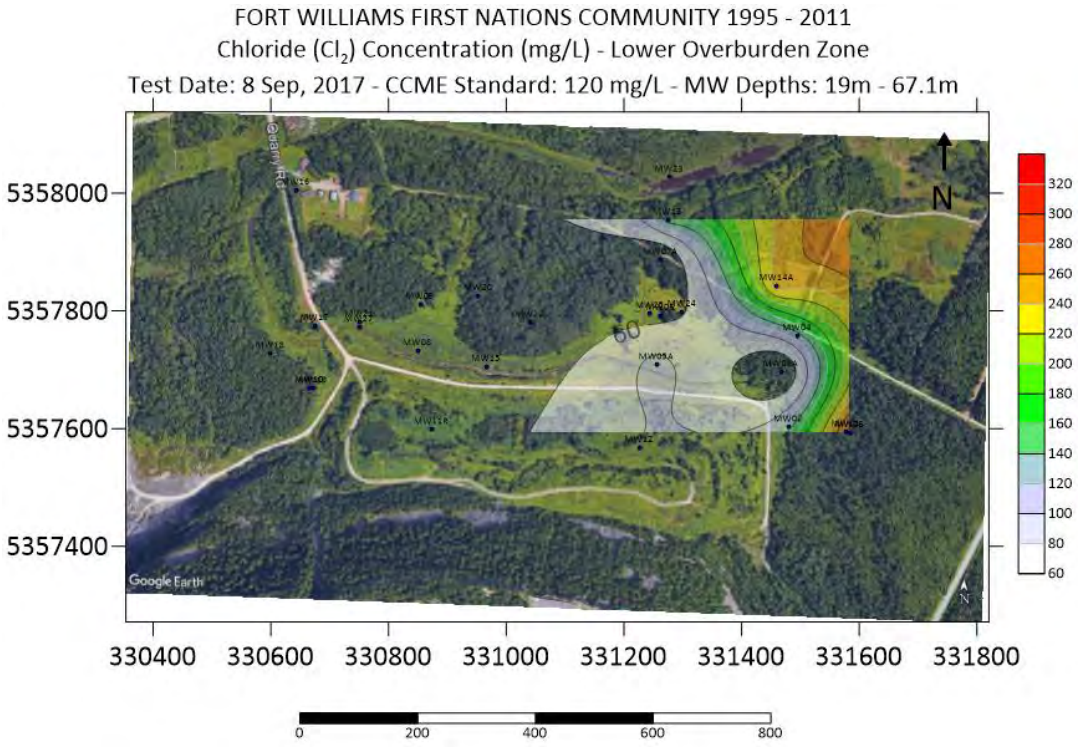

Figure 24: Chloride in Deep Groundwater (September

3.2.5. Dissolved Organic Carbon

The Dissolved Organic Carbon was tested three times during the year: 4-5 May, 19 July and 8 September. The contamination due to Dissolved Organic Carbon during the whole year (May – Figure 25, July – Figure 26 and September – Figure 27) is highly concentrated towards the East side at MW 3 A. This contamination is also high towards the North – West direction at MW 21. On comparison of all three maps (May, July and September), all the maps are quite identical with a very slight change.

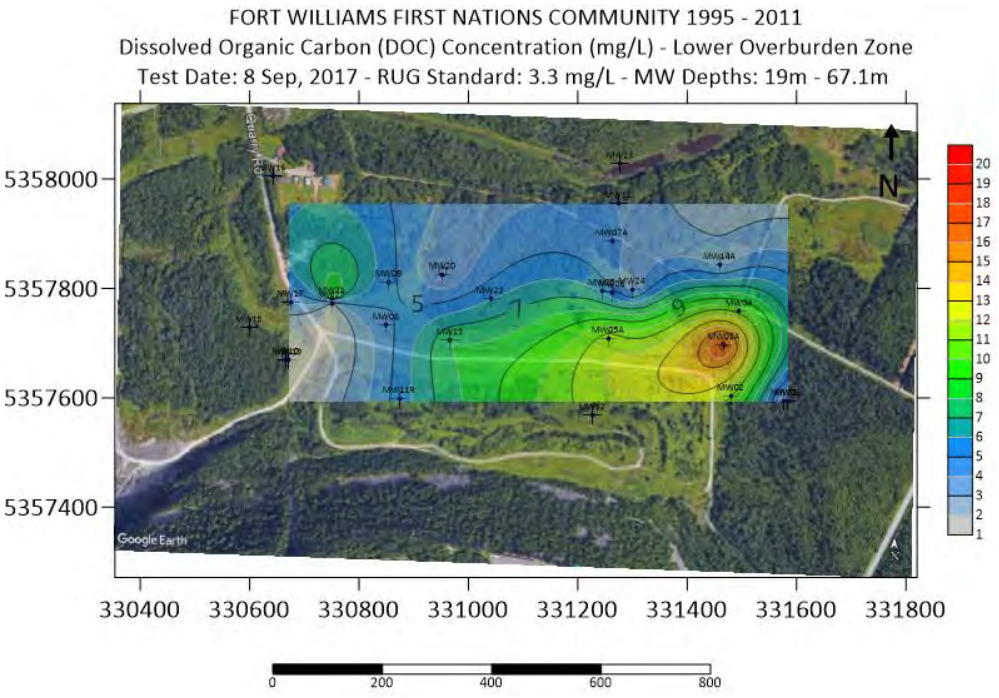

Figure 25: Dissolved Organic Carbon in Deep Groundwater (May)

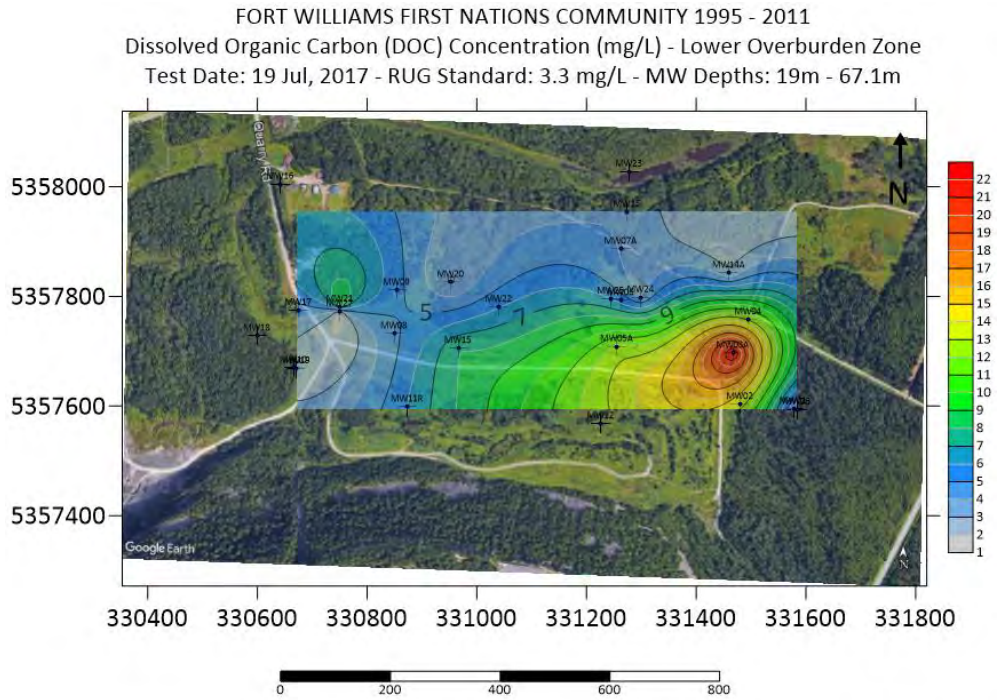

Figure 26: Dissolved Organic Carbon in Deep Groundwater (July)

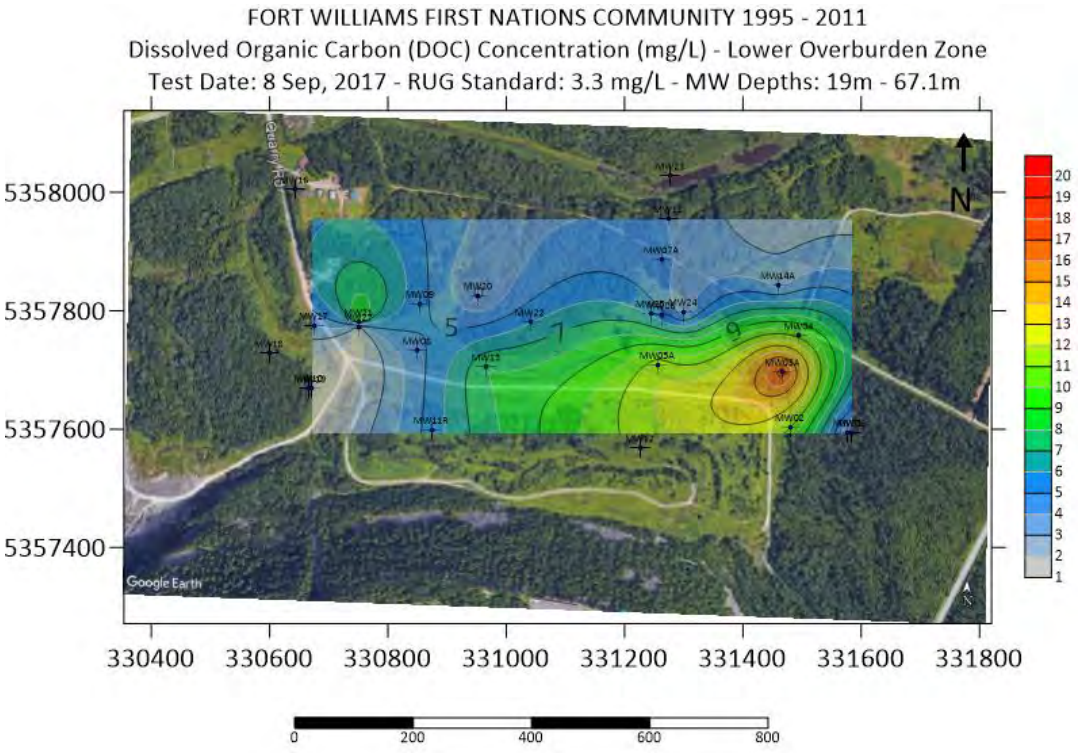

Figure 27: Dissolved Organic Carbon in Deep Groundwater (September)

3.2.6. Iron

Iron was tested only on 19 July, 2017 (Figure 28). In the Deep Groundwater, contamination due to Iron is highly concentrated towards the North – East direction at MW 27, and also at MW 15.

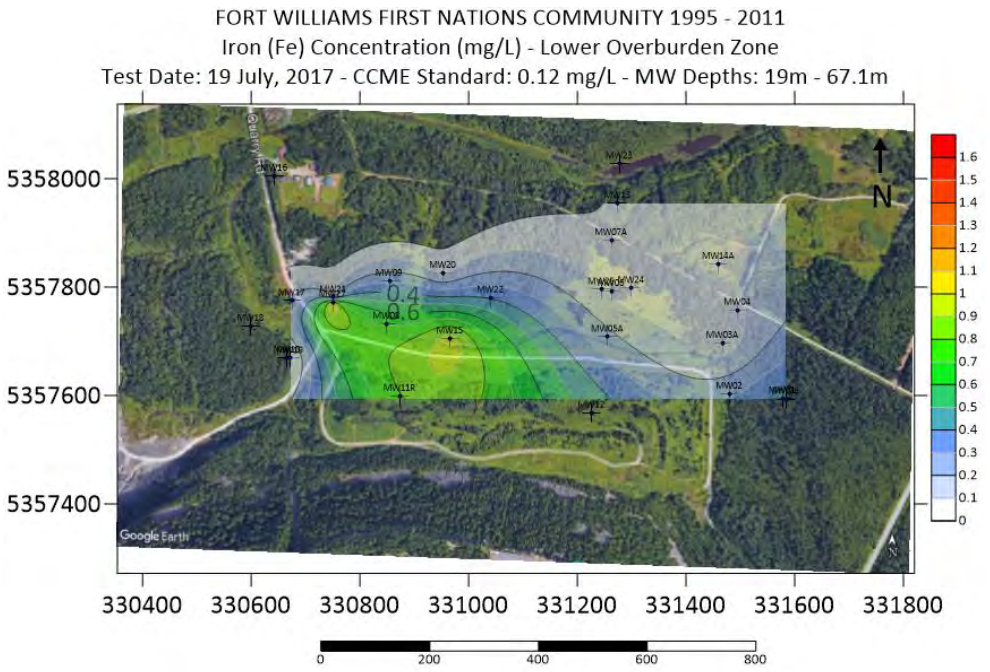

Figure 28: Iron in Deep Groundwater

3.2.7. Manganese

Manganese was tested only on 19 July, 2017 (Figure 29). In the Deep Groundwater, contamination due to Manganese has spread towards the North – East direction concentrated at MW 21, and also at MW 15.

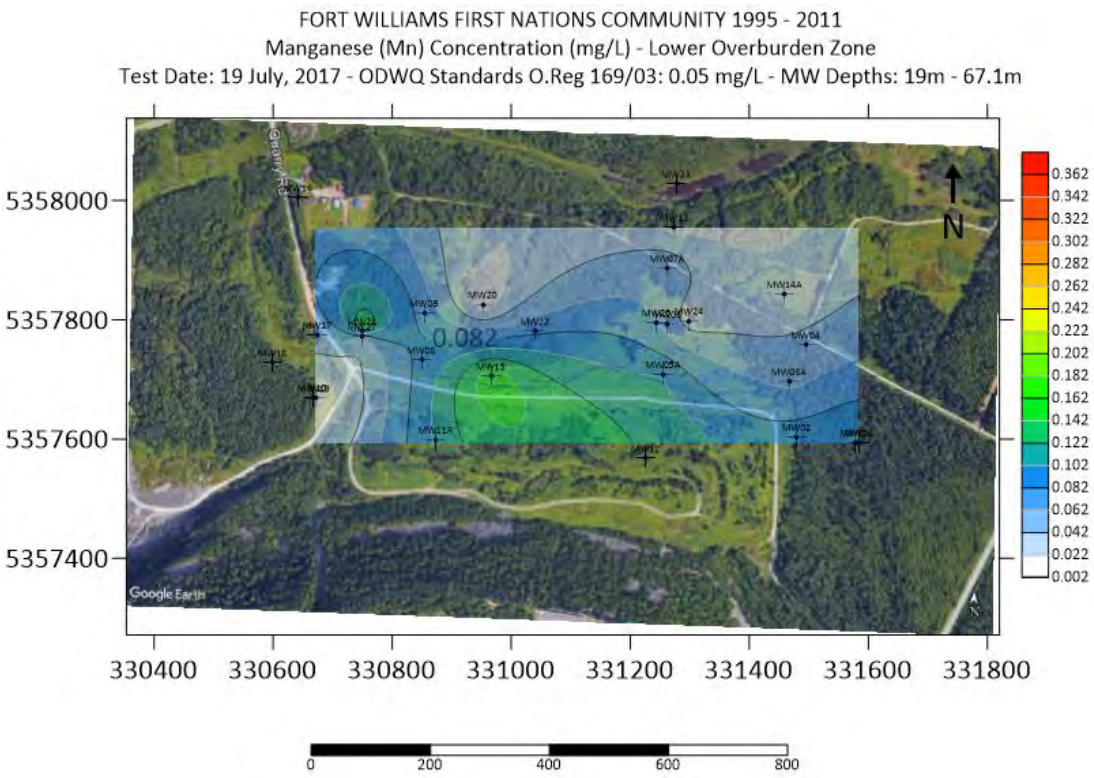

Figure 29: Manganese in Deep Groundwater

3.2.8. Total Dissolved Solids

The Total Dissolved Solids was tested three times during the year: 4-5 May, 19 July and 8 September. The contamination due to Total Dissolved Solids during the whole year (May – Figure 30, July – Figure 31 and September – Figure 32) is highly concentrated side at MW 5 A. This contamination is also high towards the North – East direction at MW 14 A. On comparison of all three maps (May, July and September), all the maps are quite identical with a very slight increase at MW 5 A from May to July.

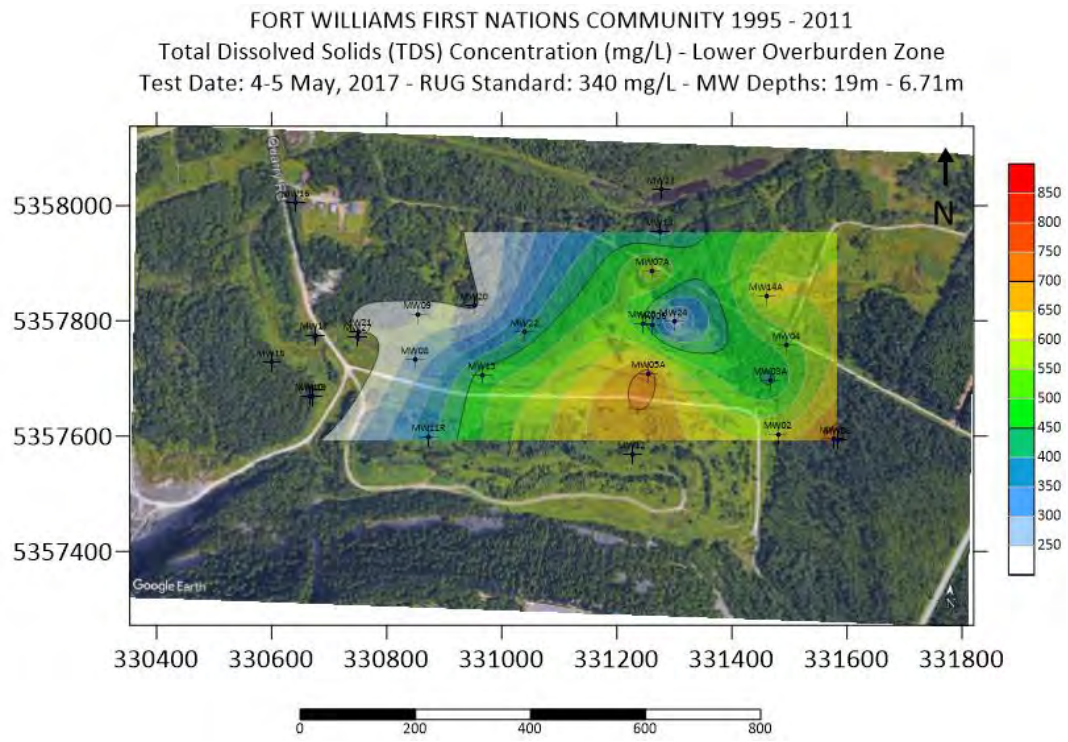

Figure 30: Total Dissolved Solids in Deep Groundwater (May)

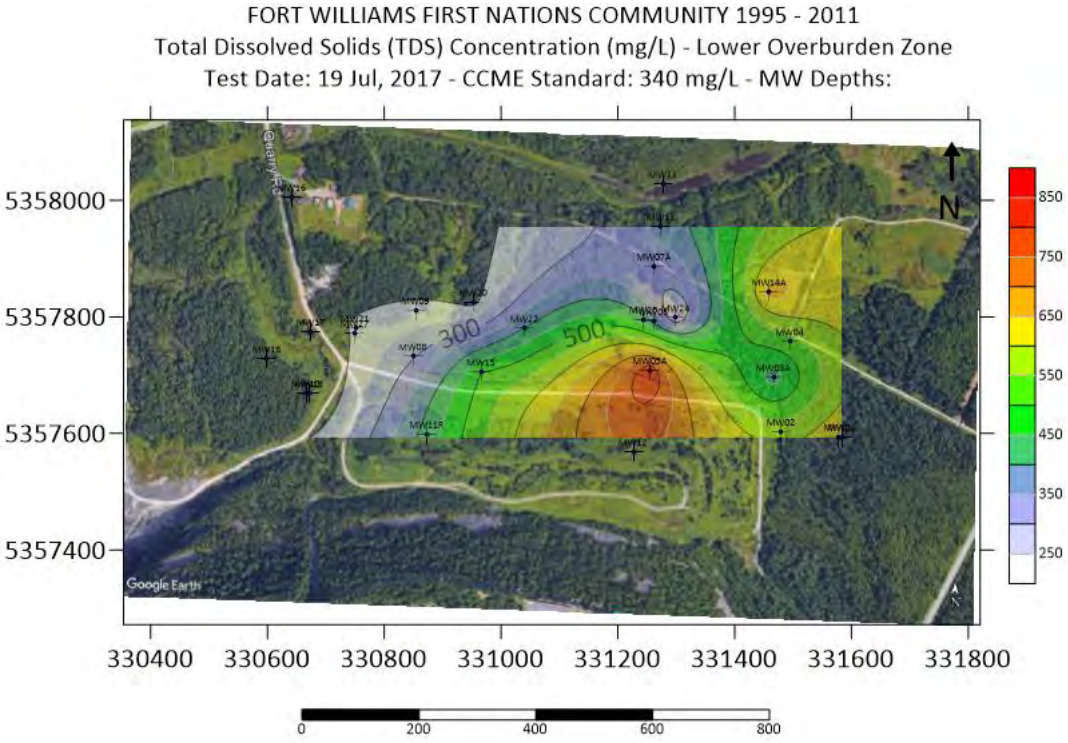

Figure 31: Total Dissolved Solids in Deep Groundwater (July)

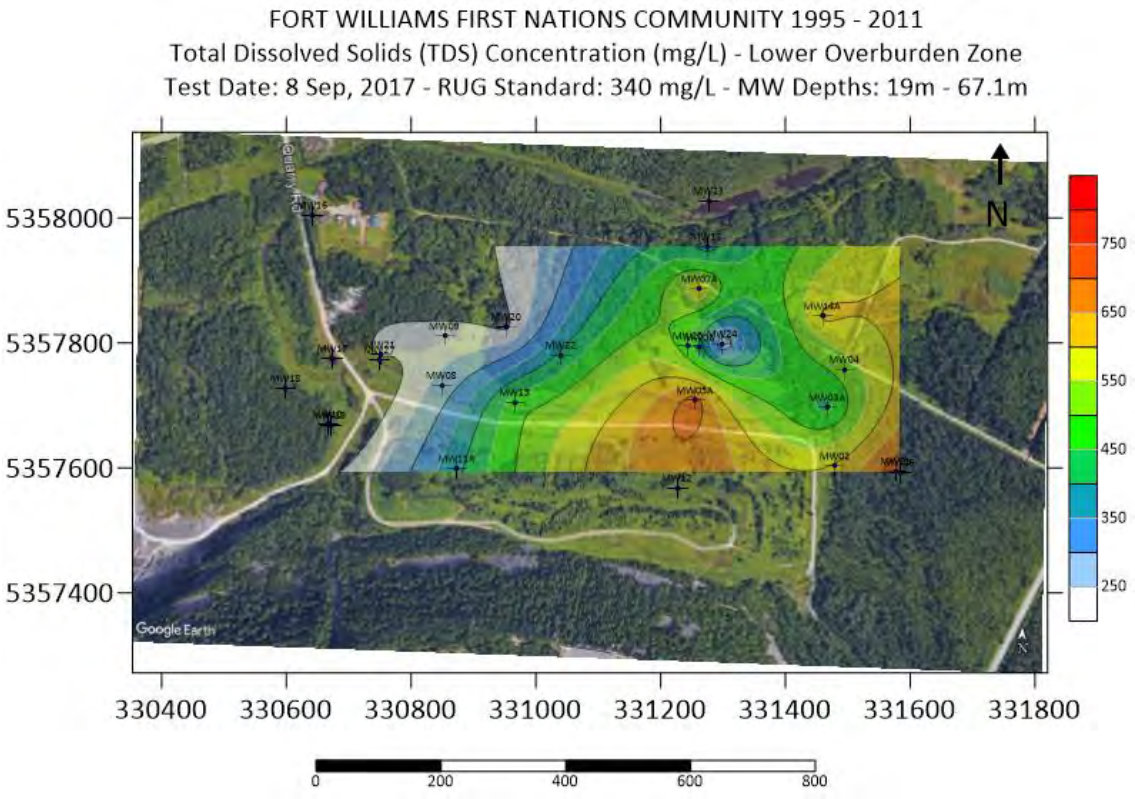

Figure 32: Total Dissolved Solids in Deep Groundwater (September)

3.3. Methane

The data provided in the Table 4 below misses a lot of monitoring wells which means a lot of monitoring wells have not been tested for Methane concentration due to which a good map that could show us contamination movement or location during the years was not possible. The yellow ones shown are the deep monitoring wells. Though from the data provided in the 2017 report it can be said that there is very high concentration of Methane (Waste Disposal Site) in the shallow and in the deep groundwater the methane concentration could be seen high in East at MW 3 A and in the center at MW 15 in May, 2017

Well ID	Units	3-May-17		18-Jul-17		6-Sep-17	
		Field	Lab	Field	Lab	Field	Lab
MW01	ppm	0	1.9	0	8.8	0	32
MW02	ppm	0	1.9	0	1.9	0	2.1
MW03A	ppm	450	248	0	223	610	194
MW03BR	ppm	0	1.9	0	1.7	0	2.9
MW04	ppm	0	1.9	0	2	0	2.7
MW05A	ppm	0	2.2	0	1.6	0	1.9
MW05B	ppm	0	2.1	0	1.9	0	1.5
MW06	ppm	0	1.9	0	1.7	0	2
MW08	ppm	0	2.3	0	2.3	0	193
MW09	ppm	0	1.9	0	1.8	0	2.2
MW10	ppm	0	1.9	0	1.9	0	2
MW11R	ppm	50250	114000	3550	1800	50250	201000
MW15	ppm	310	163	0	3.1	0	3.2
MW17	ppm	0	5.8	0	1.8	0	45
MW21	ppm	75	2.6	0	1.6	0	3.3

Table 8: Methane

4. Conclusion and Recommendations

In the Shallow Groundwater, trend was seen of contamination plumes of different contaminants shifting towards the East and North- East direction which is towards the Fort Williams First Nations Community and also some towards river. And, in the Deep Groundwater, there was no particular trend but the contamination plumes if compared from the waste disposal site (bark dump) either make their way towards the river or the Fort Williams First Nations community. This analysis basically gives better understanding of the location contamination plume which could help to estimate the area of further investigation to find the plume and remediate. So, from this analysis it is

recommended that the further research and construction of new monitoring wells should be done towards the East and North-East direction.

Leukemia is caused majorly because of exposure to BTEX (benzene, toluene, ethylbenzene, and xylene), especially Benzene. But there is no record of any of the BTEX compounds. As it is evident in the Results that nor BTEX neither any hydrocarbon detection test was conducted and recorded. Phenol, very close to Benzene was only tested for MW 11 R (at the waste disposal site), also Methane was not tested at all monitoring wells. Due to which the location of contaminants that majorly lead to the mentioned disease could not be found. So, it is recommended that the testing of Benzene should be done on all monitoring wells.

Further investigations and actions may be necessary to address the contamination and its potential impacts on the health and well-being of the Fort Williams First Nations Community and the surrounding water bodies. This may include implementing remediation measures to mitigate the contamination, conducting additional monitoring and assessment to better understand the extent and severity of the contamination, and engaging with relevant stakeholders, including the First Nation community, regulatory agencies, and the mill owners, to address the environmental concerns and find solutions to protect the health and environment of the affected area.

5. References

Bosgoed Project Consultants Ltd. (June, 1996). Phase II Environmental Issues Inventory: Addendum A. (Project No. 34604). [Fort Williams First Nation].

Oshki-Aki LP. (March 27, 2018). 2017 Water Quality Assessment: Mount McKay Waste Disposal Site, Thunder Bay, Ontario (Project No. 17-429-59). [Resolute FP Canada Inc.].