PARKS CANADA AGENCY

GARDEN RIVER, AB COMMUNITY AIRSTRIP AND OLD LANDFILL REPORTS REVIEW AND REMEDIATION OPTIONS ANALYSIS

REPORT

MARCH 2013
ISSUED FOR REVIEW
EBA FILE: E22103088-01

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EXECUTIVE SUMMARY

Parks Canada Agency (PCA) retained EBA Engineering Consultants Ltd., operating as EBA, A Tetra Tech Company (EBA) to review previous environmental reports available for the Garden River Community Airstrip and Old Landfill, conduct a remediation options analysis and provide Remediation Action Plans (RAPs)(including Class C cost estimates) for these sites. The Garden River Community is a part of the Little Red River Cree Nation and is located at the western edge of Wood Buffalo National Park in Alberta. The location of Garden River is shown on Figure 1 and the Community Airstrip and Old Landfill locations are shown on Figure 2.

The Community Airstrip is located at the northern end of the community of Garden River and is currently in use. The unpaved airstrip was constructed in the 1960s for use by the sawmill that was previously located in the community. The Old Landfill is located at the eastern end of the community of Garden River, approximately 500 m south of the Community Airstrip. The Old Landfill is understood to have been excavated and operated without a liner in place. The volume and composition of waste at this site is understood to be highly variable, as no restrictions were imposed on disposal. It is understood that dump closure in this area consisted of covering waste with fill/soil when the dump site was abandoned in 1998. The Old Landfill comprises an approximate 4,000 m^2 area with additional off-site debris areas (approximately 2,000 m^2) both north and south of the landfill. In this report, references to the Old Landfill site include both the Old Landfill and adjacent debris areas. The locations of Old Landfill and debris areas are shown on Figure 4a.

Findings

EBA reviewed the four previous environmental investigation reports available for these sites. Based on the reports review, the impacted soil volume at the Community Airstrip is estimated to be 250 m^3 where identified parameters of concern were benzene, toluene, ethylbenzene, xylenes (BTEX) and petroleum hydrocarbon fractions F1 and F2. Hydrocarbon impacts are limited to surface soils to a maximum depth of 1 m below grade (mbg) (see Table C for details). At the Old Landfill site, the impacted soils are estimated to be 7,200 m^3 where metals were the main parameters of concern. The impacted soils are limited to the surface soils to an approximate depth of 1.5 mbg (see Table E for details). Figures 3a and 4a show the estimated impacted areas at the Community Airstrip and Old Landfill sites, respectively.

EBA assessed remediation options to determine the most feasible options that could be implemented for both the sites by considering the identified parameters of concern, on and off-site conditions and site locations (see Tables G and H in the report for details). Based on the remediation options analysis, EBA provides four feasible options for each site for consideration. These options are summarized in the following tables.

Remediation Options for Hydrocarbon Impacted Soils at Community Airstrip

Options	Class C Cost Estimate	Time	Location	Flexibility	
				Pros	Cons
Option 1 - Excavation and Landfarming	$210,000	Years	On/Off-site	▪ Cost effective ▪ Can be carried out on-site or off-site	▪ Time involved to remediate soils could be substantial ▪ Toxic by-products may be produced ▪ Microbial action may be impacted by salts, metals, and trace organic compounds
Option 2 - Excavation and Landfill Disposal at Rainbow Lake, AB	$200,000	Days to weeks	Off-site	▪ Simplest remediation method ▪ Appropriate for soils with high levels of contaminants	▪ May be restrictions at landfill location ▪ Expensive transportation costs ▪ Potential human and ecological risks in the event of an accident during transportation ▪ Regulatory liaison delays ▪ Impacts to roads ▪ Greenhouse gas emissions by tracks ▪ Accidental spills
Option 3 - Excavate and Deposit in New Landfill Construct at Old Landfill Site	$150,000	Days	Off-site	▪ Please, see Option 3 in Table J below	
Option 4 - Excavate and Deposit in New Landfill Construct 3 Km West of community of Garden River	$250,000	Days	Off-site	▪ Please, see Option 4 in Table J below	

Remediation Options for Impacted Soils at Old Landfill

Options	Class C Cost Estimate	Time	Location	Flexibility	
				Pros	Cons
Option 1 - Capping and Monitoring	$1,570,000	Weeks	On-site	▪ Lower cost ▪ Less time period possible ▪ Potential end land uses – pasture, recreational, cultivation, and forestry	▪ Contaminated soils remains on-site ▪ Future monitoring (groundwater monitoring) required to verify soil leaching to groundwater and groundwater transport not occurring ▪ Soil cap thickness and design must ensure no human or ecological access to soils. ▪ Soil cap must be maintained in perpetuity. ▪ Clay cap may increase the build-up of landfill gas and venting may be required. ▪ Restricts nearby for residential development
Option 2 - Excavation and Landfill Disposal at Rainbow Lake, AB	$3,920,000	Weeks	Off-site	▪ Simplest remediation method ▪ Appropriate for soils with high levels of contaminants	▪ May be restrictions at landfill location ▪ Expensive transportation costs ▪ Potential human and ecological risks in the event of an accident during transportation ▪ Regulatory liaison delays ▪ Overall costs are high ▪ Impacts to roads ▪ GH6 emissions ▪ Accidental spills
Option 3 - Excavate and Disposal in New Landfill Construct at Old Landfill site	$1,960,000	Weeks	Off-site	▪ Simplest remediation method ▪ Appropriate for soils with high levels of contaminants	▪ AESRD may not approve the location of the new landfill ▪ Additional cost for constructing and capping new landfill ▪ Continued groundwater monitoring required ▪ Regulatory liaison delays ▪ Contaminated soils remain on-site ▪ Soil cap thickness and design must ensure no human or ecological access to soils. ▪ Soil cap must be maintained in perpetuity. ▪ Clay cap may increase the build-up of landfill gas and venting may be required. ▪ Lack of feasibility for residential

Remediation Options for Impacted Soils at Old Landfill

Options	Class C Cost Estimate	Time	Location	Flexibility	
				Pros	Cons
					development
Option 4 - Excavate and Deposit in New Landfill Construct 3 km West of the Community of Garden River	$3,270,000	Weeks	Off-site	▪ Simplest remediation method ▪ Appropriate for soils with high levels of contaminants. ▪ Could be sited at old Lagoon east of community if conditions are favorable	▪ AESRD may not approve the location of the new landfill ▪ The proposed site has not been seen if it is suitable place for new landfill ▪ Additional cost for constructing and capping new landfill ▪ Continued groundwater monitoring required ▪ Potential human and ecological risks in the event of an accident during transportation. ▪ Regulatory liaison delays ▪ Soil cap thickness and design must ensure no human or ecological access to soils. ▪ Soil cap must be maintained in perpetuity. ▪ Clay cap may increase the build-up of landfill gas and venting may be required.

Findings of the previous reports review identified that select metal concentrations in groundwater exceeded the applicable guidelines. Figures 3b and 4b show the monitoring well locations at the Community Airstrip and Old Landfill, respectively, where those exceedances were observed. Columbia - Franz, 2011 concluded that there were exceedances of metal concentrations but they were not due to the Old Landfill site. In addition, by considering the soil and groundwater analytical results (discussed in detail in Section 5.0 of the report), elevated concentrations of select metals in groundwater were considered to be naturally occurring and/or not due to on-site activities. Therefore, a remediation option analysis and action plan was not considered applicable for groundwater at either the Community Airstrip or at the Old Landfill and focussed on soils only.

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ACRONYMS

AENV	Alberta Environment
AESRD	Alberta Environment and Sustainable Resource Development
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
CCME	Canadian Council of Ministers of the Environment
CSQG	Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health
ESA	Environmental Site Assessment
F1, F2	Petroleum Hydrocarbon Fractions 1 and 2
INAC	Indian and Northern Affairs Canada
LRRCN	Little Red River Cree Nation
PAH	Polycyclic Aromatic Hydrocarbon
PCA	Parks Canada Authority
RAP	Remedial Action Plan
TDS	Total Dissolved Solids

1.0 INTRODUCTION

Parks Canada Agency (PCA) retained EBA Engineering Consultants Ltd., operating as EBA, A Tetra Tech Company (EBA) to review previous environmental reports available for the Garden River Community Airstrip and Old Landfill, conduct a remediation options analysis and provide Remediation Action Plans (RAPs), including Class C cost estimates, for these sites. The Garden River Community is a part of the Little Red River Cree Nation and is located at the western edge of Wood Buffalo National Park in Alberta. The location of Garden River is shown on Figure 1 and the Community Airstrip and Old Landfill locations are shown on Figure 2.

1.1 Scope of Work

The scope of work for this project included the following:

- Reviewing historical reports (referenced in Section 1.2) available for both the sites and preparing figures showing potentially impacted areas at these sites;
- Summarizing specific environmental concerns/parameters of concern identified at these sites using the historical reports;
- Estimating the impacted soil and/or groundwater volumes based on the findings of the historical reports review;
- Assessing the potential risks associated with the identified parameters of concern at the sites, including impacts to surface and subsurface soils and to groundwater;
- Conducting a remediation options analysis to assess feasible/appropriate options for each site;
- Preparing Remediation Action Plans (RAPs) for both sites; and
- Preparing a report summarizing the reports review, risk analysis, remediation options analysis and RAPs.

1.2 Previous Investigations

EBA reviewed the following reports available for the Community Airstrip and Old Landfill sites:

- EBA Engineering Consultants Ltd. (EBA). 2006. Phase I (Modified) Environmental Site Assessment, Garden River Indian Reserve, Little Red River Cree Nation, Wood Buffalo National Park, Alberta. Report Prepared for Public Works and Government Services Canada. (EBA File: 5101390);
- AMEC Earth and Environmental (AMEC). 2006. Phase I Environmental Site Assessment, Garden River Land Claim Selection Areas, Wood Buffalo National Park, Alberta. Report prepared for AMEC Infrastructure Limited then provided to Indian and Northern Affairs Canada (INAC) and Little Red River Cree Nation (LRRCN). (AMEC File: EE-24794);
- EBA Engineering Consultants Ltd. (EBA). 2009. Contaminated Site Assessment, Initial and Detailed Testing Programs, Wood Buffalo National Park, various Locations in the Community of Garden River, Alberta. Report Prepared for Parks Canada Agency. (EBA File: C22101178); and

- Columbia Environmental Consulting Ltd. (Columbia) and Franz Environmental Inc. (Franz). 2011. Detailed Site Assessment, Garden River Old Dump in Wood Buffalo National Park. Prepared for Parks Canada Agency. Columbia – Franz File: 2018-1001.

2.0 SITE DESCRIPTION

There were two separate areas investigated in the Garden River community: the Community Airstrip and the Old Landfill.

The Community Airstrip is located at the northern end of the community of Garden River and is currently in use. The unpaved airstrip was reportedly constructed in the 1960s for use by the sawmill that was previously located in the community.

The Old Landfill is located at the eastern end of the community of Garden River, approximately 500 m south of the Community Airstrip. The Old Landfill is understood to have been excavated and operated without a liner in place. The volume and composition of waste at this site is understood to be highly variable, as no restrictions were imposed on disposal. It is understood that dump closure in this area consisted of covering waste with fill/soil when the dump site was abandoned in 1998. The Old Landfill comprises an approximate 4,000 m^2 area with additional off-site debris areas (approximately 2,000 m^2) both north and south of the landfill. In this report, the Old Landfill site includes both the Old Landfill and adjacent debris areas. The locations of Old Landfill and debris areas are shown on Figure 4a.

For reference, select information (select tables and figures) from the previous reports are included in Appendix A of this report.

2.1 Regional Geology

Garden River is located in the Peace River Lowlands and the general area includes an active floodplain, terraces and levee deposits. The floodplain includes old cut-off channels and sloughs that are flooded much of the year. They are level to depressional; the water table is at or near the surface and drainage is poor. The alluvium is composed of stratified, stone-free, friable silts and sands with an average depth of 3 to 6 m. The terraces occur between 4 to 10 m above mean river level. They are level to depressional and are composed of stratified, uncompacted, non-stony silty clays to very fine sands. The levee deposits are found on top of the terraces 30 m above the river. The terrain is almost level but slopes slightly away from the river. The soils are stratified silt loams of alluvial origin and the drainage is good (AMEC, 2006).

2.2 Site Geology

As per the Atlas of Canada, surficial materials comprise alluvial deposits along the Peace River. Soils at the sites generally range from silt to sand to gravel, with clay stringers in the upper 7 m. Sand and gravel is generally located six metres below ground surface. No permafrost was encountered during site investigations (Columbia – Franz, 2011).

2.3 Site Hydrogeology

Groundwater is expected to follow local topography and discharge into the Peace River. The on-site groundwater flow direction inferred from groundwater elevation data collected in December 2010 was to the south-southeast toward the Peace River (see Figure 2 from Columbia – Franz, 2011 in Appendix A).

2.4 Potential Contaminant Transport Implications

Based on the Columbia – Franz, 2011 report, particle size analyses and borehole logs indicated sand and gravel at the groundwater table. Successful slug tests could not be performed because the monitoring wells recharged so quickly that accurate measurements could not be taken, indicating a high hydraulic conductivity. Sieve analysis data and corresponding literature values indicated the hydraulic conductivity to be 10^{-3} m/s to 10^{-4} m/s. Assuming the hydraulic conductivity of 10^{-4} m/s, a gradient of 0.01 m/m, and sand and gravel porosity to be 25%, the groundwater flow velocity was calculated to be 136 m/year.

The Peace River is located approximately 850 m and 250 m south of the Community Airstrip and Old Landfill, respectively. Considering the groundwater velocity of 136 m/year and the groundwater direction being south-southeast, Columbia and Franz considered that potential leachate (if any) from the Old Landfill would have reached monitoring well 2018-10BH-3M at the time of sampling in 2010. See Figures 3a and 4a for groundwater monitoring well locations at the Community Airstrip and Old Landfill, respectively.

3.0 APPLICABLE GUIDELINES

The following guidelines were used in the previous reports for comparison against the soil and groundwater analytical results: (Note: some applicable guidelines changed between 2006 and 2011)

Community Airstrip and Old Landfill (EBA, 2006)

Alberta Environment (AENV). 2001. *Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities*, Natural and Residential area land use; and

Canadian Council of Ministers of the Environment (CCME). 2003. *Canadian Environmental Quality Guidelines*, Residential land use.

Community Airstrip and Old Landfill (EBA, 2009)

AENV. 2008. *Alberta Tier 1 Soil and Groundwater Remediation Guidelines*, Residential/Parkland land use;

CCME. 2007. *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health*, Residential/Parkland land use;

CCME, 2007. *Canadian Water Quality Guidelines for the Protection of Aquatic Life;* and

Health Canada. 2008. *Guidelines for Canadian Drinking Water Quality.*

Old Landfill (Columbia – Franz, 2011)

CCME, 2007. *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (CSQG)*, Agricultural land use;

CCME, 2008, *Canada-Wide Standards for Petroleum Hydrocarbons in Soil*, Tier 1 Levels for Agricultural land use in fine-grained surface soils and coarse-grained sub soils;

CCME, 2010. *Federal Interim Groundwater Quality Guidelines*, Generic Guidelines for Agricultural land use; and

Health Canada, 2010. *Guidelines for Canadian Drinking Water Quality.*

3.1 Current Applicable Guidelines

Based on the reports review, TOR and client discussions, the following guidelines will be used for risk assessment and remediation purposes as a part of the remediation options analysis.

CCME, 2008. *Canada Wide Standards for Petroleum Hydrocarbons*, Agricultural and Residential land use (coarse-grained soils);

CCME, 2007. *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (CSQG)*, Agricultural and Residential land use (coarse-grained soils);

CCME, 2010. *Federal Interim Groundwater Quality Guidelines*, Agricultural and Residential land use (coarse-grained soils); and

CCME, 1999. *Canadian Water Quality Guidelines for the Protection of Aquatic Life*, Agricultural and Residential land use (referred in *Canadian Interim Groundwater Quality Guidelines*).

Any amendments in these guidelines should be considered at the time of remediation.

The CCME guidelines provide generic numerical standards corresponding to four generic land use scenarios: (i) Agricultural; (ii) Residential/Parkland; (iii) Commercial; and (iv) Industrial. Based on the land use considered in the previous environmental investigations, TOR and discussion with the client, the most appropriate land use categories are deemed to be Agricultural and Residential/Parkland land uses.

For the exposure pathway assessment (discussed below), the Marine Life pathway was not considered as there is no marine water in the Garden River area. All other potentially complete pathways were considered for remediation and/or risk assessment analysis.

3.2 Exposure Pathway Assessment for Community Airstrip

Based on the remediation options analysis (discussed in detail in Section 6.0), the remediation options for this site include removal of all hydrocarbon impacted soils. Therefore, the Tier 1 approach was considered for remediation purposes as was used in the previous investigations. In the Tier 1 approach, all exposure pathways are considered applicable regardless of the site conditions, and the guidelines have been developed using a number of conservative assumptions regarding site conditions at and in the vicinity of the site.

3.3 Exposure Pathway Assessment for Old Landfill

3.3.1 Soil

The *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health* (CCME, 2007) were used for comparison to the soil analytical results. For Agricultural and Residential land use categories, two potentially complete pathways are available for the parameters of concern. These pathways are human soil ingestion and ecological soil contact. It should be noted that CCME considers that these pathways are only potentially complete for soils up to 1.5 m deep (surface soils). Soil samples that are deeper than 1.5 m were therefore removed from further consideration. Table A presents the identified parameters of concern, available pathways, and guidelines. Upon completion of the data review, it was found that only two sampling locations had analytical soil concentrations exceeding the above pathway-specific guidelines. This does not include where pathways were not defined.

The following were the locations where there were exceedances for Agricultural land use:

- 2018-10-SS4 – Arsenic for human soil ingestion; and
- 2018-10-SS6 – Cadmium for human soil ingestion and ecological contact; copper, lead and zinc for ecological soil contact.

The following were the locations where there were exceedances for Residential land use:

- 2018-10-SS4 – Arsenic for human soil ingestion; and
- 2018-10-SS6 – Copper for ecological contact.

Table A: Parameters of Concern and Available Pathways for Soil at Old Landfill

Contaminant of Concern	Sample ID	Site Concentration (mg/kg)	Sampling Depth (mbg)	Agricultural Land Use Guidelines[4]			Residential Land Use Guidelines[4]		
				Applicable Guideline (mg/kg)	Soil Ingestion (mg/kg)	Soil Contact (mg/kg)	Applicable Guideline (mg/kg)	Soil Ingestion (mg/kg)	Soil Contact (mg/kg)
Se	08MW04B	**1.58**	7.6	1	NA	NA	1	NA	NA
As	2018-10SS-4	**16**	0.75	12	12	17	12	12	17
B	2018-10SS-4	**3.2**	0.75	2	NA	NA	NA	NA	NA
B	2018-10SS-5	**4.3**	0.9						
B	2018-10SS-6	**3.7**	0.8						
Cd	2018-10SS-6	**5**	0.8	1.4	1.4	3.8	10	14	10
Cu	2018-10SS-6	**409**	0.8	63	1100	63	63	1100	63
Pb	2018-10SS-6	**95**	0.8	70	140	70	140	140	300
Sn	2018-10SS-6	**140**	0.8	5	NA	NA	50	NA	NA
Zn	2018-10SS-6	**3950**	0.8	200	NA	200	200	NA	NA
Naphthalene	2018-10SS-5	**0.024**	0.8	0.013	NA	NA	0.013	NA	NA
Phenantherene	2018-10SS-5	**0.09**	0.8	0.046	NA	NA	0.046	NA	NA

Notes:

1. NA = Not available
2. mbg = metres below grade
3. **Bold and underlined** = exceeds guideline
4. CCME, 2007. *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (CSQG)*, Agricultural and Residential land use (coarse-grained soils)
5. Se=selenium; As=arsenic; B=Boron; Cd=cadmium; Cu=Copper; Pb=lead; Sn=Tin; Zn=zinc

3.3.2 Groundwater

Federal Interim Groundwater Quality Guidelines (CCME, 2010) were used for comparison of groundwater analytical results. Table B outlines the identified parameters of concern, available pathways, and guidelines for Agricultural and Residential land uses. It should be noted that as per EBA's consultation with PCA, drinking water use is not expected at the Old Landfill site and therefore was excluded from the groundwater pathway analysis.

The analytical results indicated that the irrigation groundwater use guideline values were exceeded for iron and manganese at most monitoring well locations.

The analytical results indicated that the freshwater aquatic life guideline values were exceeded at all monitoring well locations (indicated in Table B) for one or more of the following parameters: aluminium (Al), arsenic (As), cadmium (Cd), copper (Cu), fluoride (Fl), iron (Fe) and selenium(Se).

Sulfate concentrations exceeded the freshwater life guideline value at 08MW05B.

It should be noted that aquatic life guidelines are applied to groundwater assuming that the groundwater discharges to surface water 10 m away from the sampling location. At this site, the nearest surface water receptor is 250 m down gradient and therefore may not necessarily impact aquatic life at the receptor. Attenuation processes in the subsurface may reduce concentrations down gradient.

Based upon the local hydrogeological conditions, it is likely that some of the parameters exceeding guideline values are naturally occurring. This is discussed further in Section 5.2. Columbia-Franz (2011) states that the metals in groundwater are not attributable to the Old Landfill.

Table B: Parameters Exceeding Guidelines and Available Pathways for Groundwater at Old Landfill

Parameters of Concern (µg/L)	08MW04B	08MW05B	08MW06B	2018-10BH-1M	2018-10BH-2M	2018-10BH-3M	2018-10BH-4M	2018-10BH-5M	2018-10BH-6M	2018-10BH-7M	Agricultural Land Use Guidelines[4]				Residential/Parkland Guidelines[4]	
											Applicable Guideline (µg/L)	Freshwater Life	Irrigation	Livestock	Applicable Guideline (µg/L)	Freshwater Life
Al	-	-	-	**338**	-	-	-	-	**534**	-	100	100	5,000	5,000	100	100
As	**6**	**10**	-	**10**	**7**	**8**	**7**	**14**	**8**	**12**	5	5	100	25	5	5
Cd	-	-	**2**	**0.033**	**0.03**	**0.02**	-	-	**0.09**	-	0.017	0.017	5.1	80	0.017	0.017
Cu	-	**18**	**9**	-	-	-	-	-	-	-	4	4	200	500	4	4
F	**200**	**220**	-	**200**	**190**	**180**	**250**	**180**	-	**190**	120	120	1,000	1,000	120	120
Fe	**2,900**	**6,300**	-	**8,000**	**6,200**	**6,800**		**7,400**	**51,000**	**8,000**	300	300	5,000	NA	300	300
Mn	**538**	**639**	**226**	**600**	**428**	**462**	**641**	**444**	**737**	**334**	200	NA	200	NA	NA	NA
Se	**10.8**	**2**	-	-	**3**	**3**	-	-	-	-	1	1	20	50	1	1
Zn	**93.8**	**61**	**39**	-	-	-	-	-	-	-	30	30	1,000	50,000	30	30
SO4	-	**111,000**	-	-	-	-	-	-	-	-	100,000	100,000	NA	1,000,000	100,000	100,000

Notes:

1- **Inhalation**, **soil organism direct contact** and **wildlife watering pathways** were not available for these parameters.

2 - **Marine Life pathway** is excluded as there is no marine/salty water in the area.

3 - "-" means did not exceed guidelines

4 - **CCME**, 2010. *Federal Interim Groundwater Quality Guidelines*, Agricultural and Residential land use (coarse-grained soils)

5. Al=aluminum; As=arsenic; Cd=cadmium; Cu=copper; F=fluoride; Fe=iron; Mn=manganese; Se=selenium; Z=zinc; SO_4=sulfate;

4.0 SUMMARY OF HISTORICAL REPORT FINDINGS

A summary of the key findings of the four reports reviewed (discussed in Section 1.2) are summarized in the following sections.

4.1 Community Airstrip

The following tables (C and D) summarize guideline exceedances found in the soil and groundwater. Soil sampling locations (surface soil samples) and groundwater monitoring well locations are shown on Figures 3a and 3b.

Table C: Summary of Soil Guideline Exceedances and Estimated Volume at Community Airstrip

Areas	Area of Concern	Identified Contaminants Exceeding Guidelines	Surface Soil ID and Exceeding Parameters	Estimated Area of Impacts (m^2)	Estimated Depth of Impacts (m)	Estimated Volume (m^3)
1	Stained Area 1	BTEX, F1, F2(1)	Drum Storage (@ 0.3 mbg)	100(1)	0.5(1)	50
2	Stained Area 2	F1, F2(1)	08-SS36 (@ 0 – 0.6 mbg)	200(2)	1.0(2)	200
					Total Estimated Impacted Soil	250 m^3

(1) = Hydrocarbons, area and depth identified in EBA, 2006

(2) = Hydrocarbons, area and depth identified in EBA, 2009

B=benzene; T=toluene; E=ethylbenzene; X=xylenes; F1= hydrocarbon fraction C_6-C_{10}; F2= hydrocarbon fraction>C_{10}-C_{16}

Table D: Summary of Groundwater Guidelines Exceedances at Community Airstrip

No	Monitoring Well ID	Identified Parameters Exceeding Guidelines	Depth of Groundwater (mbg)
1	08MW10	**Cd**, Mn, Se, Zn(1)	8.92(1)
2	08MW11	**Cd**, Se, Zn(1)	9.08(1)
3	08MW12	**Cd**, Mn, Se, Zn(1)	8.76(1)

(1) = Identified in EBA, 2009

Highlighted and Underlined parameters were below laboratory detection limits but the detection limits were above the applicable guidelines.

(2) = Cd=cadmium; Mn=manganese; Se=selenium; Z=zinc

4.2 Old Landfill

The following tables (E and F) summarize guideline exceedances found in the soil and groundwater. Soil sampling locations (surface soil samples/boreholes) and groundwater monitoring well locations are shown on Figures 4a and 4b.

Table E: Summary of Soil Guideline Exceedances and Estimated Volume at Old Landfill

Areas	Area of Concern	Identified Contaminants	Borehole/Surface Soil ID and Exceeding Parameters	Estimated Area of Impacts (m^2)	Estimated Depth of Impacts (m)	Estimated Volume (m^3)
1	North Debris Area	Not defined	Not defined	1,350	0.3(3)	405
2	Old Landfill	As, B, Cd, Cu, Pb, Se(2), Sn, Zn, naphthalene, phenantherene, EC and SAR(1)	**08MW04B** = Se(2)(@ 7.6 mbg) **2018-10BH-6M** = As, naphthalene, phenantherene (@ 9 – 10.7 mbg) **2018-10SS-4** = As, B (@ 0 – 0.75 mbg) **2018-10SS-5** = B, naphthalene, phenantherene (@ 0 – 0.9 mbg) **2018-10SS-6** = B, Cd, Cu, Pb, Sn, Zn, SAR, EC (@ 0 – 0.8 mbg)	3,600	1.5(4)	5,400
				400	3(5)	1,200
3	Scattered Surface Debris	Not defined	Not defined	250	0.3(3)	75
4	South Debris Area	Not defined	Not defined	450	0.3(3)	135
					Total Estimated Impacted Soil	≈7,200 m^3

(1) = Parameters identified in Columbia - Franz, 2011

(2) = Parameters identified in EBA, 2009

(3) = Assumed depth

(4) = Estimated impacted depth identified in Columbia - Franz, 2011

(5) = 10% contingency for impacted depth exceeding 1.5 m; Columbia – Franz, 2011 indicated that there could be areas where impacts exceed 1.5 m.

(6) = As=arsenic; B=boron; Cd=cadmium; Cu=copper; Pb=lead; Se=selenium; Sn=tin; Zn=zinc; Ec=electric conductivity; SAR=sodium absorption ratio

Table F: Summary of Groundwater Guideline Exceedances at Old Landfill

No.	Monitoring Well ID	Identified Parameters Exceeding Guidelines	Depth of Groundwater (mbg)
1	08MW04B	As, **Cd**, F, Fe, **Hg**, Mn, Se, Zn(1 & 2)	8.02(2)
2	08MW05B	F, As, **Cd**, Cu, Fe, **Hg**, Mn, Se, Zn(1&2)	8.16(2)
3	08MW06B	Cd, Cu, **Hg**, Mn, Se, Zn(2)	7.95(2)
4	2018-10BH-1M	F, Al, As, Cd, Fe, Mn(1)	9.31(1)
5	2018-10BH-2M	F, As, Cd, Fe, Mn, Se(1)	9.51(1)
6	2018-10BH-3M	F, As, Cd, Fe, Mn, Se(1)	9.85(1)
7	2018-10BH-4M	F, As, Mn(1)	9.49(1)
8	2018-10BH-5M	F, SO4, As, Fe, Mn(1)	9.52(1)

Table F: Summary of Groundwater Guideline Exceedances at Old Landfill

No.	Monitoring Well ID	Identified Parameters Exceeding Guidelines	Depth of Groundwater (mbg)
9	2018-10BH-6M	TDS, Al, As, Cd, Fe, Mn(1)	Not Available
10	2018-10BH-7M	F, As, Fe, Mn(1)	9.67(1)

(1) = Identified in Columbia - Franz, 2011

(2) = Identified in EBA, 2009

Highlighted and underlined parameters were below laboratory detection limits but the detection limits were above the applicable guidelines.

Al=aluminum; As=arsenic, Cd= cadmium; F=fluoride; Fe=iron; Hg=mercury; Mn=manganese; Se=selenium; Zn=zinc; SO_4=sulfate;
TDS=total dissolved solids

5.0 DISCUSSION ON FINDINGS

5.1 Community Airstrip

As referenced in Table C, approximately 250 m^3 of hydrocarbon impacted soils are estimated to be located on-site, including the Stained Areas 1 and 2 (Figure 3a). Remediation options of these impacted soils are discussed in detail in Section 6.1.

Concentrations of select dissolved metals (cadmium [Cd], manganese [Mn], selenium [Se], and zinc [Zn]) were reported exceeding the guidelines in groundwater (EBA, 2009). These exceedances are discussed below.

Previous consultants reported concentrations of dissolved cadmium exceeding the guideline value for groundwater at 08MW10, 08MW11 and 08MW12; however, this is not based on measured concentrations. The reported concentrations were below laboratory detection limits, which were greater than the guidelines value. Therefore, the concentrations of dissolved cadmium are not considered an environmental concern. Additional sampling could clarify this.

Concentrations of dissolved manganese exceeded the guideline value for groundwater at 08MW10 and 08MW12. Elevated concentrations of dissolved manganese are not necessarily indicative of impacts to the groundwater quality from on-site operations. Dissolved manganese occurs naturally in groundwater under anaerobic conditions (Hem, 1985). As shown on Figure 3c, soil samples collected from above and below the water table levels did not have manganese concentrations exceeding the guideline value. Therefore, the elevated concentrations of manganese in groundwater are interpreted to be naturally occurring.

Concentrations of dissolved selenium exceeded guidelines in groundwater at 08MW10, 08MW11 and 08MW12. EBA and others have observed high selenium concentrations at other sites in Alberta that have highly mineralized groundwater. As shown on Figure 3c, soil samples collected below and above the water table did not have selenium concentrations exceeding guideline values. Therefore, the selenium concentrations are interpreted to be natural and not due to on-site activities. Additional sampling could clarify this.

Concentrations of dissolved zinc exceeded the guideline value for groundwater at 08MW10, 08MW11 and 08MW12. Since there is no identified source of zinc at the site and the soil samples collected at these

locations did not have zinc concentrations exceeding the guideline value, the elevated zinc concentrations are interpreted to be naturally occurring. Additional sampling could clarify this.

5.2 Old Landfill

As noted in Table E, approximately 7,200 m^3 of metals and polycyclic aromatic hydrocarbons (PAHs) (naphthalene and phenonthrene) impacted soils are estimated to be located on-site, including the Old Landfill and adjacent debris areas. Remediation options for these soils are discussed in detail in Section 6.2.

Concentrations of select dissolved metals were reported exceeding guideline values for groundwater (Columbia - Franz, 2011). These exceedances are discussed below.

Concentrations of dissolved aluminum exceeded the guideline value for groundwater at 2018-10BH-1M. Aluminum has limited solubility at near neutral pH values. Therefore, if a sample is properly field-filtered using a 0.45 µm pore diameter filter, aluminum concentrations in groundwater will be typically reported near or below the analytical detection limit. Based on this, the elevated aluminum is likely not indicative of impacts to groundwater, but the result of inadequate filtering.

Concentrations of dissolved iron and manganese exceeded the guideline values for groundwater at most of the wells. Elevated dissolved iron and manganese are not necessarily indicative of impacts to the groundwater quality from on-site operations. Dissolved iron and manganese occur naturally in groundwater under anoxic/anaerobic conditions (Hem, 1985).

Concentrations of dissolved arsenic exceeded the guideline value for groundwater at 08MW04B, 08MW05B, and in 2018-10BH-1M to 2018-10BH-7M. Elevated concentrations of dissolved iron and manganese also exceeded the guidelines values in most of these wells. Elevated manganese and iron concentrations are likely reflecting that the redox conditions in the vicinity of these wells are anoxic. Since arsenic is known to form precipitates with iron oxides under oxic conditions (Lemay, 2003), the elevated arsenic concentration measured are likely the result of the dissolution of iron oxide precipitates due to anoxic conditions in the groundwater in the vicinity of these wells. Therefore, the elevated concentrations of arsenic are interpreted to be natural and not due to on-site activities.

Concentrations of dissolved cadmium exceeded the guideline value for groundwater at 08MW06B, 2018-10BH-1M, 2018-10BH-2M and 2018-10BH-3M. Analytical results for cadmium in the soil samples (Columbia - Franz, 2011) were below the applicable guideline values. These soil samples were collected from surface and depths ranging from 5.5 to 9.0 mbg (refer to Figure 4b). Therefore, the elevated concentrations of cadmium in groundwater are likely naturally elevated and not due to on-site activities.

Concentrations of dissolved copper exceeded the guideline value for groundwater at 08MW05B and 08MW06B. Soil analytical results (EBA, 2009) indicated that copper concentrations were below the guideline value for soil samples collected at these locations. Soil samples were collected from 0.8 and 7.6 mbg (see Figure 4c). Therefore, elevated concentrations of copper are likely indicative of natural conditions or due to unknown sources and not due to on-site activities.

Concentrations of dissolved fluoride exceeded the guideline value for groundwater at 08MW04B and at 2018-10BH-1M to 2018-10BH-7M. Monitoring wells 2018-10BH-4M and 2018-10BH-7M are located

up-gradient of the Old Landfill. Therefore, it is concluded that elevated concentrations of fluoride in groundwater is due to natural conditions.

Previous consultants reported concentrations of mercury exceeding the applicable guideline value; however, this is not based on measured concentrations. The reported values were below laboratory detection limits, which were greater than the applicable guideline value. The soil analytical results for mercury in soil at these locations (refer to Figure 4c) did not indicate any elevated mercury concentrations. Therefore, the concentrations of dissolved mercury in groundwater are not considered an issue.

Concentrations of dissolved selenium exceeded the guideline value for groundwater at 08MW04B, 08MW05B, 08MW06B, 2018-10BH-2M and 2018-10BH-3M. Analytical results for the soil samples (Columbia - Franz, 2011) collected at these locations did not indicate any concentrations exceeding the guideline value. These soil samples were collected from surface and at depths ranging from 5.5 to 9.0 mbg (see Figure 4c). EBA and others have observed high selenium concentrations at other sites in Alberta that have highly mineralized groundwater. Therefore, the selenium concentrations are interpreted to be naturally occurring and not due to on-site activities.

Concentrations of dissolved zinc exceeded the guideline value for groundwater at 08MW04B, 08MW05B and 08MW06B. As shown on Figure 4c, soil samples collected from depths above the groundwater level did had concentrations of zinc that were below the guideline value. Therefore, elevated concentrations of zinc are not considered to be due to on-site activities and are likely naturally occurring and/or due to unknown sources. Additional sampling could clarify this.

Based on the foregoing, there is compelling information and data suggesting the groundwater at the monitoring well locations has not been impacted with the above-referenced metals of concern and the metals are likely naturally occurring. Further, Columbia-Franz (2011) stated metals in groundwater are not attributable to the Old Landfill.

6.0 REMEDIAL OPTIONS ANALYSIS

6.1 Community Airstrip

Potential remediation options available for remediation of hydrocarbon impacted soils at this site are summarized in Table G:

Table G: Summary of Potential Remediation Options for Hydrocarbon Impacted Soils at Community Airstrip

Option	Principle and Application	Typical Costs	Time	Location	Equipment Requirements	Flexibility		EBA Evaluation
						Pros	Cons	
1. Aerobic Treatment (landfarming)	▪ Remediation of hydrocarbon contaminated soils by landfarming	$50-300/$m^3$	Years	In-situ. On/Off-site	▪ Excavators ▪ Monitoring ▪ Organic nutrients ▪ Possibly liners	▪ Cost effective ▪ Can be carried out in-situ, on-site or off-site	▪ Time involved to remediate soils could be substantial. ▪ Toxic by-products may be produced. ▪ Microbial action may be impacted by salts, metals, and trace organic compounds.	▪ Feasible due to site conditions and estimated quantity of impacted soils (250 m^3)
2. Excavation and Landfill Disposal at Rainbow Lake Landfill	▪ Simplest method to remove contaminated soils ▪ Used for soils with high level of contaminants	$50-500/$m^3$	Days to weeks	Off-Site	▪ Transportation ▪ Remediation success monitoring required	▪ Simplest remediation method ▪ Appropriate for soils with high levels of contaminants.	▪ May be restrictions on landfill location ▪ May be expensive transportation costs ▪ Regulatory liaison delays ▪ Very expensive if large volumes of soil requires remediation ▪ Impacts to roads ▪ Greenhouse gas emissions from trucks ▪ Accidental spills	▪ Feasible due to site conditions and estimated quantity of impacted soils (250 m^3)
3. Excavate and Deposit in New Landfill Construct at Old Landfill Location	▪ Simplest method to remove contaminated soils	$50-300/$m^3$	Days to weeks	Off-Site	▪ Transportation ▪ Remediation success monitoring required	▪ Please see Option 3 of Table H		

Table G: Summary of Potential Remediation Options for Hydrocarbon Impacted Soils at Community Airstrip

Option	Principle and Application	Typical Costs	Time	Location	Equipment Requirements	Flexibility		EBA Evaluation
						Pros	Cons	
4. Excavate and Deposit in New Landfill construct 3 Km west of community of Garden River	▪ Simplest method to remove contaminated soils	$50-300/$m^3$	Days to weeks	Off-Site	▪ Transportation ▪ Remediation success monitoring required	▪ Please see Option 4 of Table H		
5. Thermal Stripping	▪ Removal of VOCs from soils using heat ▪ Low concentrations of VOCs ▪ Where VOC's are insoluble in water ▪ Where air emissions will not be unacceptable	$150-500/$m^3$	Days to weeks	On/Off-site	▪ Excavators ▪ Tank ▪ Heat Source	▪ Removal of highly volatile organic compounds ▪ Can reduce air emissions through use of incineration or condensing to recover hydrocarbon products.	▪ May be restrictions on air emissions, does not remove non-volatile organics. ▪ Increase cost.	▪ Not feasible due to low quantity of hydrocarbon impacted soils (250 m^3)
6. Soils Washing	▪ Removal of contaminants by water washing. ▪ Ideal for salt contaminated soils	$50-150/$m^3$	Days to months	In-situ, On/Off-site	▪ Excavators ▪ Soil and water monitoring probes ▪ Tanks ▪ Water ▪ Tile Drain ▪ Pumps	▪ Can be carried out on-site or off-site. ▪ Suitable for organic and inorganic contamination.	▪ Water supply ▪ Water treatment ▪ Water disposal ▪ Less effective in silts and clays	▪ Not feasible due to low quantity of hydrocarbon impacted soils (250 m^3)

Table G: Summary of Potential Remediation Options for Hydrocarbon Impacted Soils at Community Airstrip

Option	Principle and Application	Typical Costs	Time	Location	Equipment Requirements	Flexibility		EBA Evaluation
						Pros	Cons	
7. Vacuum Extraction	▪ Removal of VOCs from soils by vapour extractions ▪ In homogeneous isotropic soils	$150-1,000/$m^3$	Months to years	In-situ, On/Off-site	▪ Excavators ▪ Extraction wells ▪ Soil and air HC monitoring probes ▪ Vacuum Pump and Piping	▪ Can be performed in-situ without excavation of soils. ▪ Removal of VOCs	▪ Can take months to years to remediate ▪ Air emissions and monitoring	▪ Not feasible due to low quantity of hydrocarbon impacted soils (250 m^3)
8. Neutralization	▪ Chemical neutralization ▪ Suitable for acid or alkali contaminated soils	$150-250/$m^3$	Days to weeks	In-situ, On/Off-site	▪ Excavators ▪ Soil and water monitoring probes ▪ Tanks	▪ Contaminants transformed into harmless chemicals	▪ Chemical reaction between treatment chemicals and waste to form additional toxic or hazardous contaminants	▪ Not feasible due to low quantity of hydrocarbon impacted soils (250 m^3) and as impacts are shallow
9. Oxidation /Reduction	▪ Adding chemicals to oxidize or reduce contaminants in soils. ▪ Oxidation can be used to remove cyanide and organic chemicals while reduction can be used to remove chromium, silver and mercury.	$150-500/$m^3$	Days to weeks	In-situ. On/Off-site	▪ Excavators ▪ Chemicals ▪ Tanks ▪ Soil monitoring	▪ Contaminants transformed into harmless chemicals.	▪ Chemical reactions between waste and oxidants/reductants can form explosive reactions, and produce additional toxic or hazardous contaminants.	▪ Not feasible due to low quantity of hydrocarbon impacted soils (250 m^3)
10. Incineration	▪ Removal of severely hydrocarbon contaminated soil and PCBs by incineration	$500/$m^3$	Days to weeks	Off-site	▪ Excavators ▪ Transportation ▪ Incineration facility	▪ Complete removal of contamination from site	▪ Costly capital and operating expenses ▪ Disposal of ash and air emissions ▪ Incomplete combustion	▪ Not feasible due to low quantity of hydrocarbon impacted soils (250 m^3)

Table G: Summary of Potential Remediation Options for Hydrocarbon Impacted Soils at Community Airstrip

Option	Principle and Application	Typical Costs	Time	Location	Equipment Requirements	Flexibility		EBA Evaluation
						Pros	Cons	
11. Pyrolysis	▪ Slow addition of heat for organic recovery	$500/m^3	Days to weeks	In-situ, On-site	▪ Excavators ▪ Soil monitoring ▪ Contamination tanks	▪ Carried out in-situ or off-site ▪ Removal and recovery of products	▪ Costly ▪ Disposal of product	▪ Not feasible due to low quantity of hydrocarbon impacted soils (250 m^3) and as impacts are shallow
12. Anaerobic Treatment	▪ Remediation of hydrocarbon in anaerobic environment ▪ Remediation of hydrocarbon contaminated soils	$150-300/m^3	Years	In-situ, On/Off-site	▪ Excavators ▪ Monitoring ▪ Organic nutrients	▪ Can be carried out, in-situ on-site or off-site ▪ Cost effective	▪ Remediation may be incomplete ▪ Toxic by-products may be produced. ▪ Microbial action may be impacted by salts, metals, and trace organic compounds ▪ Odor problems such as hydrogen sulphide gas	▪ Not feasible due to low quantity of hydrocarbon impacted soils (250 m^3)

Table G: Summary of Potential Remediation Options for Hydrocarbon Impacted Soils at Community Airstrip

Option	Principle and Application	Typical Costs	Time	Location	Equipment Requirements	Flexibility		EBA Evaluation
						Pros	Cons	
13. Capping and Monitoring	▪ Risk management approach. ▪ Used for old landfill final closure ▪ Can be sued where metals are primarily contaminants of concern.	$50-500/$m^3$	Days to weeks	On -site	▪ Excavators ▪ Compactors	▪ Lower cost ▪ Less time period ▪ Potential land uses – pasture, recreational, cultivation, and forestry	▪ Contaminated soils remains on-site ▪ Future monitoring (groundwater monitoring) required to verify soil leaching to groundwater and groundwater transport not occurring) ▪ Soil cap thickness and design must ensure no human or ecological access to soils. ▪ Soil cap must be maintained in perpetuity. ▪ Clay cap may increase the build-up of landfill gas and venting may be required. ▪ Lack of feasibility for residential development ▪ AENV may not approve this approach	▪ Not feasible due to low quantity of hydrocarbon impacted soils (250 m^3)
14. Fixation / Encapsulating	▪ Removal and encapsulation of contaminants. ▪ Contaminants may be used as construction materials. ▪ Ideal where landfill disposal is not available.	$50-500/$m^3$	Days to weeks	Off-Site	▪ Excavators ▪ Encapsulation fixations	▪ Fixated waste may be placed in landfill or used as construction material.	▪ May be costly ▪ May not be appropriate due to incomparability of other associated contaminants/chemical species	▪ Not feasible due to low quantity of hydrocarbon impacted soils (250 m^3)

Due to the location of the Community Airstrip and volume of impacted soils, EBA considers Options 1 to 4 as the most feasible options for remediation of hydrocarbon impacted soils. The key activities involved with these options are discussed below.

6.1.1 Option 1 - Excavation and Landfarming

In this method, impacted soils are excavated and placed as a layer (0.3 m) on a liner. The impacted soils are subsequently periodically aerated via mechanical mixing to promote biodegradation. Nutrients may be added to promote growth of hydrocarbon degrading bacteria. The landfarming area may require run-off and run-on control to prevent potential release of runoff from the landfarm. Landfarming is a common remediation option in the environmental industry.

The key activities will include the following:

- Regulatory approvals from the local municipality and Alberta Environment;
- Tender preparation for excavating, backfilling, compacting the backfill soils, landfarm preparation and periodic aeration for two to three years;
- Project management and site visits;
- Landfarm construction per provincial standards, including placement of liner (approximately 1,000 m^2 area);
- Excavating and landfarming contaminated soils (approximately 250 m^3);
- Conduct a confirmatory soil sampling program of approximately 300 m^2 area for contaminants of concern (BTEX, F1 and F2) reported for this site. Approximately 20 samples will be collected from the walls and bases of Areas 1 and 2;
- Backfill and compact backfill soils (approximately 300 m^3).
- Placing top soil (approximately 60 m^3), seeding and re-contouring;
- Preparing a report of the work conducted;
- Annual monitoring of landfarmed soils and reporting (assuming four years). This will include collection of 10 confirmatory soil samples and analyzing them for BTEX, F1 to F4; and
- No groundwater monitoring is recommended at this time.

The cost for conducting this option is estimated at $210,000. The Class C cost estimate for this option is provided in Table 1.

Assumptions for Cost Estimation

- Excavation mass of 2000 kg per cubic metre (2 tonnes/m^3)
- Suitable backfill material is available on site or within 5 km radius
- Backfill material required for excavation includes 20% swell factor

- Suitable landfarm area available on site (Possible suitable locations are on runway approaches)
- Parks Canada to maintain seeded areas until complete grass germination
- CFU4 Airport Operator (Little Red River Cree Nation) to provide NOTAM communications to CYOJ FSS (High Level Airport Flight Service Station) during construction

6.1.2 Option 2 - Excavation and Landfill Disposal at Rainbow Lake

This option involves excavation and landfilling of soils exceeding the applicable guidelines and backfilling the excavation with clean soils. Prior to backfilling the excavation, confirmatory soil samples are collected from the base and walls of the excavation to assess if the excavation boundaries are clean (i.e., concentrations are below guidelines) and the contaminated soils are removed.

The key activities include the following:

- Conduct soil sampling for landfill disposal characterization analysis (5 samples);
- Tender preparation for excavating, backfilling and compacting backfill soils;
- Project management and meetings, including: site visit; trucking routes; potential crossing agreements; local road bans; safety requirements; and landfill hours;
- Field work preparation, line locates, ground disturbance;
- Excavate and landfill disposal of approximately 250 m^3 of impacted soils from Community Strip to the Rainbow Lake landfill;
- Conduct a confirmatory soil sampling program of approximately 300 m^2 area for contaminants of concern (BTEX, F1 and F2) reported for this site. Approximately 20 samples will be collected from the walls and bases of Areas 1 and 2;
- Backfill excavations with source fill material and compact;
- Placing topsoil (approximately 60 m^3), seeding and re-contouring; and
- Complete a post remediation report including the findings of the confirmatory soil sampling.

The cost for conducting this option is estimated at $200,000. The Class C cost estimate for this option is provided in Table 2.

Assumptions for Cost Estimation

- Excavation mass of 2,000 kg per cubic metre (2 tonnes/m^3)
- Suitable backfill material is available on site or within 5 km radius
- Backfill material required for excavation includes 20% swell factor
- Parks Canada to maintain seeded areas until complete grass germination
- All materials hauled to Rainbow Lake landfill are accepted.

- CFU4 Airport Operator (Little Red River Cree Nation) to provide NOTAM communications to CYOJ FSS (High Level Airport Flight Service Station) during construction.

6.1.3 Option 3 - Excavate and Deposit in New Landfill Constructed at Old Landfill Site

Please refer to Section 6.2.3 for details.

The cost for conducting this option is estimated at $150,000. The Class C cost estimate for this option is provided in Table 3.

6.1.4 Option 4 - Excavate and Deposit in New Landfill Constructed West of Garden River

Please refer to Section 6.2.4 for details.

The cost for conducting this option is estimated at $250,000. The Class C cost estimate for this option is provided in Table 4.

6.2 Old Landfill

Potential remediation options available for remediation of impacted soils at the Old Landfill site are summarized in Table H:

Table H: Summary of Potential Remediation Options for Impacted Soils at Old Landfill

Option	Principle and Application	Typical Costs	Time	Location	Equipment Requirements	Flexibility		EBA Evaluation
						Pros	Cons	
1. Capping and Monitoring	▪ Risk management approach. ▪ Used for old landfill final closure ▪ Can be used where metals are primarily contaminants of concern.	$50-500/$m^3$	Days to weeks	On -site	▪ Excavators ▪ Compactors	▪ Lower cost ▪ Less time period ▪ Potential land uses – pasture, recreational, cultivation, and forestry ▪ Is an accepted practice	▪ Contaminated soils remains on-site ▪ Future monitoring (groundwater monitoring) required to verify soil leaching to groundwater and groundwater transport not occurring) ▪ Soil cap thickness and design must ensure no human or ecological access to soils. ▪ Soil cap must be maintained in perpetuity. ▪ Clay cap may increase the build-up of landfill gas and venting may be required. ▪ Lack of feasibility for residential development ▪ AENV may not approve this approach	▪ Feasible as metals are the major contaminants of concern

Table H: Summary of Potential Remediation Options for Impacted Soils at Old Landfill

Option	Principle and Application	Typical Costs	Time	Location	Equipment Requirements	Flexibility		EBA Evaluation
						Pros	Cons	
2. Excavation and Landfill Disposal at Rainbow Lake	▪ Simplest method to remove contaminated soils ▪ Used for soils with high level of contaminants	$50-500/$m^3$	Days to weeks	Off-Site	▪ Transportation ▪ Remediation success monitoring required	▪ Simplest remediation method ▪ Appropriate for soils with high levels of contaminants.	▪ May be restrictions on landfill location ▪ May be expensive transportation costs ▪ Potential human and ecological risks in the event of an accident during transportation. ▪ Regulatory liaison delays ▪ Very expensive if large volumes of soil require remediation ▪ Impact to roads ▪ Greenhouse gas emissions from trucks ▪ Accidental spills	▪ Feasible as metals are the major contaminants of concern
3. Excavate and Deposit in New Landfill Construct at Old Landfill Site	▪ Simplest method to remove contaminated soils ▪ Used for soils with high level of contaminants	$50-500/$m^3$	Days to weeks	Off-Site	▪ Transportation ▪ Remediation success monitoring required	▪ Simplest remediation method ▪ Appropriate for soils with high levels of contaminants	▪ AENV may not approve the location of the new landfill ▪ Additional cost for constructing new landfill ▪ Additional cost for capping impacted soils at new landfill ▪ Continued groundwater monitoring required ▪ Regulatory liaison delays ▪ Contaminated soils remain on-site ▪ Soil cap thickness and design must ensure no human or	▪ Feasible as metals are the major contaminants of concern

Table H: Summary of Potential Remediation Options for Impacted Soils at Old Landfill

Option	Principle and Application	Typical Costs	Time	Location	Equipment Requirements	Flexibility		EBA Evaluation
						Pros	Cons	
							ecological access to soils. ▪ Soil cap must be maintained in perpetuity. ▪ Clay cap may increase the build-up of landfill gas and venting may be required. ▪ Lack of feasibility for residential development	
4. Excavate and Deposit in New Landfill Construct 3 km West of Community of Garden River	▪ Simplest method to remove contaminated soils ▪ Used for soils with high level of contaminants	$50-500/m^3	Days to weeks	Off-Site	▪ Transportation ▪ Remediation success monitoring required	▪ Simplest remediation method ▪ Appropriate for soils with high levels of contaminants ▪ Could be sited at old Lagoon east of community if conditions are favourable	▪ AENV may not approve the location of the new landfill ▪ The proposed site has not been seen if it is suitable place for new landfill ▪ Additional cost for constructing new landfill ▪ Additional cost for capping impacted soils at new landfill ▪ Continued groundwater monitoring required ▪ Potential human and ecological risks in the event of an accident during transportation. ▪ Regulatory liaison delays ▪ Soil cap thickness and design must ensure no human or ecological access to soils. ▪ Soil cap must be maintained in perpetuity.	▪ Feasible as metals are the major contaminants of concern

Table H: Summary of Potential Remediation Options for Impacted Soils at Old Landfill

Option	Principle and Application	Typical Costs	Time	Location	Equipment Requirements	Flexibility		EBA Evaluation
						Pros	Cons	
							▪ Clay cap may increase the build-up of landfill gas and venting may be required.	
5. Thermal Stripping	▪ Removal of VOCs from soils using heat ▪ Low concentrations of VOCs. ▪ Where VOCs are insoluble in water ▪ Where air emissions will not be unacceptable	$150-500/$m^3$	Days to weeks	On/Off-site	▪ Excavators ▪ Tank ▪ Heat Source	▪ Removal of highly volatile organic compounds ▪ Can reduce air emissions through use of incineration or condensing to recover hydrocarbon products.	▪ May be restrictions on air emissions, does not remove non-volatile organics. ▪ Need to develop risk management plan for emissions to protect workers on site and public off site. ▪ Increase cost.	▪ Not feasible as metals are the major contaminants of concern
6. Soils Washing	▪ Removal of contaminants by water washing. ▪ Ideal for salt contaminated soils	$50-150/$m^3$	Days to months	In-situ, On/Off-site	▪ Excavators ▪ Soil and water monitoring probes ▪ Tanks ▪ Water ▪ Tile Drain ▪ Pumps	▪ Can be carried out on-site or off-site. ▪ Suitable for organic and inorganic contamination.	▪ Water supply ▪ Water treatment ▪ Water disposal ▪ Potential for chemical releases in wash water. Need to develop a risk management plan. ▪ Less effective in silts and clays	▪ Not feasible as metals are the major contaminants of concern
7. Vacuum Extraction	▪ Removal of VOCs from soils by vapour extraction ▪ In homogeneous isotropic ▪ soils	$150-1,000/$m^3$	Months to years	In-situ, On/Off-site	▪ Excavators ▪ Extraction wells ▪ Soil and air HC monitoring probes ▪ Vacuum Pump and Piping	▪ Can be performed in-situ without excavation of soils. ▪ Removal of VOCs	▪ Can take months to years to remediate ▪ Air emissions and monitoring ▪ Need to develop risk management plan for emissions to protect workers on site and public off site.	▪ Not feasible as metals are the major contaminants of concern

Table H: Summary of Potential Remediation Options for Impacted Soils at Old Landfill

Option	Principle and Application	Typical Costs	Time	Location	Equipment Requirements	Flexibility		EBA Evaluation
						Pros	Cons	
8. Neutralization	▪ Chemical neutralization ▪ Suitable for acid or alkali contaminated soils	$150-250/m^3	Days to weeks	In-situ, On/Off-site	▪ Excavators ▪ Soil and water monitoring probes ▪ Tanks	▪ Contaminants transformed into harmless chemicals.	▪ Chemical reaction between treatment chemicals and waste to form additional toxic or hazardous contaminants ▪ Potential for chemical releases. ▪ Need to risk assess and/or develop risk management plan for chemicals.	▪ Not feasible as metals are the major contaminants of concern
9. Oxidation /Reduction	▪ Adding chemicals to oxidize or reduce contaminants in soils. ▪ Oxidation can be used to remove cyanide and organic chemicals while reduction can be used to remove chromium, silver and mercury.	$150-500/m^3	Days to weeks	In-situ. On/Off-site	▪ Excavators ▪ Chemicals ▪ Tanks ▪ Soil monitoring	▪ Contaminants transformed into harmless chemicals.	▪ Chemical reactions between waste and oxidants/reductants can form explosive reactions, and produce additional toxic or hazardous contaminants. ▪ Need to risk assess and/or develop risk management plan for chemicals.	▪ Not feasible as metals are the major contaminants of concern
10. Incineration	▪ Removal of severely hydrocarbon contaminated soil and PCBs by incineration	$500/m^3	Days to weeks	Off-site	▪ Excavators ▪ Transportation ▪ Incineration facility	▪ Complete removal of contamination from site	▪ Costly capital and operating expenses ▪ Disposal of ash and air emissions ▪ Need to develop a risk management plan for workers on site and public off site from emissions. ▪ Incomplete combustion	▪ Not feasible as metals are the major contaminants of concern

Table H: Summary of Potential Remediation Options for Impacted Soils at Old Landfill

Option	Principle and Application	Typical Costs	Time	Location	Equipment Requirements	Flexibility		EBA Evaluation
						Pros	Cons	
11. Pyrolysis	▪ Slow addition of heat for organic recovery	$500/m^3	Days to weeks	In-situ, On-site	▪ Excavators ▪ Soil monitoring ▪ Contamination tanks	▪ Carried out in-situ or off-site ▪ Removal and recovery of products	▪ Costly ▪ Disposal of product	▪ Not feasible as metals are the major contaminants of concern
12. Aerobic Treatment (landfarming)	▪ Remediation of hydrocarbon contaminated soils.	$50-300/m^3	Years	In-situ, On/Off-site	▪ Excavators ▪ Monitoring ▪ Organic nutrients	▪ Cost effective ▪ Can be carried out in-situ, on-site or off-site	▪ Time involved to remediate soils could be substantial. ▪ Toxic by-products may be produced and are accessible for human and ecological exposure by direct contact or dust inhalation. ▪ Microbial action may be impacted by salts, metals, and trace organic compounds.	▪ Not feasible as metals are the major contaminants of concern

Table H: Summary of Potential Remediation Options for Impacted Soils at Old Landfill

Option	Principle and Application	Typical Costs	Time	Location	Equipment Requirements	Flexibility		EBA Evaluation
						Pros	Cons	
13. Anaerobic Treatment	▪ -Remediation of hydrocarbon contaminated soils in anaerobic environment	$150-300/$m^3$	Years	In-situ, On/Off-site	▪ Excavators ▪ Monitoring ▪ Organic nutrients	▪ Can be carried out, in-situ on-site or off-site ▪ Cost effective	▪ Remediation may be incomplete ▪ Toxic by-products may be produced. ▪ Microbial action may be impacted by salts, metals, and trace organic compounds ▪ Odor problems such as hydrogen sulphide gas ▪ Need to develop risk management plan for vapours for workers on site a public off site.	▪ Not feasible as metals are the major contaminants of concern
14. **Fixation / Encapsulating**	▪ Removal and encapsulation (eg: in concrete) of contaminants. ▪ Contaminants may be used as construction materials. ▪ Ideal where landfill disposal is not available.	$50-500/$m^3$	Days to weeks	Off-Site	▪ Excavators ▪ Encapsulation fixations	▪ Fixated waste may be placed in landfill or used as construction material.	▪ High cost ▪ May not be appropriate due to incompatibility of other associated contaminants/chemical species	▪ Feasible as metals are the major contaminants of concern

Based on the location of the Old Landfill and estimated volume of impacted soils, EBA considers Options 1 to 4 as the most feasible options for remediation of impacted soils. The key activities involved with these options are discussed below.

6.2.1 Option 1 - Capping and Monitoring

This option involves capping the old landfill area and each of the adjacent debris areas separately with an impermeable liner or cap. The liner acts to prevent infiltration of rainwater and consequent leading of contaminants downward to underlying groundwater. The cap or liner also acts as a barrier to potential human or environmental exposure to the landfill materials. Key activities include the following:

- Tender preparation for capping and compacting borrow soils;
- Project management and meetings, including site visit with contractors to discuss the final project scope, trucking routes, potential crossing agreements, local road bans, safety requirements;
- Fieldwork preparation, field area preparation, line locates, ground disturbance, temporary storage area construction;
- Decommissioning of three monitoring wells in the Old Landfill area;
- Placement and compaction of borrow soils at Old Landfill and adjacent debris areas. The borrow soils will include:
- **Area 1 – North Debris Area**:
  - 0.6 m of a clay layer (approximately 810 m^3)
  - 0.8 m of subsoil for cultivated land use or forestry (approximately 1,080 m^3)
  - 0.2 m topsoil (approximately 270 m^3)
- **Area 2 – Old Landfill:**
  - 0.6 m of a clay layer (approximately 2,400 m^3)
  - 0.8 m of subsoil for cultivated land use or forestry (approximately 3,200 m^3)
  - 0.2 m topsoil (approximately 800 m^3)
- **Area 3 – Scattered Surface Debris:**
  - 0.6 m of a clay layer (approximately 150 m^3)
  - 0.8 m of subsoil for cultivated land use or forestry (approximately 200 m^3)
  - 0.2 m topsoil (approximately 50 m^3)
- **Area 4 – South Debris Area:**
  - 0.6 m of a clay layer (approximately 270 m^3)
  - 0.8 m of subsoil for cultivated land use or forestry (approximately 360 m^3)

- 0.2 m topsoil (approximately 90 m^3)

- Complete a post closure report for the site;
- A post closure groundwater monitoring program including preparation, implementation and reporting. This will include groundwater monitoring at the existing wells and installing an additional eight groundwater monitoring wells; and
- Continued groundwater monitoring and reporting (assume five years). The cost for conducting this option is estimated at $1,570,000. The Class C cost estimate for this option is provided in Table 5.

Assumptions for Cost Estimation

- Excavation mass of 2,000 kg per cubic metre (2 tonnes/m^3)
- Suitable backfill material is available on site or within 5 km radius
- Backfill material includes 20% swell factor
- Parks Canada to maintain seeded areas until complete grass germination

Discussion

Former landfill sites have frequently been capped and closed in place even when they did not previously have a liner (clay or geosynthetic) as they are historic facilities. Examples that EBA is directly familiar with include capped and closed landfill sites at Ermineskin and Alexander First Nations and Enoch Cree Nation in Alberta. The City of Edmonton also has old landfill sites in Rundle Park and former ravines that have been capped to minimize infiltration but in each case, domestic waste was consolidated in one location, compacted and covered with up to 1 m of clay fill and topsoil and sloped to promote runoff and minimize infiltration. The waste materials do not generate significant leachate in this situation as infiltration is minimized and the waste does not come in contact with the water table. Regular inspections are required are to ensure that the cap has good grass cover and is not eroding and groundwater monitoring wells are sampled and tested annually for landfill indicator parameters. Typical ones include chloride, phenol, metals, sulphates, etc. but are specific to each site. This monitoring is carried out to ensure that there is no migration of impacts.

End Use Alternatives

There are many examples of former landfill sites that have been closed and utilized for a range of new land uses. Closed and capped landfill sites have been developed as golf courses (Millwoods Golf Course, Edmonton), active recreational areas (Rundle Park, Edmonton), and passive open space. In all cases, the capped waste needs to be well above the fluctuation zone for the water table and graded to promote runoff (no flat areas where water can pond and infiltrate). One issue to consider with Class II waste (domestic waste including organics) is the generation of methane gas. Where levels are high, passive or active venting is provided as gas can build up in the ground (and adjacent basements of dwellings) and potentially be explosive. This happened at a landfill in Ontario about 20 years ago. As a result, residential and commercial development is usually set back from the edge of the waste by at least 100 m, depending on the site particulars. In the case of Garden River, there are no residences near the site and if it is capped, there should be stipulations that no new development be allowed nearby. That should not be difficult to

regulate in this case. A reasonable end use for the Old Landfill Site at Garden River if capped in place would be for passive recreational use. In general, grass and low shrub growth on the cap could be promoted to prevent erosion but large tree growth would result in root systems that could penetrate the cap and open pathways for the infiltration of runoff. Therefore, tree growth should be discouraged. There would be no apparent need to fence off the closed site but this could be done. Groundwater monitors should be protected (locked) and clearly marked from ATV's and snowmobiles for safety reasons and vandalism if the area is left open for public access.

6.2.2 Option 2 - Excavation and Landfill Disposal at Rainbow Lake

This option involves excavation and landfilling of soils exceeding the applicable guidelines and backfilling the excavation with clean soils. Prior to backfilling the excavation, confirmatory soil samples are collected from the base and walls of the excavation to assess if the excavation boundaries are clean and the contaminated soils are removed. In addition, EBA would recommend the completion of at least one groundwater monitoring and sampling event following remediation to confirm that subsurface conditions have not been affected, followed by the decommissioning of the existing monitoring wells.

The key activities will include the following:

- Conduct soil sampling for landfill disposal characterization analysis (five samples);
- Tender preparation for excavating, backfilling and compacting backfill soils;
- Project management and meetings, including: site visit with contractors to discuss the final project scope; trucking routes; potential crossing agreements; local road bans; safety requirements; and landfill hours;
- Fieldwork preparation, field area preparation, line locates, ground disturbance;
- Decommissioning of three groundwater monitoring wells in the Old Landfill area;
- Construction of temporary storage area may be required to stockpile excavated soils;
- Excavate and landfill disposal of approximately 7,200 m^3 of impacted soils from Old Landfill and adjacent debris areas to the Rainbow Lake landfill;
- Conduct a confirmatory soil sampling program of approximately 6,000 m^2 area for contaminants of concern reported for this site. Approximately 90 samples will be collected from the walls and bases of the excavations;
- Backfilling the excavations with source fill material and compacting backfill;
- Placing top soil (approximately 1,200 m^3), seeding and re-contouring;
- Complete a post remediation report including the findings of the confirmatory soil sampling; and
- Complete a post-remediation groundwater monitoring and sampling program. This will include groundwater monitoring from the existing wells on-site (six wells). Prepare a report of the post-treatment groundwater monitoring.

The cost for conducting this option is estimated at $3,920,000. The Class C cost estimate for this option is provided in Table 6.

Assumptions for Cost Estimation

- Excavation mass of 2,000 kg per cubic metre (2 tonne/m^3)
- Suitable backfill material is available on site or within 5 km radius
- Backfill material required for excavation includes 20% swell factor
- Parks Canada to maintain seeded areas until complete grass germination
- All materials hauled to Rainbow Lake landfill are accepted by the Mackenzie Regional Waste Management Commission

6.2.3 Option 3 - Excavate and Disposal in New Landfill Constructed at Old Landfill Site

This option involves excavation of impacted soils and stockpiling them in a separate area, followed by construction of a new landfill at the Old Landfill location and then placing the stockpiled soils at the new landfill, followed by capping and annual monitoring as discussed in Section 6.2.1.

It should be noted that hydrocarbon impacted soils from the Community Airstrip (discussed in Section 6.1.3) will also be deposited in the new landfill, if constructed.

The key activities will include the following:

- Conduct soil sampling for landfill disposal characterization analysis (five samples);
- Obtain approval from AESRD for construction of a new landfill;
- Tender preparation for excavating, landfill construction at Old Landfill location, backfilling with impacted soils, and capping;
- Project management and meetings, including: site visit with contractors to discuss the final project scope; trucking routes; potential crossing agreements; local road bans; and safety requirements;
- Fieldwork preparation, field area preparation, line locates, ground disturbance;
- Decommissioning of three groundwater monitoring wells in the Old Landfill area;
- Construction of temporary storage area to stockpile excavated soils;
- Excavate and stockpile impacted soils (approximately 7,200 m^3) at the temporary storage area;
- Conduct a confirmatory soil sampling program of approximately 6,000 m^2 area for parameters of concern reported for this site. Approximately 90 samples will be collected from the walls and bases of the excavations;
- Construct a new landfill at the Old Landfill location once confirmatory sampling results show that clean boundaries have been reached;
- Deposit stockpiled soil in the new landfill followed by capping, which will include:

  - 0.6 m of a clay layer (approximately 2,400 m^3)
  - 0.8 m of subsoil for cultivated land use or forestry (approximately 3,200 m^3)
  - 0.2 m topsoil (approximately 800 m^3)
- Backfilling debris areas with topsoil (approximately 600 m^3), seeding and re-contouring;
- Complete a landfill construction and post closure report for the site;
- Conduct a post closure groundwater monitoring program including preparation, implementation and reporting. This will include groundwater monitoring at the existing wells and installing an additional eight groundwater monitoring wells; and
- Continued groundwater monitoring and reporting (assume ten years).

The cost for conducting this option is estimated at $1,960,000. The Class C cost estimate for this option is provided in Table 7.

Assumptions for Cost Estimation

- Excavation mass of 2,000 kg per cubic metre (2 tonne/m^3)
- Suitable backfill material (top soil) is available on site or within 5 km radius
- Backfill material required for excavation includes 20% swell factor
- Parks Canada to maintain seeded areas until complete grass germination

6.2.4 Option 4 - Excavate and Deposit in New Landfill Constructed West of Garden River

This option involves excavating and landfilling of soils exceeding the applicable guidelines to a new landfill to be constructed at approximately 3 km west of the community of Garden River. The approximate location of the proposed landfill is shown on Figure 5, included in Appendix A. The landfill could also be sited at the old lagoon east of the community, if conditions are favourable.

It should be noted that hydrocarbon impacted soils from the Community Airstrip (discussed in Section 6.1.3) will also be deposited in this new landfill, if constructed.

The key activities will include the following:

- Conduct soil sampling for landfill disposal characterization analysis (five samples);
- Obtain approval from AESRD for construction of a new landfill;
- Tender preparation for construction of the new landfill, new landfill capping, excavating impacted soils from the Old Landfill and hauling to the new landfill, and backfilling excavations at the Old Landfill;
- Project management and meetings, including: site visits with contractors to discuss the final project scope; trucking routes; potential crossing agreements; local road bans; and safety requirements;
- Fieldwork preparation, field area preparation, line locates, ground disturbance;

- Construct a new landfill at the proposed location approximately 3 km west of the community of Garden River;
- Decommissioning of three groundwater monitoring wells in the Old Landfill area;
- Construction of temporary storage area may be required to stockpile excavated soils;
- Excavate and landfill disposal of approximately 7,200 m^3 of impacted soils from the Old Landfill and adjacent debris areas to the new landfill;
- Conduct a confirmatory soil sampling program of approximately 6,000 m^2 area for contaminants of concern reported for this site. Approximately 90 samples will be collected from the walls and bases of the excavations;
- Backfilling the excavations with source fill material and compacting backfill;
- Placing top soil (approximately 1,200 m^3), seeding and re-contouring;
- Capping new landfill with 0.6 m of a clay layer, 0.8 m of subsoil, and 0.2 m of topsoil. The quantities of clay, subsoil and top soil will depend upon the depth of the impacted soils in the new landfill. However, for this cost estimate, it is assumed that a 4,000 m^2 area of the new landfill will be capped. The capping will then include:
  - 0.6 m of a clay layer (approximately 2,400 m^3)
  - 0.8 m of subsoil for cultivated land use or forestry (approximately 3,200 m^3)
  - 0.2 m topsoil (approximately 800 m^3)
- Complete a post remediation report for the Old Landfill including the findings of the confirmatory soil sampling;
- Complete a post-remediation groundwater monitoring and sampling program at the Old Landfill. This will include groundwater monitoring from the existing wells on-site (six wells). Prepare a report of the post-treatment groundwater monitoring;
- Complete a landfill construction and capping report;
- Conduct a post closure groundwater monitoring program for the new landfill, including preparation, implementation and reporting. This will include installation of 12 groundwater monitoring wells around the new landfill; and
- Continued groundwater monitoring and reporting for the new landfill (assume 10 years).

The cost for conducting this option is estimated at $3,270,000. The Class C cost estimate for this option is provided in Table 8.

Assumptions for Cost Estimation

- Excavation mass of 2,000 kg per cubic metre (2 tonnes/m^3)
- Suitable backfill material (top soil) is available on site or within 5 km radius

- Backfill material required for excavation includes 20% swell factor
- Parks Canada to maintain seeded areas until complete grass germination

7.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the reports review, the volume of impacted soils at the Community Airstrip is estimated to be 250 m^3 where identified parameters of concerns were BTEX, F1 and F2. Hydrocarbon impacts are limited to surface soils to a maximum depth of 1 mbg. At the Old Landfill site, the volume of impacted soils is estimated to be 7,200 m^3 where metals were the main parameters of concern. The impacted soils are generally limited to the surface soils to a maximum depth of 1.5 mbg. It is noted that there may be impacts to 3 m in some areas (Columbia – Franz, 2011) and a 10% contingency has been applied to account for this possibility.

Based on the remediation options analysis, EBA provides four feasible options for remediation of impacted soils at each site which are presented to PCA for their consideration. The remedial options are summarized in the following tables.

Table I: Remediation Options for Hydrocarbon Impacted Soils at Community Airstrip

Options	Class C Cost Estimate	Time	Location	Flexibility	
				Pros	Cons
Option 1 - Excavation and Landfarming (estimated 250 m^3 of impacted soils)	$210,000	Years	On/Off-site	▪ Cost effective ▪ Can be carried out on-site or off-site	▪ Time involved to remediate soils could be substantial. ▪ Toxic by-products may be produced. ▪ Microbial action may be impacted by salts, metals, and trace organic compounds
Option 2 - Excavation and Landfill Disposal at Rainbow Lake (estimated 250 m^3 of impacted soils)	$200,000	Days to weeks	Off-site	▪ Simplest remediation method ▪ Appropriate for soils with high levels of contaminants.	▪ May be restrictions at landfill location ▪ Expensive transportation costs ▪ Potential human and ecological risks in the event of an accident during transportation ▪ Regulatory liaison delays ▪ Impact to roads ▪ Greenhouse gas emissions by trucks ▪ Accidental spills
Option 3 - Excavate and Disposal in New Landfill Construct at Old Landfill Site (estimated 250 m^3 of impacted soils)	$150,000	Days	Off-site	▪ Please, see Option 3 in Table J	

Table I: Remediation Options for Hydrocarbon Impacted Soils at Community Airstrip

Options	Class C Cost Estimate	Time	Location	Flexibility	
				Pros	Cons
Option 4 - Excavate and Disposal in New Landfill Construct 3 Km West of Community (estimated 250 m^3 of impacted soils)	$250,000	Days	Off-site	▪ Please, see Option 4 in Table J	

Table J: Remediation Options for Impacted Soils at Old Landfill

Options	Class C Cost Estimate	Time	Location	Flexibility	
				Pros	Cons
Option 1 - Capping and Monitoring	$1,570,000	Weeks	On-site	▪ Lower cost ▪ Less time period possible ▪ Potential end land uses – pasture, recreational, cultivation, and forestry	▪ Contaminated soils remains on-site ▪ Future monitoring (groundwater monitoring) required to verify soil leaching to groundwater and groundwater transport not occurring ▪ Soil cap thickness and design must ensure no human or ecological access to soils. ▪ Soil cap must be maintained in perpetuity. ▪ Clay cap may increase the build-up of landfill gas and venting may be required. ▪ Restricts nearby for residential development
Option 2 - Excavation and Landfill Disposal at Rainbow Lake	$3,920,000	Weeks	Off-site	▪ Simplest remediation method ▪ Appropriate for soils with high levels of contaminants. ▪ Could be sited at old lagoon east of community if conditions are favourable	▪ May be restrictions at landfill location ▪ Expensive transportation costs ▪ Potential human and ecological risks in the event of an accident during transportation ▪ Regulatory liaison delays ▪ Overall costs are high

Table J: Remediation Options for Impacted Soils at Old Landfill

Options	Class C Cost Estimate	Time	Location	Flexibility	
				Pros	Cons
Option 3 - Excavate and Disposal in New Landfill Construct at Old Landfill site	$1,960,000	Weeks	Off-site	▪ Simplest remediation method ▪ Appropriate for soils with high levels of contaminants.	▪ AESRD may not approve the location of the new landfill ▪ Additional cost for constructing and capping new landfill ▪ Continued groundwater monitoring required ▪ Regulatory liaison delays ▪ Contaminated soils remain on-site ▪ Soil cap thickness and design must ensure no human or ecological access to soils. ▪ Soil cap must be maintained in perpetuity. ▪ Clay cap may increase the build-up of landfill gas and venting may be required. ▪ Lack of feasibility for residential development
Option 4 - Excavate and Disposal in New Landfill Construct 3 km West of Community of Garden River	$3,270,000	Weeks	Off-site	▪ Simplest remediation method ▪ Appropriate for soils with high levels of contaminants.	▪ AESRD may not approve the location of the new landfill ▪ The proposed site has not been seen if it is suitable place for new landfill ▪ Additional cost for constructing and capping new landfill ▪ Continued groundwater monitoring required ▪ Potential human and ecological risks in the event of an accident during transportation. ▪ Regulatory liaison delays ▪ Soil cap thickness and design must ensure no human or ecological access to soils. ▪ Soil cap must be maintained in perpetuity. ▪ Clay cap may increase the build-up of landfill gas and venting may be required.

Findings of the previous reports review identified that select metal concentrations in groundwater exceeded the applicable guidelines. Figures 3b and 4b show the monitoring well locations at the Community Airstrip and Old Landfill, respectively, where those exceedances were observed. Columbia - Franz, 2011 concluded that there were exceedances of metal concentrations but were not due to the Old Landfill site. In addition, by considering the soil and groundwater analytical results (discussed in detail in Section 5.0 of the report), elevated concentrations of select metals were considered to be naturally occurring and/or not due to on-site activities. Therefore, a remediation option analysis and action plan was not considered applicable for groundwater at either the Community Airstrip or at the Old Landfill.

8.0 LIMITATIONS OF LIABILITY

This report and its contents are intended for the sole use of PCA and their agents. EBA Engineering Consultants Ltd. does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than PCA, or for any project other than the remediation of the sites. Any such unauthorized use of this letter report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in EBA's Services Agreement. EBA's General Conditions are provided in Appendix B of this report.

9.0 CLOSURE

We trust this report meets your present requirements. Should you have any questions or comments, please contact the undersigned at your convenience.

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REFERENCES

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TABLES

Table 1: Option 1 Community Airstrip: Class C Cost Estimate for Excavation and Landfarming

	Garden River Community Airport Stained Area 1 and Stained Area 2 at East End of Rwy 07-25	**Unit of Measure**	**Approx. Quantity**	**Unit Price**	**Total Cost**
1	Locates - Alberta One-Call	lump sum	1	$2,500	$2,500
2	Land farm construction including liner (1,000 m^2)	m^2	1000	$10	$10,000
3	Excavate soils from Areas 1 and 2 and place on landfarm area in 0.3 m lift	m^3	250	$20	$5,000
4	Construct 0.3 m high berm around perimeter of land farm	lin m	120	$25	$3,000
5	Backfill with common & compact - Area 1 [(0.3 m x 100 m^2) x1.2]	m^3	40	$75	$3,000
6	Backfill with common & compact - Area 2 [(0.8 m x 200 m^2) x1.2]	m^3	200	$75	$15,000
7	Regrade Sites 1 and 2	m^2	300	$10	$3,000
8	Supply and place 0.2 m thick topsoil	m^2	300	$50	$15,000
9	Seeding (Parks Canada to water and maintain)	m^2	300	$5	$1,500
10	Mob and demob from site (+/- 20 %)	lump sum			$11,600
	Subtotal - Estimated Construction Cost				$69,600.00
	Estimated Construction Cost Contingency (15%)				$10,440.00
Additional Costs	Engineering fee and reporting		1	$50,000	$50,000.00
Additional Costs	Annual Monitoring of Land farmed Soils (Cost Table AC)	Year	4	$19,115	$76,460
	Total Estimated Cost				$206,500
	Class C Estimated Cost				**$210,000**

Assumptions:

Excavation mass of 2,000 kg per cubic metre (2 tonnes/m^3)
Suitable backfill material is available on site or within 5 km radius
Backfill material required for excavation includes 20% swell factor
Suitable landfarm area available on site (Possible suitable locations are on runway approaches)
Parks Canada to maintain seeded areas until complete grass germination
CFU4 Airport Operator (Little Red River Cree Nation) to provide NOTAM communications to CYOJ FSS (High Level Airport Flight Service Station) during construction

Table 2: Option 2 Community Airstrip: Class C Cost Estimate for Excavation and Landfill Disposal at Rainbow Lake

Item No.	Description	Unit of Measure	Approx. Quantity	Unit Price	Total Cost
	Garden River Community Airport **Stained Area 1 and Stained Area 2 at East End of Rwy 07-25**				
1	Locates - Alberta One-Call	lump sum	1	$2,500	$2,500
2	Excavate and haul to the Tervita landfill, 40km east of Rainbow Lake (Site 1 - 0.5 m depth; Site 2 - 1.0 m depth) Using 15 m^3 per load trucks	m^3	250	$200	$50,000
3	Backfill with common & compact - Area 1 [(0.3 m x 100 m^2) x1.2]	m^3	40	$75	$3,000
4	Backfill with common & compact - Area 2 [(0.8 m x 200 m^2) x1.2]	m^3	200	$75	$15,000
5	Regrade Sites 1 and 2	m^2	300	$10	$3,000
6	Supply and place 0.2 m thick topsoil	m^2	300	$50	$15,000
7	Seeding (Parks Canada to water and maintain)	m^2	300	$5	$1,500
8	Mob and demob from site (+/- 20 %)	lump sum			$18,000
	Subtotal - Estimated Construction Cost				$108,000
	Estimated Construction Cost Contingency (15%)				$16,200
Additional Costs	Engineering fee and reporting		1	$50,000.00	$50,000
Additional Costs	Class 2 Soil Samples Collection (Cost Table AA)				$21,595
	Total Estimated Cost				$195,795
	Class C Estimated Cost				**$200,000**

Assumptions:

Excavation mass of 2,000 kg per cubic metre (2 tonnes/m^3)
Suitable backfill material is available on site or within 5 km radius
Backfill material required for excavation includes 20% swell factor
Parks Canada to maintain seeded areas until complete grass germination
All materials hauled to the Tervita Landfill site east of Rainbow Lake are accepted
CFU4 Airport Operator (Little Red River Cree Nation) to provide NOTAM communications to CYOJ FSS (High Level Airport Flight Service Station) during construction

Table 3: Community Airstrip Option 3: Class C Cost Estimate for Excavation of Community Airstrip Soils and Disposal in New Landfill at Old Landfill Site

Item No.	Description	Unit of Measure	Approx. Quantity	Unit Price	Total Cost
	Garden River Community Airport **Stained Area 1 and Stained Area 2 at East End of Rwy 07-25**				
1	Locates - Alberta One-Call	lump sum	1	$2,500	$2,500
2	Excavate and haul contaminated material to the Old Landfill Site (Old Landfill Site has previously been remediated to a New Landfill Site - See Table 7)	m^3	250	$50	$12,500
3	Backfill with common & compact - Area 1 [(0.3 m x 100 m^2) x1.2]	m^3	40	$75	$3,000
4	Backfill with common & compact - Area 2 [(0.8 m x 200 m^2) x1.2]	m^3	200	$75	$15,000
5	Regrade Sites 1 and 2	m^2	300	$10	$3,000
6	Supply and place 0.2 m thick topsoil	m^2	300	$50	$15,000
7	Seeding (Parks Canada to water and maintain)	m^2	300	$5	$1,500
8	Mob and demob from site (+/- 20 %)	lump sum			$10,500
	Subtotal - Estimated Construction Cost				$63,000
	Estimated Construction Cost Contingency (15%)				$9,450
Additional Costs	Engineering fee and reporting		1	$50,000.00	$50,000
Additional Costs	Class 2 Soil Samples Collection (Cost Table AA)				$21,595
	Total Estimated Cost				$144,045
	Class C Estimated Cost				**$150,000**

Assumptions:

Excavation mass of 2,000 kg per cubic metre (2 tonnes/m^3)
Suitable backfill material is available on site or within 5 km radius
Backfill material required for excavation includes 20% swell factor
Parks Canada to maintain seeded areas until complete grass germination
Remediation of the Airstrip is done at the same time as the construction of the New Landfill at the Old landfill Site.
CFU4 Airport Operator (Little Red River Cree Nation) to provide NOTAM communications to CYOJ FSS (High Level Airport Flight Service Station) during construction

Table 4: Community Airstrip Option 4: Class C Cost Estimate for Excavation and Disposal in New Landfill 3 km West of Community

Item No.	Description	Unit of Measure	Approx. Quantity	Unit Price	Total Cost
	Garden River Community Airport **Stained Area 1 and Stained Area 2 at East End of Rwy 07-25**				
1	Locates - Alberta One-Call	lump sum	1	$2,500	$2,500
2	Excavate and haul contaminated material to a New Landfill 3 Km west of Village (New Landfill Site has previously been constructed - See Table 8)	m^3	250	$50	$12,500
3	Backfill with common & compact - Area 1 [(0.3 m x 100 m^2) x1.2]	m^3	40	$75	$3,000
4	Backfill with common & compact - Area 2 [(0.8 m x 200 m^2) x1.2]	m^3	200	$75	$15,000
5	Regrade Sites 1 and 2	m^2	300	$10	$3,000
6	Supply and place 0.2 m thick topsoil	m^2	300	$50	$15,000
7	Seeding (Parks Canada to water and maintain)	m^2	300	$5	$1,500
8	Mob and demob from site (+/- 20 %)	lump sum			$10,500
	Subtotal - Estimated Construction Cost				$63,000
	Estimated Construction Cost Contingency (15%)				$9,450
Additional Costs	Engineering costs for new landfill design and reporting		1	$150,000.00	$150,000
Additional Costs	Class 2 Soil Samples Collection (Cost Table AA)				$21,595
	Total Estimated Cost				$244,045
	Class C Estimated Cost				**$250,000**

Assumptions:

Excavation mass of 2,000 kg per cubic metre (2 tonnes/m^3)
Suitable backfill material is available on site or within 5 km radius
Backfill material required for excavation includes 20% swell factor
Parks Canada to maintain seeded areas until complete grass germination
Remediation of the Airstrip is done at the same time as the construction of the New Landfill 3 KM west of Village
CFU4 Airport Operator (Little Red River Cree Nation) to provide NOTAM communications to CYOJ FSS (High Level Airport Flight Service Station) during construction

Table 5: Old Landfill Option 1: Class C Cost Estimate for Capping and Monitoring

Item No.	Description	Unit of Measure	Approx. Quantity	Unit Price	Total Cost
	Garden River Community - Old Landfill				
1	Locates - Alberta One-Call	lump sum	1	$2,500	$2,500
2	Area 1 - Load, place and compact borrow materials				
2.1	0.6 m layer of clay	m^3	810	$75	$60,750
2.2	0.8 m subsoil	m^3	1080	$75	$81,000
2.3	0.2 m topsoil	m^2	1350	$50	$67,500
3	Area 2 - Load, place and compact borrow materials				
3.1	0.6 m layer of clay	m^3	2400	$75	$180,000
3.2	0.8 m subsoil	m^3	3200	$75	$240,000
3.3	0.2 m topsoil	m^2	4000	$50	$200,000
4	Area 3 - Load, place and compact borrow materials				
4.1	0.6 m layer of clay	m^3	150	$75	$11,250
4.2	0.8 m subsoil	m^3	200	$75	$15,000
4.3	0.2 m topsoil	m^2	250	$50	$12,500
5	Area 4 - Load, place and compact borrow materials				
5.1	0.6 m layer of clay	m^3	270	$75	$20,250
5.2	0.8 m subsoil	m^3	360	$75	$27,000
5.3	0.2 m topsoil	m^2	450	$50	$22,500
6	Mob and demob from site (+/- 20 %)	lump sum			$188,050
	Subtotal - Estimated Construction Cost				$1,128,300
	Estimated Construction Cost Contingency (15%)				$169,245
Additional Costs	Additional cost and reporting		1	$100,000.00	$100,000
	Decommissioning of 3 monitoring wells (Cost Table AG)				$20,968
	Post Remediation Groundwater Monitoring and Adding 8 New Wells (Cost Table AE)				$38,551
	Continued Groundwater Monitoring (Cost Table AF)	Year	5	$21,775	$108,875
	Total Estimated Cost				$1,565,939
	Class C Estimated Cost				**$1,570,000**

Assumptions:

Excavation mass of 2,000 kg per cubic metre (2 tonnes/m^3)

Suitable backfill material is available on site or within 5 km radius

Backfill material required for excavation includes 20% swell factor

Parks Canada to maintain seeded areas until complete grass germination

Table 6: Old Landfill Option 2: Class C Cost Estimate for Excavation and Landfill Disposal at Rainbow Lake

Item No.	Description	Unit of Measure	Approx. Quantity	Unit Price	Total Cost
	Garden River Community - Old Landfill				
1	Locates - Alberta One-Call	lump sum	1	$2,500	$2,500
2	Construct temporary stockpile site (clearing & grading)	m^2	1000	$5	$5,000
3	Excavate, separate and stockpile contaminated soils and other debris	m^3	7200	$40	$288,000
4	Load, Haul and disposal to Tervita Landfill east of Rainbow Lake (Contaminated Soil approved for Daily Cover; Tipping Fee - $30/tonne)	m^3	1800	$200	$360,000
5	Load, Haul and disposal to High River Landfill (Assorted Metals, Debris etc. Tipping Fee - $140/tonne)	m^3	5400	$250	$1,350,000
6	Backfill with common native material ; compact and regrade	m^3	8640	$75	$648,000
7	Supply and place 0.2 m thick topsoil	m^2	1200	$50	$60,000
8	Seeding (Parks Canada to water and maintain)	m^2	1200	$5	$6,000
9	Mob and demob from site (+/- 20 %)	lump sum			$543,900
	Subtotal - Estimated Construction Cost				$3,263,400
	Estimated Construction Cost Contingency (15%)				$489,510
Additional Costs	Engineering cost and reporting		1	$100,000.00	$100,000
	Class 2 Landfill Soil Samples Collection (Cost Table AB)				$21,595
	Well Decommissioning and Monitoring in Old landfill area (Cost Table AG)				$20,968
	Post Remediation GW Monitoring/Sampling (Cost Table AD)				$20,000
	Total Estimated Cost				$3,915,473
	Class C Estimated Cost				**$3,920,000**

Assumptions:

Excavation mass of 2,000 kg per cubic metre (2 tonnes/m^3)
Suitable backfill material is available on site or within 5 km radius
Backfill material required for excavation includes 20% swell factor
Parks Canada to maintain seeded areas until complete grass germination
All materials hauled to the Tervita landfill site east of Rainbow Lake are accepted
All materials hauled to High Level landfill are accepted by the Mackenzie Regional Waste Management Commission

Table 7: Old Landfill Option 3: Class C Cost Estimate for Excavation of Landfill Material and Disposal in New Landfill at Existing Site

Item No.	Description	Unit of Measure	Approx. Quantity	Unit Price	Total Cost
	Garden River Community - Old Landfill				
1	Locates - Alberta One-Call	lump sum	1	$2,500	$2,500
2	Construct temporary stockpile site (clearing & grading)	m^2	1000	$5	$5,000
3	Excavate, separate and stockpile contaminated soils and other debris from Old Landfill Areas 1,2,3 and 4	m^3	7200	$35	$252,000
4	Prepare base of Old Landfill site for clay liner	m^2	6050	$3	$18,150
5	Load, haul, place and compact 1.0m clay liner sub-grade	m^3	6050	$25	$151,250
6	Install geomembrane liner	m^2	6050	$15	$90,750
7	Load, haul, and place contaminated soils and other debris from adjacent stockpiles to New Landfill cells in Old Landfill site (Contaminated materials from Airport to be placed in New Landfill cell at the same time)	m^3	7200	$25	$180,000
	Cap New Landfill:				
8	Load, haul, place and compact 0.6 m clay layer from borrow area	m^3	3630	$25	$90,750
9	Load, haul, place and compact 0.8 m sub-soil layer from borrow area	m^3	4840	$25	$121,000
10	Supply and place 0.2 m thick topsoil Layer	m^2	6050	$50	$302,500
11	Seeding (Parks Canada to water and maintain)	m^2	6050	$5	$30,250
12	Mob and demob from site (+/- 20 %)	lump sum			$248,830
	Subtotal - Estimated Construction Cost				$1,492,980
	Estimated Construction Cost Contingency (15%)				$223,947
Additional Costs	Engineering costs for new landfill development and siting including construction monitoring and reporting				$150,000
	Final Landfill Closure and Post-Closure Engineering				$50,000
	Well Decommissioning and Monitoring in Old landfill area (Cost Table AG)				$20,968
	Post Remediation GW Monitoring/Sampling (Cost Table AD)				$20,000
	Total Estimated Cost				$1,957,895
	Class C Estimated Cost				**$1,960,000**

Assumptions:

Excavation mass of 2,000 kg per cubic metre (2 tonnes/m^3)
Suitable backfill material is available on site or within 5 km radius
Backfill material required for excavation includes 20% swell factor
Parks Canada to maintain seeded areas until complete grass germination
New Landfill development and closure meets development and siting criteria as per Standards For Landfills in Alberta

Table 8: Old Landfill Option 4: Class C Cost Estimate for Excavation of Old Landfill Material and Disposal in New Landfill 3 km West of Community

Item No.	Description	Unit of Measure	Approx. Quantity	Unit Price	Total Cost
	Garden River Community - Old Landfill				
1	Locates - Alberta One-Call	lump sum	1	$2,500	$2,500
2	Construct temporary stockpile site (clearing & grading)	m^2	1000	$5	$5,000
3	Excavate, separate and stockpile contaminated soils and other debris from Old Landfill Areas 1, 2, 3 and 4	m^3	7200	$35	$252,000
4	Load, haul, and place contaminated soils and other debris from adjacent stockpiles to New Landfill cells in New Landfill 3 Km west of Village	m^3	7200	$40	$288,000
	Prepare New Landfill Site:				
5	Prepare base of New Landfill site for clay liner	m^2	6050	$3	$18,150
6	Load, haul, place and compact 1.0 m clay liner sub-grade	m^3	6050	$25	$151,250
7	Install geomembrane liner	m^2	6050	$15	$90,750
	Cap Old Landfill:				
8	Area 1 - Load, place and compact borrow materials				
8.1	0.6 m layer of clay	m^3	810	$75	$60,750
8.2	0.8 m subsoil	m^3	1080	$75	$81,000
8.3	0.2 m topsoil	m^2	1350	$50	$67,500
9	Area 2 - Load, place and compact borrow materials				
9.1	0.6 m layer of clay	m^3	2400	$75	$180,000
9.2	0.8 m subsoil	m^3	3200	$75	$240,000
9.3	0.2 m topsoil	m^2	4000	$50	$200,000
10	Area 3 - Load, place and compact borrow materials				
10.1	0.6 m layer of clay	m^3	150	$75	$11,250
10.2	0.8 m subsoil	m^3	200	$75	$15,000
10.3	0.2 m topsoil	m^2	250	$50	$12,500
11	Area 4 - Load, place and compact borrow materials				
11.1	0.6 m layer of clay	m^3	270	$75	$20,250
11.2	0.8 m subsoil	m^3	360	$75	$27,000
11.3	0.2 m topsoil	m^2	450	$50	$22,500
14	Seeding (Parks Canada to water and maintain)	m^2	1200	$5	$6,000
	Cap New Landfill:				
15	Load, haul, place and compact 0.6 m clay layer at New Landfill site	m^3	3630	$25	$90,750
16	Load, haul, place and compact 0.8 m sub-soil layer at New Landfill site	m^3	4840	$25	$121,000
17	Load, haul, and place 0.2 m topsoil layer at New Landfill site	m^2	6050	$50	$302,500
18	Seeding (Parks Canada to water and maintain)	m^2	6050	$5	$30,250
19	Mob and demob from site (+/- 20 %)	lump sum			$350,280
	Subtotal - Estimated Construction Cost				$2,646,180
	Estimated Construction Cost Contingency (15%)				$396,927
Additional Costs	Engineering costs for new landfill development and siting including construction monitoring and reporting				$150,000
	Final Landfill Closure and Post-Closure Engineering				$50,000
	Post Remediation GW Monitoring/Sampling (Cost Table AD)				$20,000
	Total Estimated Cost				$3,263,107
	Class C Estimated Cost				**$3,270,000**

Assumptions:

Excavation mass of 2,000 kg per cubic metre (2 tonnes/m^3)

Suitable backfill material is available on site or within 5 km radius

Backfill material required for excavation includes 20% swell factor

Parks Canada to maintain seeded areas until complete grass germination

New Landfill development and closure meets development and siting criteria as per Standards For Landfills in Alberta

Table 9: Comparison of Applicable Environmental Management Options Community Airstrip

Assessment Criteria	Excavation and Landfarming	Excavation and Landfill Disposal at Rainbow Lake	Excavate and Disposal at Reconstructed Landfill Site	Excavate and Disposal at New Landfill 3 km West
Liability Reduction	High	High	High	High
Impact on Site Operations	Limited if landfarm is located on site	Limited (during excavation)	Limited (during excavation)	Limited (during excavation)
Complexity	Low to Moderate	Low	Low	Low
Public/ Stakeholder Perception	unknown	unknown	unknown	unknown
Risk to Human Health and the Environment	Low	Low	Low	Low
Timeframe	Years	Days to weeks	Days to weeks	Days to weeks
Relative cost	$210,000	$200,000	$150,000	$250,000
Land Use Restrictions	High ▪ Landfarm area cannot be used until soil has been remediated	None	None	None
Regulatory Compliance	Yes	Yes	Yes – if new landfill is approved	Yes – if new landfill is approved
Local Economic Benefit	Minimal	Minimal	Minimal	Minimal
Sustainability of Approach	Moderate ▪ Few resources used ▪ Low risk to environment during remediation ▪ Land cannot be used during remediation	High ▪ Few resources used ▪ Low risk to environment during remediation	High ▪ Few resources used ▪ Low risk to environment during remediation	High ▪ Few resources used ▪ Low risk to environment during remediation
Implementation Risks	Low to Moderate ▪ Soil remediation may not progress as expected ▪ Potential for long term (years) to remediate soil	Low ▪ Spills during transportation	Moderate ▪ Landfill may not be approved	Moderate ▪ Landfill may not be approved
Other Advantages	Low cost	Low cost	Low cost	Low cost
Other Disadvantages	Time to remediate soil	None	None	None

Table 10: Comparison of Applicable Environmental Management Options Old Landfill

Assessment Criteria	Capping and Monitoring	Excavation and Landfill Disposal at Rainbow Lake	Excavate and Disposal at Reconstructed Landfill Site	Excavate and Disposal at New Landfill 3 km West
Liability Reduction	High	High	High	High
Impact on Site Operations	High	High	High	High
Complexity	Moderate	Low	Moderate to high	Moderate to high
Public/ Stakeholder Perception	May be unacceptable	Likely acceptable	May be unacceptable	Likely acceptable
Risk to Human Health and the Environment	Low Monitoring required	Low	Low Monitoring required	Low Monitoring required
Timeframe	Day to weeks	Days to weeks	Months	Months
Relative cost	$1,570,000	$3,920,000	$1,960,000	$,3,270,000
Land Use Restrictions	Moderate ▪ No housing within setbacks	none	Moderate ▪ No housing within setbacks	None
Regulatory Compliance	Yes	Yes	Yes – if new landfill is approved	Yes – if new landfill is approved
Local Economic Benefit	Minimal	Minimal	Minimal	Minimal
Sustainability of Approach	Moderate ▪ Few resources used ▪ Low risk to environment during remediation ▪ Land use restrictions	High ▪ No land use restrictions	Moderate ▪ Few resources used ▪ Low risk to environment during remediation ▪ Land use restrictions	High ▪ No land use restrictions
Implementation Risks	Moderate Monitoring required Land use restrictions	Low	Moderate Land use restrictions May not be approved	Moderate Landfill may not be approved
Other Advantages	Lower relative cost	Impact removed from site	Convenience of local landfill	Convenience of local landfill
Other Disadvantages	May not be acceptable	Higher relative cost	May not be acceptable	Higher relative cost

FIGURES

NOTES

Background imagery courtesy of Google Earth and is shown for visual presentation purposes only.

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Parks Canada Agency

GARDEN RIVER, ALBERTA COMMUNITY AIRSTRIP AND OLD LANDFILL REPORTS REVIEW AND REMEDIAL OPTIONS ANALYSIS
GARDEN RIVER, AB

SITE LOCATION PLAN

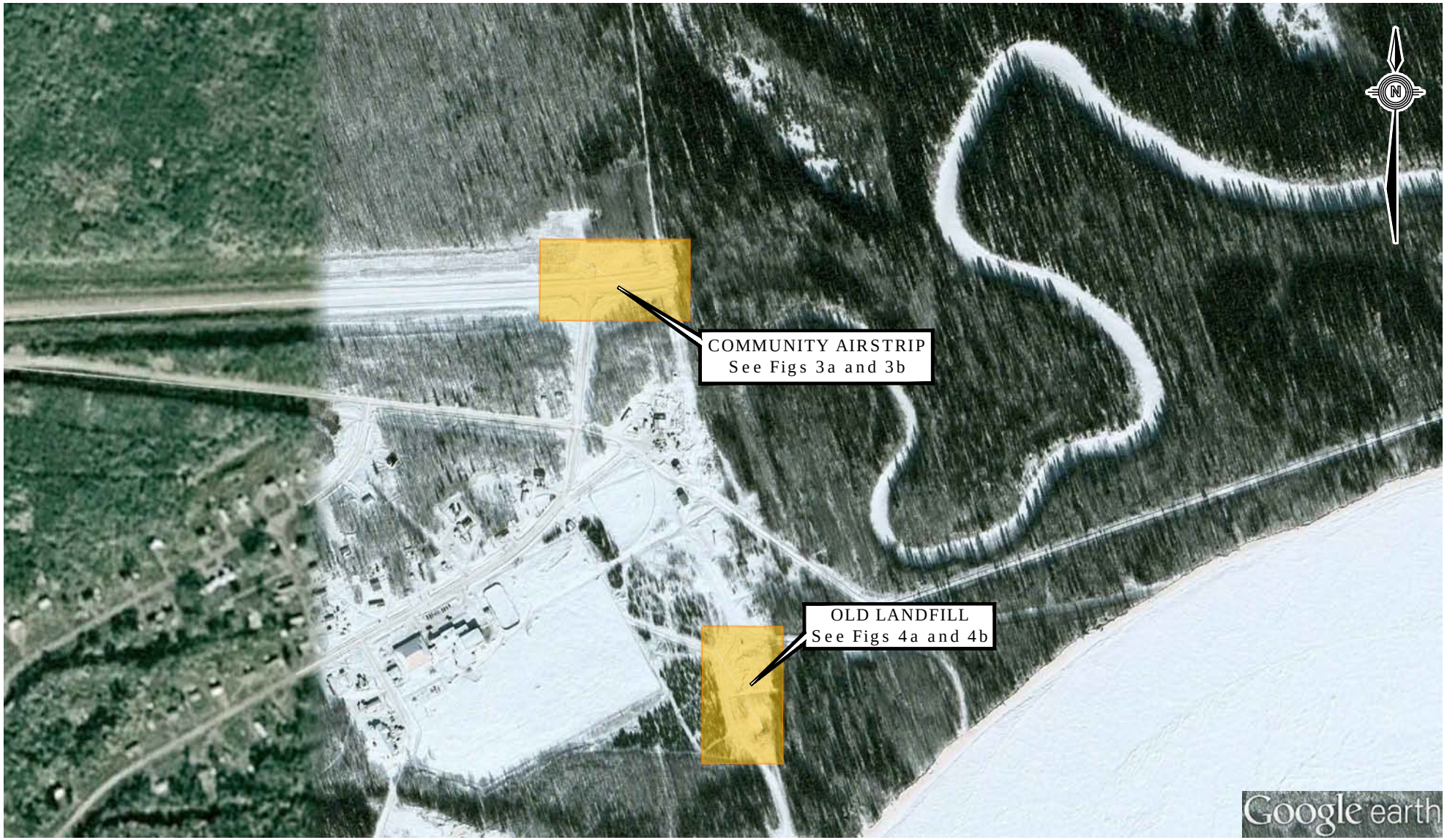
A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	REV
E22103088-01	TK	JM	0

OFFICE	DATE
EDM	January 2013

Figure 1

Q:\Edmonton\Drafting\PROJECTS\E221\E22103088-01\01\Report Components\Phase 001\Autocad\E22103088-01_FIG 2.dwg [FIGURE 2] January 28, 2013 - 9:34:31 am (BY: KIROS, TIGISTI)



0 250 m

Scale: 1: 7 500

CLIENT

Parks Canada Agency

GARDEN RIVER, ALBERTA COMMUNITY AIRSTRIP AND OLD LANDFILL REPORTS REVIEW AND REMEDIAL OPTIONS ANALYSIS
GARDEN RIVER, AB

SITE PLAN SHOWING COMMUNITY AIRSTRIP AND OLD LANDFILL SITES

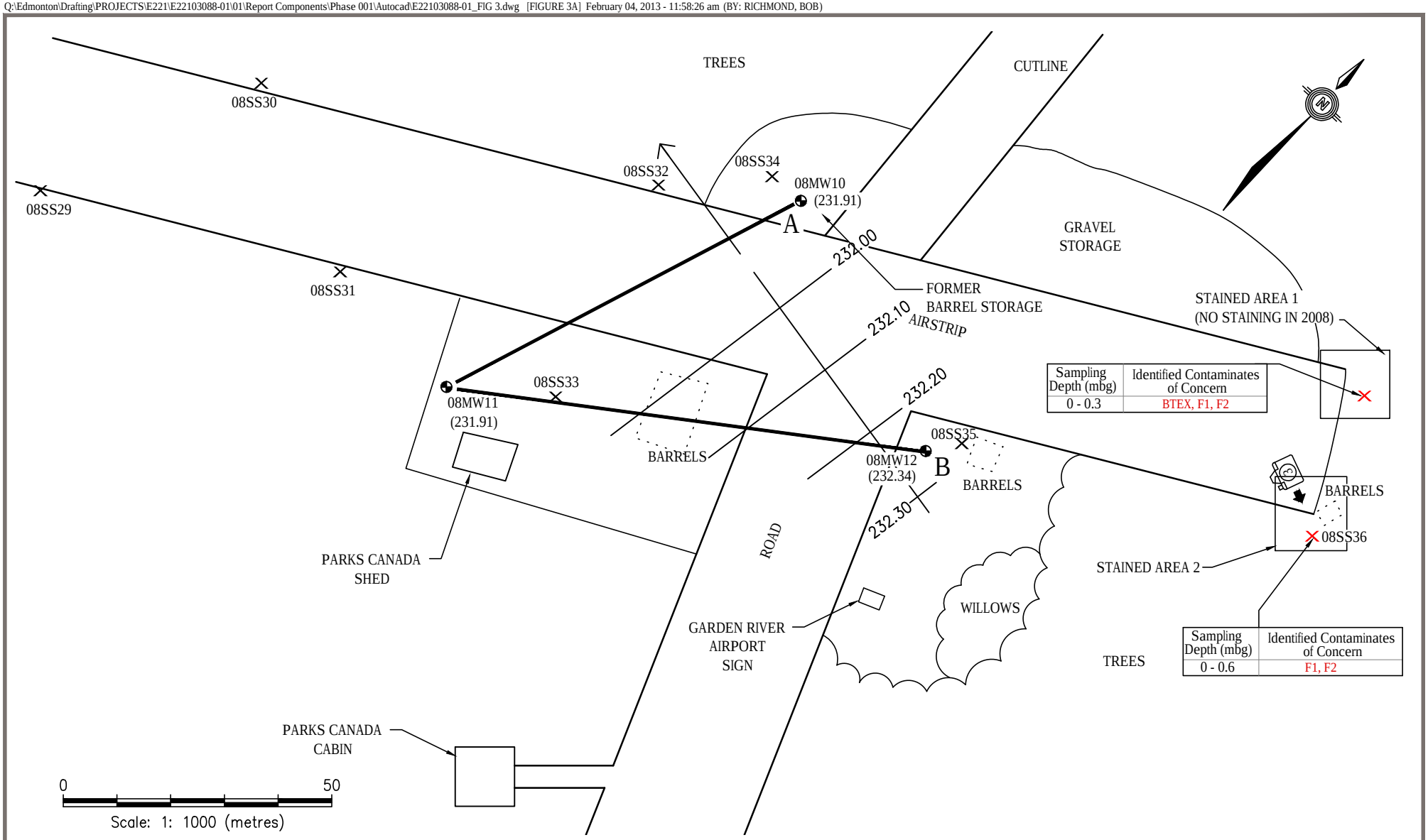
eba
A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	REV
E22103088-01	TK	JM	0

OFFICE	DATE
EDM	January 2013

Figure 2

Q:\Edmonton\Drafting\PROJECTS\E221\E22103088-01\01\Report Components\Phase 001\Autocad\E22103088-01_FIG 3.dwg [FIGURE 3A] February 04, 2013 - 11:58:26 am (BY: RICHMOND, BOB)



LEGEND:

- 08MW## - MONITORING WELL LOCATION
- 08SS## - SHALLOW SOIL SAMPLE LOCATION
- (###.##) - GROUNDWATER ELEVATION
- ###.## - GROUNDWATER ELEVATION CONTOUR
- - INTERPRETED LOCAL GROUNDWATER FLOW DIRECTION
- (1) - PHOTO DIRECTION AND NUMBER
- X - RED INDICATES SOIL EXCEEDED THE APPLICABLE GUIDELINE

NOTES

MONITORING WELL LOCATIONS ARE ON SCALE AND OTHER FEATURES ON THE DRAWING ARE NOT TO SCALE
ALL INFORMATION FROM EBA, 2009

CLIENT

Parks Canada Agency

GARDEN RIVER, ALBERTA COMMUNITY AIRSTRIP AND OLD LANDFILL REPORTS REVIEW AND REMEDIAL OPTIONS ANALYSIS
GARDEN RIVER, AB

COMMUNITY AIRSTRIP SITE PLAN SHOWING SOIL EXCEEDANCES

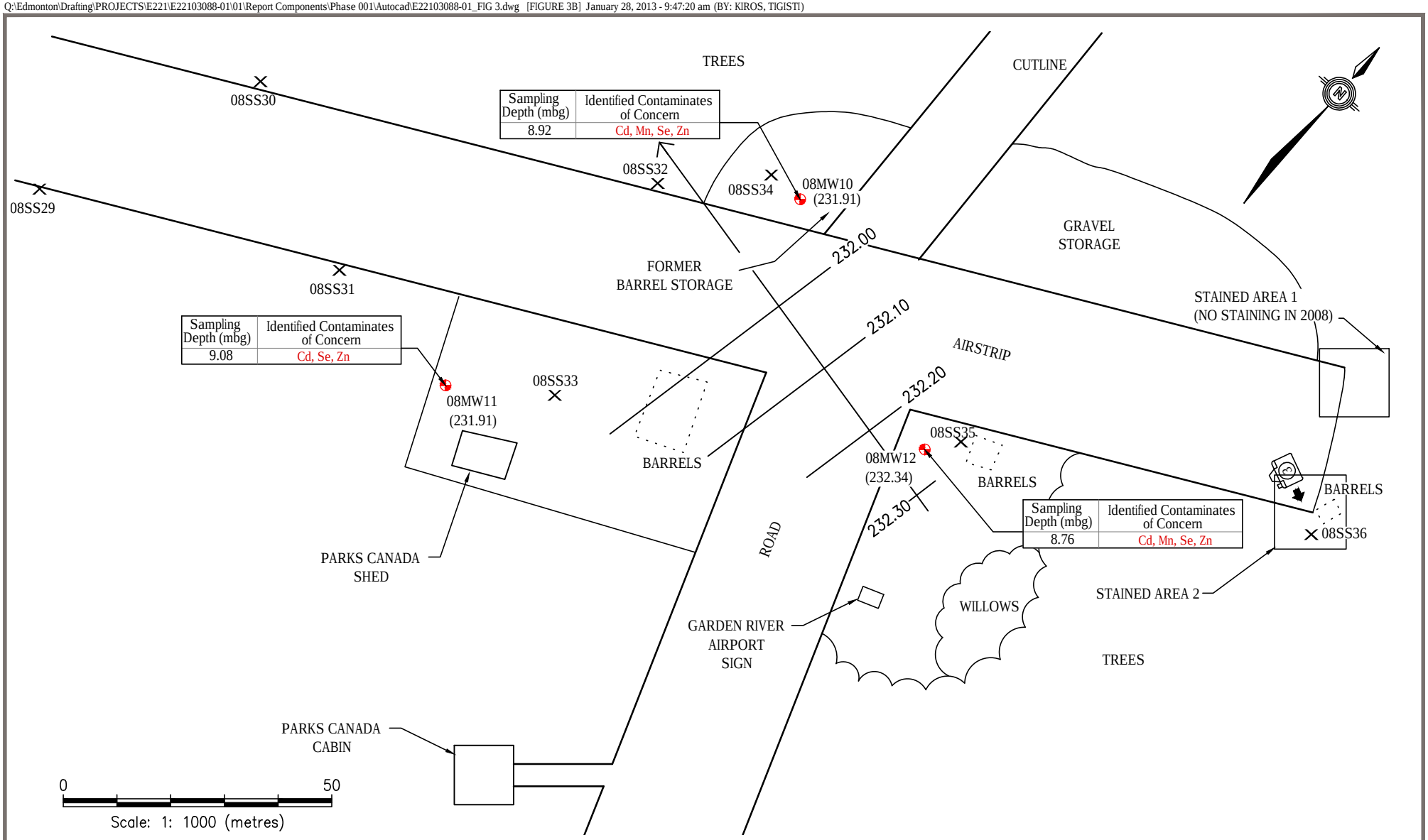
eba A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	REV
E22103088-01	TK	JM	0

OFFICE	DATE
EDM	February 2013

Figure 3a

Q:\Edmonton\Drafting\PROJECTS\E221\E22103088-01\01\Report Components\Phase 001\Autocad\E22103088-01_FIG 3.dwg [FIGURE 3B] January 28, 2013 - 9:47:20 am (BY: KIROS, TIGISTI)



LEGEND:

- 08MW## - MONITORING WELL LOCATION
- 08SS## - SHALLOW SOIL SAMPLE LOCATION
- (###.##) - GROUNDWATER ELEVATION
- ###.## - GROUNDWATER ELEVATION CONTOUR
- - INTERPRETED LOCAL GROUNDWATER FLOW DIRECTION
- - PHOTO DIRECTION AND NUMBER
- - RED INDICATES GROUNDWATER EXCEEDED THE APPLICABLE GUIDELINE

NOTES

MONITORING WELL LOCATIONS ARE ON SCALE AND OTHER FEATURES ON THE DRAWING ARE NOT TO SCALE

CLIENT

Parks Canada Agency

GARDEN RIVER, ALBERTA COMMUNITY AIRSTRIP AND OLD LANDFILL REPORTS REVIEW AND REMEDIAL OPTIONS ANALYSIS GARDEN RIVER, AB

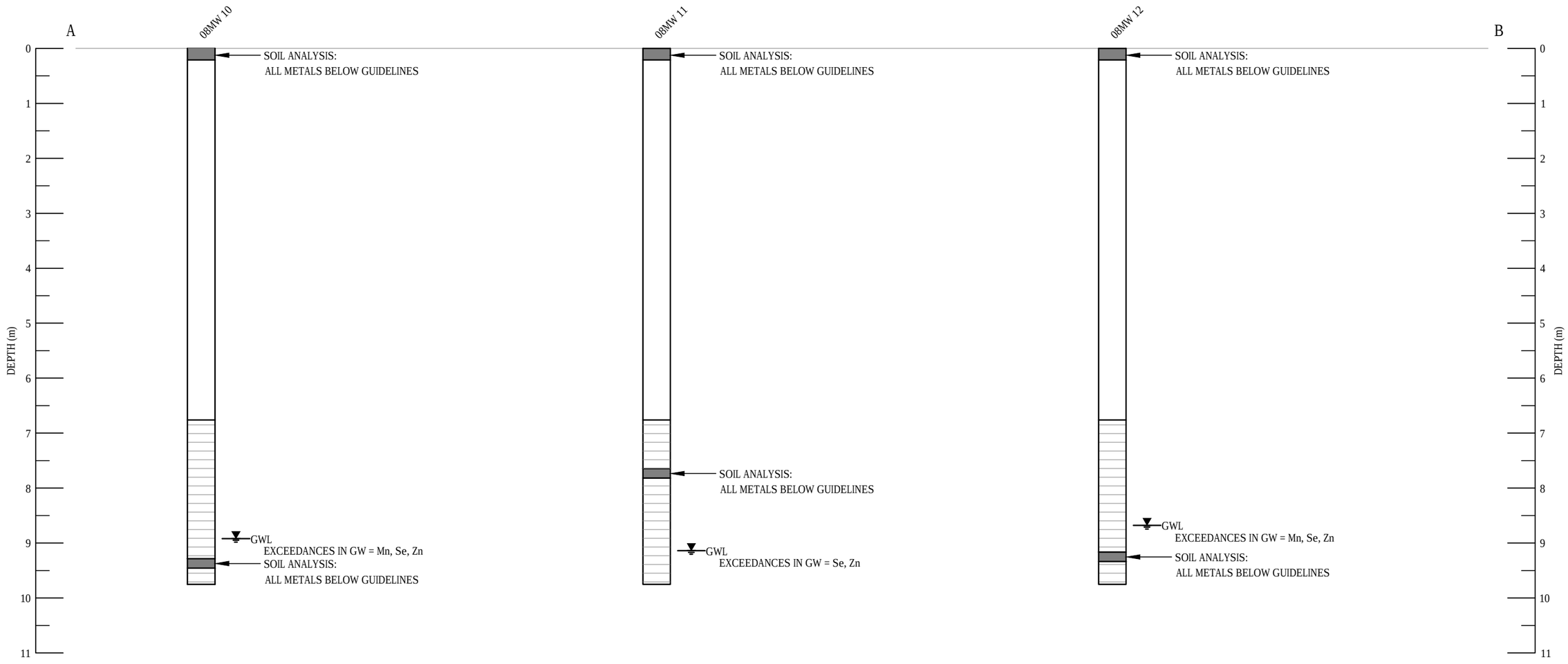
COMMUNITY AIRSTRIP SITE PLAN SHOWING GROUNDWATER EXCEEDANCES

PROJECT NO.	DWN	CKD	REV
E22103088-01	TK	JM	0

OFFICE	DATE
EDM	January 2013

A TETRA TECH COMPANY

Figure 3b



LEGEND:

- SOIL SAMPLE
- MONITORING WELL SCREEN

DRAWING NOT TO SCALE

CLIENT

Parks Canada Agency

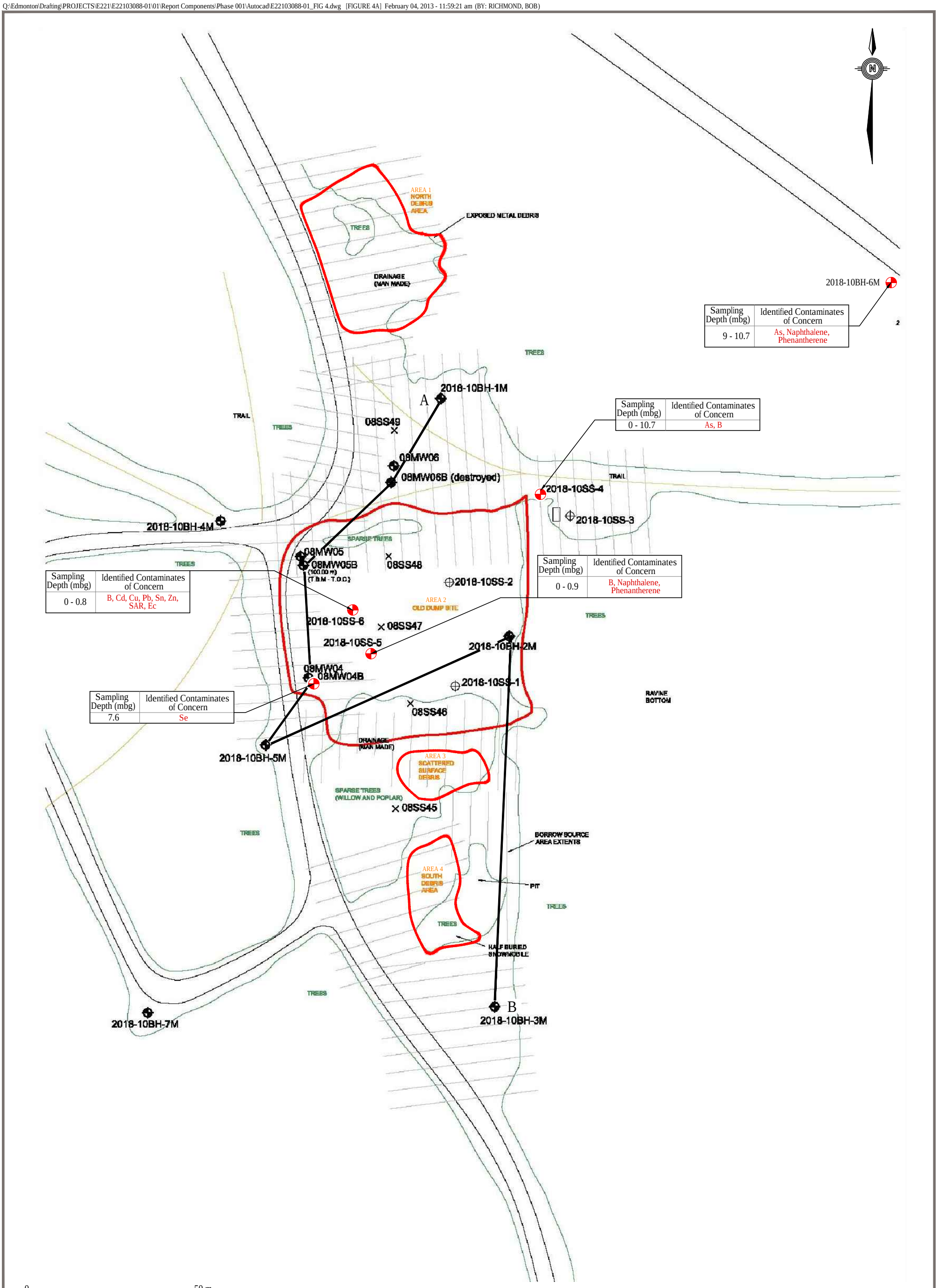
GARDEN RIVER, ALBERTA COMMUNITY AIRSTRIP AND OLD LANDFILL REPORTS REVIEW AND REMEDIAL OPTIONS ANALYSIS
GARDEN RIVER, AB

DETAILS OF GROUNDWATER MONITORING WELL PROFILE SHOWING SOIL AND GROUNDWATER EXCEEDANCES (COMMUNITY AIRSTRIP)

A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	REV
E22103088-01	BR/TK	JM	0
OFFICE: EDM	DATE: February 2013		

Figure 3c



LEGEND:

- AREA OF CONCERN
- TREE LINE
- TRAILS
- RED INDICATES SOIL EXCEEDED THE APPLICABLE GUIDELINE
- INCINERATOR
- MONITORING WELL
- BOREHOLE
- SURFACE SOIL SAMPLE

NOTES

ALL INFORMATION FROM COLUMBIA - FRANZ, 2011

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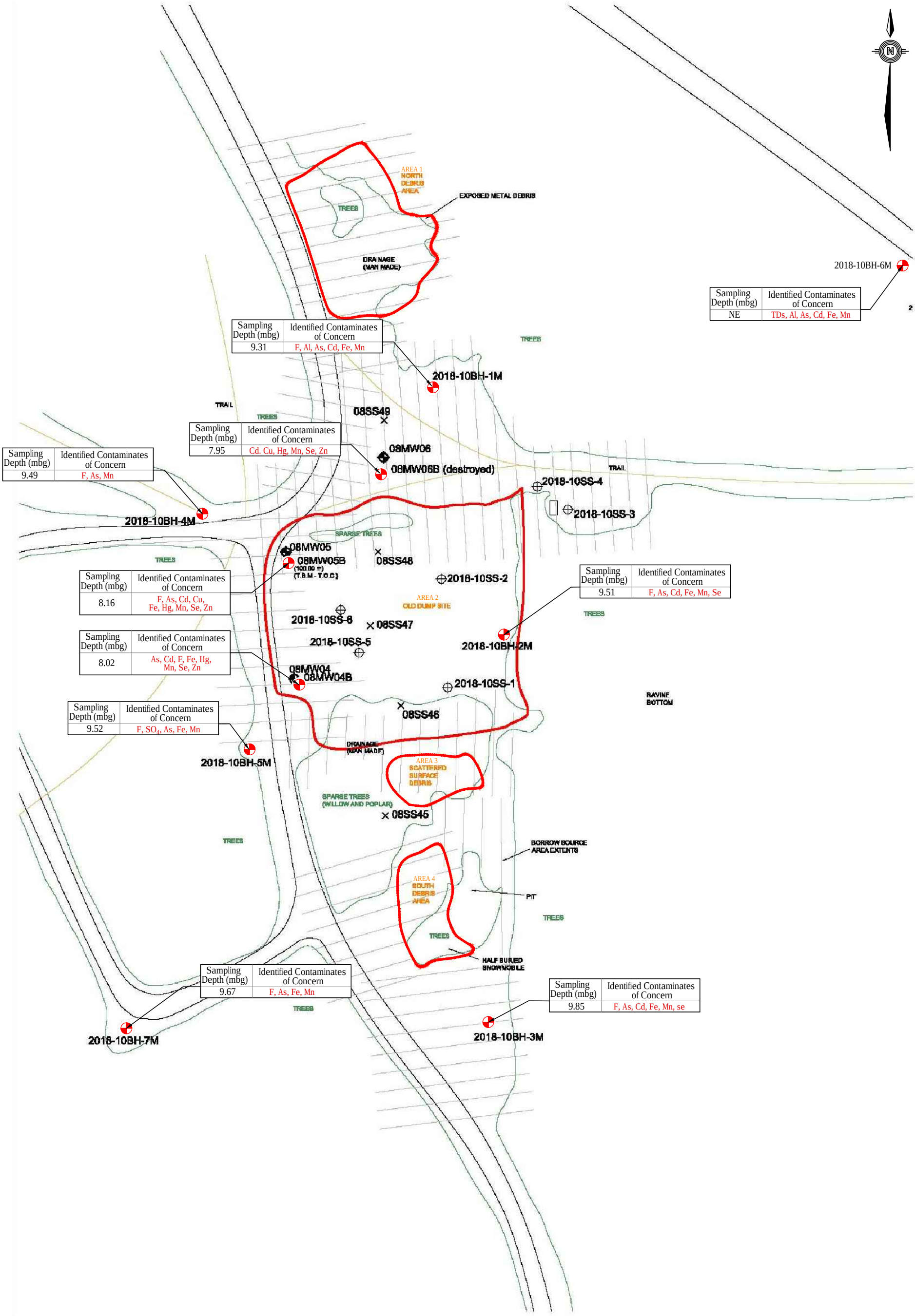
GARDEN RIVER, ALBERTA COMMUNITY AIRSTRIP AND OLD LANDFILL REPORTS REVIEW AND REMEDIAL OPTIONS ANALYSIS
GARDEN RIVER, AB

OLD LANDFILL SITE PLAN SHOWING
SOIL EXCEEDANCES

PROJECT NO.	DWN	CKD	REV
E22103088-01	TK	JM	0

OFFICE	DATE
EDM	February 2013

Figure 4a



LEGEND:

- AREA OF CONCERN
- TREE LINE
- TRAILS
- RED INDICATES GROUNDWATER EXCEEDED THE APPLICABLE GUIDELINE
- INCINERATOR
- MONITORING WELL
- BOREHOLE
- SURFACE SOIL SAMPLE

CLIENT

Parks Canada Agency

A TETRA TECH COMPANY

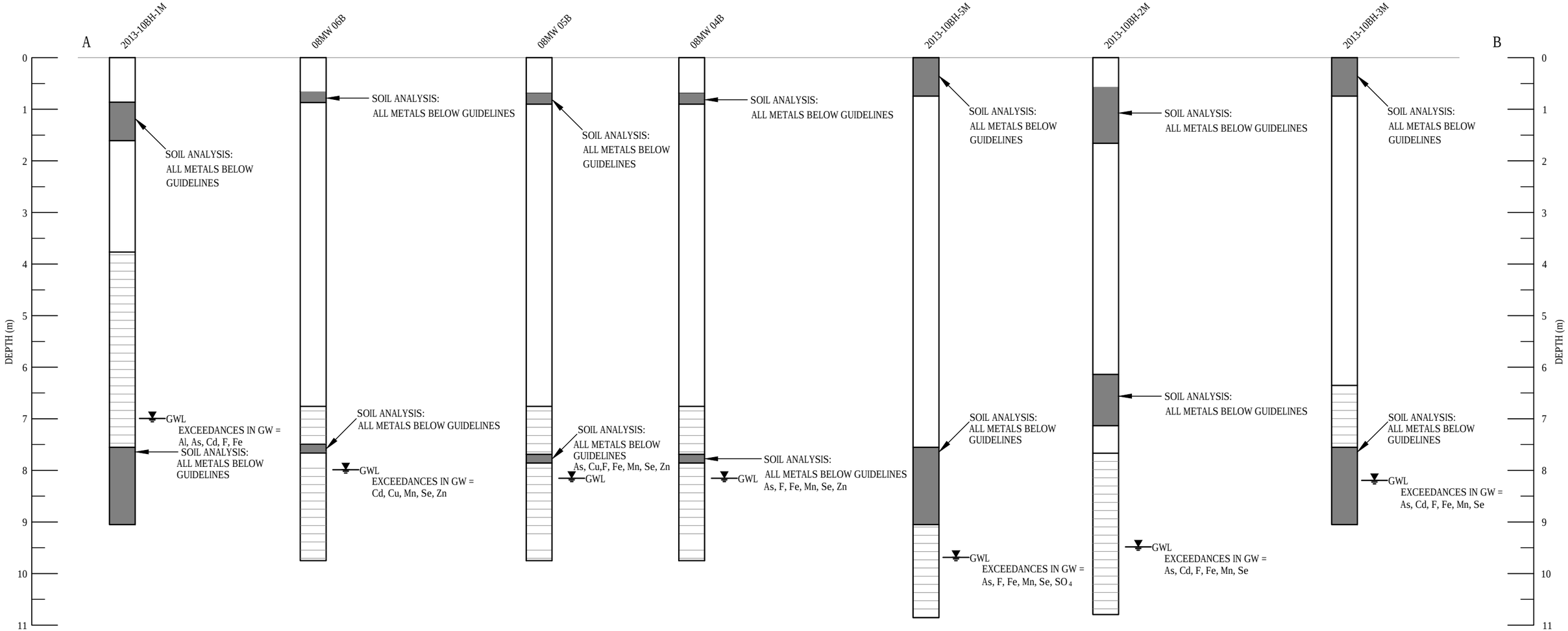
GARDEN RIVER, ALBERTA COMMUNITY AIRSTRIP AND OLD LANDFILL REPORTS REVIEW AND REMEDIAL OPTIONS ANALYSIS
GARDEN RIVER, AB

OLD LANDFILL SITE PLAN SHOWING GROUNDWATER EXCEEDANCES

PROJECT NO.	DWN	CKD	REV
E22103088-01	TK	JM	0

OFFICE	DATE
EDM	January 2013

Figure 4b



LEGEND:

- SOIL SAMPLE
- MONITORING WELL SCREEN

DRAWING NOT TO SCALE

CLIENT

Parks Canada Agency

GARDEN RIVER, ALBERTA COMMUNITY AIRSTRIP AND OLD LANDFILL REPORTS REVIEW AND REMEDIAL OPTIONS ANALYSIS
GARDEN RIVER, AB

DETAILS OF GROUNDWATER MONITORING WELL PROFILE SHOWING SOIL AND GROUNDWATER EXCEEDANCES (OLD LANDFILL)

eba
A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	REV
E22103088-01	BR/TK	JM	0

OFFICE: EDM

DATE: January 2013

Figure 4c

APPENDIX A

INFORMATION FROM THE PREVIOUS REPORTS

TABLE 1: SOIL ANALYTICAL RESULTS

Parameters	Units	Guidelines[1]	Guidelines[2]	Garden River Landfill										Garden River Old Dump									
				08MW01		08MW02		08MW03		08SS24	08SS25	08SS26	08SS27	08SS28	08MW04	08MW04B	08MW05	08MW05B	08MW06		08SS45	08SS46	08SS47	08SS48	08SS49
				0.8 m	9.2 m	0.8 m	4.6 m	0.8 m	9.2 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m	0.8 m	7.6 m	0.8 m	7.6 m	0.8 m	7.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m
Physical Observations																									
Material Type		NG	NG				Clayey Silt Gr	Sand Br			Silty Sand Br	Silty Sand Br	Silty Sand Br				Sandy Silt LtOlBe		Clayey Silt LtGr	Sand	Silty Sand Br	Silty Sand Br	Silty Sand Br	Silty Sand Br	Silty Sand Br
Field Texture		NG	NG																						
Colour		NG	NG																						
Measured Headspace Vapours		NG	NG				50 ppm	25 ppm	20 ppm		5 ppm	10 ppm	10 ppm				25 ppm	ND	50 ppm	50 ppm	20 ppm	30 ppm	25 ppm	25 ppm	25 ppm
Soil Staining		NG	NG																						
Hydrocarbons																									
Benzene		0.073				<0.005	<0.005	<0.005	<0.005	0.039	<0.005	<0.005	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Toluene		0.49				<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ethylbenzene		0.21				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Xylenes	mg/kg	12				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
F1 (C_6 to C_{10})		24	NG	<5	<5	<5	<5	<5	<5	<0.02	<0.02	<0.02	<0.02	<0.02	<5	<5	<5	<5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
F2 (C_{10} to C_{16})		130	NG	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
F3 (C_{16} to C_{34})		900	NG	7	<5	6	7	6	<5	<20	<20	<20	<20	<20	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
F4 (C_{34} to C_{50})		2,800	NG	<5	<5	<5	<5	<5	<5	810	<20	<20	<20	<20	6	10	7	7	7	<5	<20	<20	<20	<20	<20
F4 (C_{34}) HGT[3]		2,800	NG							50	<20	<20	<20	<20	<5	<5	<5	<5	<5	<5	<20	<20	<20	<20	<20
Chromatograph to baseline at nC_{50}			NG							Yes	Yes	Yes	Yes	Yes							Yes	Yes	Yes	Yes	Yes
Total Purgeable Hydrocarbons (TPH)	mg/kg		NG	<5	<5	<5	<5	<5	<5						<5	<5	<5	<5	<5	<5					
Total Hydrocarbons (TEH)	mg/kg		NG	7	<5	6	7	6	<5	860	<20	<20	<20	<20	6	10	7	7	7	<5	<20	<20	<20	<20	<20
Soil Moisture Content	%		NG	5.3	5	12	15	16	12	18	9.0	10	6.5	7.1	11	27	16	10	24	8.8	8.1	7.8	7.8	10	11
Routine																									
pH	pH Unit	6 to 8.5	6 to 8	7.78	7.94	6.44	7.48	7.42	7.88						7.12	7.82	7.43	7.89	7.73	8.05				7.3	
Electrical Conductivity (EC)	dS/m	**	2	0.33	0.44	0.27	0.35	0.39	0.23						0.19	0.27	0.39	0.23	0.25	0.28				0.33	
Sodium Adsorption Ratio (SAR)	Ratio	**	5	0.68	0.56	0.56	0.7	0.6	0.36						0.42	0.6	0.31	0.47	0.33	0.49				0.3	
Saturation	%	NG	NG	28.7	26.7	46	27.3	45	30.7						40.7	60	50	29.3	56	27.3				44.3	
Soluble Salts																									
Calcium (Ca)	mg/kg	NG	NG	13	16	15	12	25	9						10	15	32	8	21	9				29	
Magnesium (Mg)	mg/kg	NG	NG	1.6	3.3	3	2.1	3	2						2	6	5	1.9	4	2.4				7	
Sodium (Na)	mg/kg	NG	NG	5.2	4.9	6.3	5.2	8	2.5						3.6	9	5	3	5	3.4				4.5	
Potassium (K)	mg/kg	NG	NG	0.9	1.1	1.7	1.4	1.5	1.1						1.5	3	2	1.2	<1	1.5				<0.9	
Chloride (Cl)	mg/kg	NG	NG	<6	7	<9	5	<9	<6						<8	<10	<10	<6	<10	<5				<9	
Sulphate (SO_4)	mg/kg	NG	NG	8	25	23	11	15	4						3	20	18	9	4	10				7	
Calcium (Ca)	meq/L	NG	NG	2.2	2.99	1.66	2.14	2.72	1.45						1.18	1.24	3.15	1.32	1.88	1.68				3.3	
Magnesium (Mg)	meq/L	NG	NG	0.46	1.01	0.6	0.63	0.6	0.54						0.5	0.89	0.78	0.55	0.65	0.72				1.3	
Sodium (Na)	meq/L	NG	NG	0.79	0.79	0.59	0.83	0.78	0.56						0.39	0.62	0.44	0.45	0.38	0.54				0.45	
Potassium (K)	meq/L	NG	NG	0.08	0.11	0.1	0.13	0.08	0.09						0.09	0.14	0.1	0.1	<0.05	0.14				<0.05	
Chloride (Cl)	meq/L	NG	NG	<0.56	0.76	<0.56	<0.56	<0.56	<0.56						<0.56	<0.56	<0.56	<0.56	<0.56	<0.56				<0.56	
Sulphate (SO_4)	meq/L	NG	NG	0.55	1.97	1.04	0.82	0.67	0.24						0.14	0.69	0.74	0.61	0.15	0.78				0.32	
Particle Size Analysis																									
MUST PSA % > 75um	%	NG	NG									25						98			12				
Metals																									
Antimony (Sb)	mg/kg	20	20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2				<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20		<0.2	<0.2		
Arsenic (As)	mg/kg	17	12	5.47	3.50	10.7	5.91	10.4	3.12	5.7				6.5	10.3	7.90	10.4	1.57	9.32	2.71		5.8	10.3		
Barium (Ba)	mg/kg	500	500	127	79.2	134	122	160	65.9	442				152	168	224	250	37.8	319	54.5		270	255		
Beryllium (Be)	mg/kg	5	4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1				<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0		<1	<1		
Cadmium (Cd)	mg/kg	10	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5				<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		<0.5	<0.5		
Chromium (Cr)	mg/kg	64	64	7.04	5.73	17.0	8.69	17.9	5.21	15.7				10.1	12.9	18.3	14.8	4.18	14.7	5.16		19.5	20.9		
Cobalt (Co)	mg/kg	20	50	4.3	2.8	8.9	4.7	8.0	2.8	7.0				5.0	7.9	10.8	8.6	1.9	7.9	2.7		8.0	8.0		
Copper (Cu)	mg/kg	63	63	8.7	4.7	23.2	10.6	22.5	4.9	204				10	22.8	27.3	26.8	3.1	25.1	5.2		12	22		
Lead (Pb)	mg/kg	140	140	5.6	<5.0	9.5	<5.0	8.8	<5.0	9.0	7.0	10		<5	9.0	10.3	10.7	<5.0	9.6	<5.0	10	10	11		10
Mercury (Hg)	mg/kg	6.6	6.6	<0.050	<0.050	0.066	<0.050	0.065	<0.050	<0.05				<0.05	0.061	0.056	0.084	<0.050	0.068	<0.050		<0.05	<0.05		
Molybdenum (Mo)	mg/kg	4	10	<1.0	<1.0	1.1	<1.0	1.2	<1.0	<1				<1	1.0	<1.0	<1.0	<1.0	<1.0	<1.0		<1	1.0		
Nickel (Ni)	mg/kg	50	50	13.1	7.9	25.9	14.8	27.0	8.6	15				14	30.2	33.3	29.9	4.8	25.7	7.9		16	24		
Selenium (Se)	mg/kg	1	1	<0.50	<0.50	0.51	<0.50	0.50	<0.50	0.3				0.3	<0.50	1.58	<0.50	<0.50	<0.50	<0.50		0.4	0.6		
Silver (Ag)	mg/kg	20	20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<1				<1	<0.20	<0.20	0.23	<0.20	0.25	<0.20		<1	<1		
Thallium (Tl)	mg/kg	1	1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<1				<1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		<1	<1		
Tin (Sn)	mg/kg	5	50	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5				<5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0		<5	<5		
Uranium (U)	mg/kg	23	23	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2				<2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0		<2	<2		
Vanadium (V)	mg/kg	130	130	14.0	9.1	28.9	16.8	27.3	9.9	30				23	24.8	28.5	27.5	6.0	27.2	9.2		36	40		
Zinc (Zn)	mg/kg	200	200	40.4	22.4	67.7	45.7	62.8	23.4	140				50	81.1	89.9	83.2	13.3	78.2	22.1		90	90		
Chlorinated Aliphatics																									
1,1-Dichloroethene	mg/kg	0.021	5							<0.01			<0.01									<0.01		<0.01	
Methylene Chloride	mg/kg	0.095	5							<0.01			<0.01									<0.01		<0.01	
trans-1,2-Dichloroethene	mg/kg	NG	5							<0.01			<0.01									<0.01		<0.01	
1,1-Dichloroethane	mg/kg	NG	5							<0.01			<0.01									<0.01		<0.01	
Chloroform	mg/kg	0.0010	5							<0.01			<0.01									<0.01		<0.01	
1,1,1-Trichloroethane	mg/kg	NG	5							<0.01			<0.01									<0.01		<0.01	
Carbon Tetrachloride	mg/kg	0.00056	5							<0.01			<0.01									<0.01		<0.01	
Trichloroethene	mg/kg	0.012	5							<0.01			<0.01									<0.01		<0.01	
1,2-Dichloropropane	mg/kg	NG	5							<0.01			<0.01									<0.01		<0.01	
cis-1,3-Dichloropropene	mg/kg	NG	5							<0.01			<0.01									<0.01		<0.01	
trans-1,3-Dichloropropene	mg/kg	NG	5							<0.01			<0.01									<0.01		<0.01	
1,1,2-Trichloroethane	mg/kg	NG	5							<0.01			<0.01									<0.01		<0.01	
1,2-Dichloroethane	mg/kg	0.0027	5							<0.01			<0.01									<0.01		<0.01	
Tetrachloroethylene	mg/kg	0.16	5							<0.01			<0.01									<0.01		<0.01	
1,1,2,2-Tetrachloroethane	mg/kg	NG	5							<0.02			<0.02									<0.02		<0.02	
Volatile Hydrocarbons (EPA)																									
Thiophene	mg/kg	NG	NG							<0.01			<0.01									<0.01		<0.01	
Chlorobenzene	mg/kg	0.018	2							<0.01			<0.01									<0.01		<0.01	
Styrene	mg/kg	NG	5							<0.01			<0.01									<0.01		<0.01	
1,3-Dichlorobenzene	mg/kg	NG	2							<0.01			<0.01									<0.01		<0.01	
1,4-Dichlorobenzene	mg/kg	0.098	2							<0.01			<0.01									<0.01		<0.01	
1,2-Dichlorobenzene	mg/kg	0.18	2							<0.01			<0.01									<0.01		<0.01	
Carcinogenic Polyaromatic Hydrocarbons (PAHs)																									
Naphthalene	mg/kg	0.018	0.6							0.02			<0.01								<0.01				<0.01
Quinoline	mg/kg	NG	NG							<0.01			<0.01								<0.01				<0.01
Phenanthrene	mg/kg	0.061	5							0.01			<0.01								<0.01				<0.01
Pyrene	mg/kg	0.040	10							0.01			<0.01								<0.01				0.02
Benzo(a)anthracene	mg/kg	0.083	1							<0.01			<0.01								<0.01				<0.01
Benzo(b&j)fluoranthene	mg/kg	NG	1							<0.01			<0.01								<0.01				<0.01
Benzo(k)fluoranthene	mg/kg	NG	1							<0.01			<0.01								<0.01				<0.01
Benzo(a)pyrene	mg/kg	0.77	0.7							<0.01			<0.01								<0.01				<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	NG	1							<0.01			<0.01								<0.01				<0.01
Dibenzo(a,h)anthracene	mg/kg	8.4	1							<0.01			<0.01								<0.01				<0.01
Laboratory Identification No.				L613338	L613338	L613338	L613338	L613338	L613338	L676396-180	L676396-181	L676396-182	L676396-183	L676396-184	L613338	L613338	L613338	L613338	L613338	L613338	L676396-202	L676396-203	L676396-204	L676396-205	L676396-206

Notes:

[1] Alberta Environment (AENV). August 2008. Alberta Tier 1 Soil and Groundwater Remediation Guidelines. Referenced guidelines are for Residential/Park Land use, coarse textured surface soils.

[2] Canadian Council of Ministers of the Environment (CCME). September 2007. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health. Referenced guidelines are for Residential/Parkland Land use, coarse textured surface soils.

[3] Fraction F4 (C_{34}) HGT determined by high temperature gas chromatograph.

NG - No guidelines established.

Blank - Not analyzed.

Bold - Greater than the referenced guideline.

Soil Texture Abbreviations: L=Loam, CL=Clay Loam, SL=Sandy Loam, SiL=Silt Loam, LS=Loamy Sand, S=Sand, Si=Silt, C=Clay, HC=Heavy Clay, SiCL=Silty Clay Loam, SCL=Sandy Clay Loam.

Soil Colour Abbreviations: Bl.=Black, Dk.=Dark, Lt.=Light, Br.=Brown, Gr.=Grey or Greyish, Ol.=Olive, Ye.=Yellowish, Re.=Reddish.

Parameter**	Material Type			
	Topsoil (A-horizon)		Subsoil (B-horizon)	
	Value	Rational	Value	Rational
EC (dS/m)	<2	Good	<3	Good
SAR	<4	Good	<4	Good

TABLE 1: SOIL ANALYTICAL RESULTS

Parameters	Units	Guidelines[1]	Guidelines[2]	Former Septic Tile Field												Garden River Airstrip																							
				08MW07	08MW07B	08MW08		08MW09		08SS50	08SS51	08SS52	08SS52D	08SS53	08SS54	08MW10		08MW11		08MW12		08SS29	08SS30	08SS31	08SS32	08SS33	08SS33D	08SS34	08SS35	08SS36											
				3.1 m	7.6 m	3.1 m	7.6 m	3.1 m	7.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.1 m	9.2 m	0 - 0.1 m	7.6 m	0 - 0.1 m	9.2 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m											
Physical Observations																																							
Material Type		NG	NG																																				
Field Texture		NG	NG	Sand	Sand		Silty Clay	Silty Sand			Silty Sand	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Sandy Silt		Sandy Silt		Sandy Silt	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Silty Sand										
Colour		NG	NG	Br				Br			Br	Br	Br	Br	Br	ReBr		ReBr		Br	Gr	Br	Br	Br	Br	Br	Br	Br	Br										
Measured Headspace Vapours	%LEL/ppm	NG	NG	25 ppm	ND		ND	100 ppm			15 ppm	30 ppm	30 ppm	ND	ND	25 ppm	25 ppm	ND	10 ppm	ND	ND	ND	ND	25 ppm	25 ppm	ND	ND	ND	10 ppm	5% LEL										
Soil Staining		NG	NG																																				
Hydrocarbons																																							
Benzene	mg/kg	0.073	0.030	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005										
Toluene	mg/kg	0.49	0.37	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01										
Ethylbenzene	mg/kg	0.21	0.082	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01										
Xylenes	mg/kg	12	11	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.46	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	2.7										
F1 (C_6 to C_{10})	mg/kg	24	NG	<5	<5	<5	<5	<5	<5	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	540										
F2 (C_{10} to C_{16})	mg/kg	130	NG	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<20	<20	<20	<20	<20	<20	<20	<20	3,200										
F3 (C_{16} to C_{34})	mg/kg	300	NG	<5	5	<5	<5	<5	<5	<20	<20	<20	<20	<20	<20	<5	<5	<5	<5	<5	<5	<20	<20	<20	<20	<20	<20	<20	<20	40										
F4 (C_{34} to C_{50})	mg/kg	2,800	NG	<5	<5	<5	<5	<5	110	20	<20	<20	<20	30	<20	100	6	<5	<5	<5	<5	<20	<20	<20	<20	<20	<20	<20	<20										
F4 (C_{34})HGT[3]	mg/kg	2,800	NG						33	<20	<20	<20	30	<20	<20	<5	<5	<5	<5	<5	<5	<20	<20	<20	30	<20	<20	<20	<20										
Chromatograph to baseline at nC_{50}		NG	NG																																				
Total Purgeable Hydrocarbons (TPH)	mg/kg	NG	NG	<5	<5	<5	<5	<5	<5	Yes	Yes	Yes	Yes	Yes	Yes	<5	<5	5	<5	<5	<5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes										
Total Hydrocarbons (TEH)	mg/kg	NG	NG	<5	5	<5	<5	<5	140	20	<20	<20	30	30	<20	100	6	5	<5	<5	<5	20	<20	<20	60	<20	<20	<20	<20	3,800										
Soil Moisture Content	%	NG	NG	5.3	3.7	5.8	5.1	5.6	14	6.7	7.3	7.5	7.6	7.3	6.5	9.5	20	11	2.7	13	18	7.2	12	6.3	8.6	9.3	11	4.9	7.6	22										
Routine																																							
pH	pH-unit	6 to 8.5	6 to 8		7.94	7.84	7.88	7.84	7.94						7.6															7.0										
Electrical Conductivity (EC)	dS/m	**	2		0.24	0.32	0.28	0.24	0.24						0.26															0.28										
Sodium Adsorption Ratio (SAR)	Ratio	**	5		0.67	2.28	1.22	0.54	0.69						0.1															0.1										
Saturation	%	NG	NG		32	34.7	28	33.3	24						39.1															52.6										
Soluble Salts																																							
Calcium (Ca)	mg/kg	NG	NG	13	8	7	7	8	6						23																									
Magnesium (Mg)	mg/kg	NG	NG	4	2	2	2	3	1.7						3															32										
Sodium (Na)	mg/kg	NG	NG	4.6	4.8	15.1	7.4	4.1	3.6						1.6															5										
Potassium (K)	mg/kg	NG	NG	1.7	1.3	1.1	1.2	1	1						1.1															2										
Chloride (Cl)	mg/kg	NG	NG	<8	<6	<7	<6	<7	<5						<8															7										
Sulphate (SO_4)	mg/kg	NG	NG	9	7	13	8	5	6						4															<10										
Calcium (Ca)	meq/L	NG	NG	1.67	1.26	0.97	1.16	1.16	1.2						3.0															7										
Magnesium (Mg)	meq/L	NG	NG	0.79	0.63	0.42	0.6	0.82	0.59						0.73															3.0										
Sodium (Na)	meq/L	NG	NG	0.51	0.65	1.9	1.15	0.53	0.66						0.18															0.8										
Potassium (K)	meq/L	NG	NG	0.11	0.11	0.08	0.11	0.08	0.1						0.07															0.14										
Chloride (Cl)	meq/L	NG	NG	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56						<0.56															<0.56										
Sulphate (SO_4)	meq/L	NG	NG	0.46	0.42	0.78	0.58	0.32	0.56						0.22															0.28										
Particle Size Analysis																																							
MUSTPSA% > 75um	%	NG	NG																																				
Metals														13			94	71																					
Antimony (Sb)	mg/kg	20	20	<0.20	<0.20	<0.20	0.35	<0.20	<0.20	<0.2																				9										
Arsenic (As)	mg/kg	17	12	7.39	5.37	7.79	4.54	6.44	3.16	8.4		<0.2	<0.2			<0.20	<0.20	<0.20	<0.20	<0.20	<0.20																			
Barium (Ba)	mg/kg	500	500	238	99.1	212	78.1	167	60.3	236		6.7	6.3			7.35	4.56	6.58	2.84	10.4	3.61			<0.2	<0.2	<0.2	<0.2			<0.2										
Beryllium (Be)	mg/kg	5	4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1		272	219			69.8	89.5	150	56.0	169	97.1			8.8	8.5	8.7	6.6			4.2										
Cadmium (Cd)	mg/kg	10	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5		<1	<1			<1.0	<1.0	<1.0	<1.0	<1.0	<1.0			167	195	194	173			309										
Chromium (Cr)	mg/kg	64	64	8.11	6.43	9.82	5.36	8.23	3.97	21.1		<0.5	<0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50			<1	<1	<1	<1			<1										
Cobalt (Co)	mg/kg	20	50	4.9	4.0	6.0	3.6	4.5	2.6	8		20.4	19.8			11.7	7.67	8.94	4.79	19.5	7.53			<0.5	<0.5	<0.5	<0.5			<0.5										
Copper (Cu)	mg/kg	63	63	11.4	7.2	14.4	6.7	9.3	4.5	14		9	7			5.7	4.1	5.3	2.4	8.9	3.8			20.1	21.1	23.9	22.0			18.6										
Lead (Pb)	mg/kg	140	140	5.6	<5.0	6.6	<5.0	<5.0	<5.0	10	9	12	11			14.7	7.1	11.6	4.5	24.9	7.5			8	8	9	9			7										
Mercury (Hg)	mg/kg	6.6	6.6	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.05		11	9	10		5.6	<5.0	5.1	<5.0	9.3	<5.0	7	7	14	17	14	9			9										
Molybdenum (Mo)	mg/kg	4	10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1		<0.05	<0.05			<0.050	<0.050	<0.050	<0.050	0.067	<0.050			9	10	9	8	8	7	7										
Nickel (Ni)	mg/kg	50	50	15.4	11.3	17.8	11.0	14.2	6.9	20		<1	<1			<1.0	<1.0	1.0	<1.0	<1.0	<1.0			<0.05	<0.05	<0.05	<0.05			<0.05										
Selenium (Se)	mg/kg	1	1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.6		16	16			19.8	13.0	16.2	7.0	29.9	12.2			<1	<1	<1	<1			<1										
Silver (Ag)	mg/kg	20	20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<1		0.4	0.4			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50			20	21	20	17			14										
Thallium (Tl)	mg/kg	1	1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<1		<1	<1			<0.20	<0.20	<0.20	<0.20	<0.20	<0.20			0.5	0.4	0.4	0.3			0.3										
Tin (Sn)	mg/kg	5	50	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<1		<1	<1			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50			<1	<1	<1	<1			<1										
Uranium (U)	mg/kg	23	23	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<5		<5	<5			<5.0	<5.0	<5.0	<5.0	<5.0	<5.0			<1	<1	<1	<1			<1										
Vanadium (V)	mg/kg	130	130	17.2	13.3	19.8	11.7	16.5	7.9	40		<2	<2			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0			<5	<5	<5	<5			<5										
Zinc (Zn)	mg/kg	200	200	57.1	36.1	64.6	30.0	47.1	19.9	70		40	37			22.2	14.6	19.2	8.5	30.9	15.2			<2	<2	<2	<2			<2										
Chlorinated Aliphatics												70	70			46.3	34.2	52.9	18.6	66.0	34.9			37	39	42	38			32										
1,1-Dichloroethene	mg/kg	0.021	5																					70	70	70	60			80										
Methylene Chloride	mg/kg	0.095	5																																				
trans-1,2-Dichloroethene	mg/kg	NG	5																																				
1,1-Dichloroethane	mg/kg	NG	5																																				
Chloroform	mg/kg	0.0010	5																																				
1,1,1-Trichloroethane	mg/kg	NG	5																																				
Carbon Tetrachloride	mg/kg	0.00056	5																																				
Trichloroethene	mg/kg	0.012	5																																				
1,2-Dichloropropane	mg/kg	NG	5																																				
cis-1,3-Dichloropropene	mg/kg	NG	5																																				
trans-1,3-Dichloropropene	mg/kg	NG	5																																				
1,1,2-Trichloroethane	mg/kg	NG	5																																				
1,2-Dichloroethane	mg/kg	0.0027	5																																				
Tetrachloroethylene	mg/kg	0.16	5																																				
1,1,2,2-Tetrachloroethane	mg/kg	NG	5																																				
Volatile Hydrocarbons (EPA)																																							
Thiophene	mg/kg	NG	NG																																				
Chlorobenzene	mg/kg	0.018	2																																				
Styrene	mg/kg	NG	5																																				
1,3-Dichlorobenzene	mg/kg	NG	2																																				
1,4-Dichlorobenzene	mg/kg	0.098	2																																				
1,2-Dichlorobenzene	mg/kg	0.18	2																																				
Carcinogenic Polyaromatic Hydrocarbons (PAHs)																																							
Naphthalene	mg/kg	0.018	0.6																																				
Quinoline	mg/kg	NG	NG																																				
Phenanthrene	mg/kg	0.061	5																																				
Pyrene	mg/kg	0.040	10																																				
Benzo(a)anthracene	mg/kg	0.083	1																																				
Benzo(b&j)fluoranthene	mg/kg	NG	1																																				
Benzo(k)fluoranthene	mg/kg	NG	1																																				
Benzo(a)pyrene	mg/kg	0.77	0.7																																				
Indeno(1,2,3-cd)pyrene	mg/kg	NG	1																																				
Dibenzo(a,h)anthracene	mg/kg	8.4	1																																				
Laboratory Identification No.				L613338	L613338	L613338	L613338	L613338	L613338	L676396-207	L676396-208	L676396-209	L676396-212	L676396-210	L676396-211	L613338	L613338	L613338	L613338	L613338	L613338	L676396-185	L676396-186	L676396-187	L676396-188	L676396-189	L676396-193	L676396-190	L676396-191	L676396-192										

Notes:

[1] Alberta Environment (AENV). August 2008. Alberta Tier 1 Soil and Groundwater Remediation Guidelines. Referenced guidelines are for Residential/Park Land use, coarse textured surface soils.

[2] Canadian Council of Ministers of the Environment (CCME). September 2007. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health. Referenced guidelines are for Residential/Parkland Land use, coarse textured surface soils.

[3] Fraction F4 (C_{34})HGT determined by high temperature gas chromatograph.

NG - No guidelines established.

Blank - Not analyzed.

Bold - Greater than the referenced guideline.

Soil Texture Abbreviations: L=Loam, CL=Clay Loam, SL=Sandy Loam, SiL=Silt Loam, LS=Loamy Sand, S=Sand, Si=Silt, C=Clay, HC=Heavy Clay, SiCL=Silty Clay Loam, SCL=Sandy Clay Loam.

Soil Colour Abbreviations: Bl.=Black, Dk.=Dark, Lt.=Light, Br.=Brown, Gr.=Grey or Greyish, Ol.=Olive, Ye.=Yellowish, Re.=Reddish.

Parameter**	Material Type			
	Topsoil (A-horizon)		Subsoil (B-horizon)	
	Value	Rational	Value	Rational
EC (dS/m)	<2	Good	<3	Good
SAR	<4	Good	<4	Good

TABLE 2: GROUNDWATER MONITORING RESULTS

Monitoring Well ID	Borehole Depth (mbg)	Ground Surface Elevation (m)	Top of Casing (TOC) Elevation (m)	Height of Stickup (m)	Slotted Interval (mBG)		Groundwater levels (mBTOC)	Groundwater levels (mbg)	Groundwater levels (mBTOC)	Groundwater levels (mbg)	Slotted Interval Elevation		Groundwater Elevation* (m)	Groundwater Elevation* (m)
					Top (m)	Bottom (m)	21-Mar-08		29-Aug-08		Top (m)	Bottom (m)	21-Mar-08	29-Aug-08
Garden River Landfill														
08MW01	11.3	241.37	242.29	0.92	8.2	11.3	10.06	9.14	10.58	9.66	233.17	230.07	232.23	231.71
08MW02	6.7	240.73	241.87	1.14	3.7	6.7	7.01	5.87	7.01	5.87	237.03	234.03	234.86	234.86
08MW03	11.3	241.38	242.47	1.09		11.3	10.68	9.59	10.66	9.57			231.79	231.81
Garden River Old Dump														
08MW04	6.1	238.84	240.03	1.19	3.1	6.1	dry	dry	dry	dry	235.74	232.74	dry	dry
08MW04B	9.8	238.88	240.16	1.29	6.7	9.8	9.28	8.00	9.31	8.02	232.18	229.08	230.88	230.85
08MW05	6.1	239.09	240.31	1.22	3.1	6.1	dry	dry	dry	dry	235.99	232.99	dry	dry
08MW05B	9.8	239.07	240.27	1.20	6.7	9.8	9.34	8.14	9.35	8.16	232.37	229.27	230.93	230.92
08MW06	8.4	239.06	240.34	1.28	6.4	8.4	dry	dry	9.27	7.99	232.66	230.66	dry	dry
08MW06B	9.8	238.95	240.29	1.34	6.7	9.8	9.32	7.98	9.29	7.95	232.25	229.15	230.97	231.00
Former Septic Tile Field														
08MW07	6.1	239.12	239.00	-0.12	3.1	6.1	dry	dry	5.87	5.99	236.02	233.02	dry	dry
08MW07B	9.2	239.21	239.04	-0.17	6.1	9.2	7.85	8.03	7.85	8.02	233.11	230.01	231.19	231.19
08MW08	9.8	239.33	239.22	-0.11	6.7	9.8	8.10	8.21	8.01	8.13	232.63	229.53	231.12	231.20
08MW09	9.2	239.14	239.03	-0.11	6.1	9.2	7.89	8.00	damaged	damaged	233.04	229.94	231.14	#VALUE!
Garden River Airstrip														
08MW10	9.8	240.87	242.08	1.20	6.7	9.8	10.16	8.96	10.12	8.92	234.17	231.07	231.91	231.95
08MW11	9.8	240.98	242.26	1.27	6.7	9.8	10.35	9.08	10.35	9.08	234.28	231.18	231.91	231.90
08MW12	9.8	241.33	242.57	1.24	6.7	9.8	10.23	8.99	10.00	8.76	234.63	231.53	232.34	232.57
Garden River Trading (Charlie Rose)														
08MW14	10.1	235.73	235.62	-0.11	6.9	9.9			9.07	9.19	228.83	225.83		226.55
Fifth Meridian Market														
08MW16	9.9	236.50	236.39	-0.10	6.9	9.9			9.21	9.31	229.60	226.60		227.18
08MW18	9.9	235.99	235.91	-0.08	6.9	9.9			8.96	9.04	229.09	226.09		226.94
Garden River Public Works														
08MW20	11.4	240.72	240.66	-0.06	8.4	11.4			9.16	9.22	232.32	229.32		231.50
08MW21	9.8	240.19	240.13	-0.06	6.9	9.9			8.60	8.67	233.29	230.29		231.52
08MW22	9.7	240.17	240.06	-0.10	6.9	9.9			8.54	8.64	233.27	230.27		231.52
08MW23	9.9	239.82	239.76	-0.06	6.9	9.9			8.41	8.47	232.92	229.92		231.34

Notes:

mbg - Metres beneath ground level.

mBTOC - Metres below top of casing.

Blank cell - No data.

Bold - Groundwater elevation is above the screen elevation.

TABLE 3: GROUNDWATER ANALYTICAL RESULTS

Parameters	Units	Comparative Guidelines[1]	Comparative Guidelines[2]	Comparative Guidelines[3]	Garden River Old Dump					
					08MW04B		08MW05B		08MW06B	
					24-Mar-08	31-Aug-08	24-Mar-08	31-Aug-08	24-Mar-08	31-Aug-08
Routine Parameters										
Combustible Vapour Concentration (field)	ppm	NG	NG	NG		25		ND		10
pH (lab)	pH	6.5 to 8.5	6.5 to 8.5	6.5 to 9.0	7.74		7.71		7.73	
pH (field)	pH	NG	NG	NG	6.41	6.73	6.54	6.91	6.49	6.77
Electrical Conductivity (EC) (lab)	µS/cm	NG	NG	NG	739		752		786	
Electrical Conductivity (EC) (field)	µS/cm	NG	NG	NG	728	750	775	737	746	776
Temperature (Field)	Degrees C	NG	NG	NG	2.1	13.8	2.2	13.7	2.7	13.6
Alkalinity Total (as $CaCO_3$)	mg/L	NG	NG	NG	356		355		371	
Total Dissolved Solids	mg/L	500	500	NG	420		428		449	
Hardness	mg/L	NG	NG	NG	394		381		398	
Calcium (Ca)	mg/L	NG	NG	NG	111	78.2	107	114	110	117
Magnesium (Mg)	mg/L	NG	NG	NG	28.4	24.5	27.7	29.0	30	31.4
Potassium (K)	mg/L	NG	NG	NG	3.73	1.3	3.33	3.8	3.32	5.1
Sodium (Na)	mg/L	200	200	NG	8.6	55.7	10.6	10.7	11	12.9
Chloride (Cl)	mg/L	230	250	NG	4.4		4.7		4.2	
Sulphate (SO_4)	mg/L	500	500	NG	48		57.2		64.1	
Bicarbonate (HCO_3)	mg/L	NG	NG	NG	435		433		452	
Carbonate (CO_3)	mg/L	NG	NG	NG	<5		<5		<5	
Hydroxide	mg/L	NG	NG	NG	<5		<5		<5	
Nitrite + Nitrate - N	mg/L	NG	NG	NG	0.55		0.9		0.81	
Nitrate - N[3]	mg/L	3	10	3	0.55		0.9		0.81	
Nitrite - N	mg/L	NG	1	0.018	<0.05		<0.05		<0.05	
Ionic Balance	%	NG	NG	NG	101		96.2		95.6	
Volatile Hydrocarbons										
Benzene	mg/L	0.005	0.005	0.37	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thiophene	mg/L	NG	NG	NG		<0.001		<0.001		<0.001
Toluene	mg/L	0.024	0.024	0.002	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Chlorobenzene	mg/L	0.0013	NG	0.0013		<0.001		<0.001		<0.001
Ethylbenzene	mg/L	0.0024	0.0024	0.09	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Xylenes	mg/L	0.3	0.3	0.18	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Styrene	mg/L	0.072	NG	0.072		<0.001		<0.001		<0.001
F1 (C_6 to C_{10})	mg/L	0.81	NG	NG	<0.1		<0.1		<0.1	
F2 (C_{10} to C_{16})	mg/L	1.1	NG	NG	<0.05		<0.05		<0.05	
1,3-Dichlorobenzene	mg/L	NG	NG	0.15		<0.001		<0.001		<0.001
1,4-Dichlorobenzene	mg/L	0.001	0.005	0.026		<0.001		<0.001		<0.001
1,2-Dichlorobenzene	mg/L	0.0007	0.2	0.0007		<0.001		<0.001		<0.001
Naphthalene	mg/L	0.0011	NG	0.0011		<0.00001		<0.00001		<0.00001
Quinoline	mg/L	NG	NG	NG		<0.00001		<0.00001		<0.00001
Acenaphthene	mg/L	0.0058	NG	0.0058		<0.00001		<0.00001		<0.00001
Fluorene	mg/L	0.003	NG	0.003		<0.00001		<0.00001		<0.00001
Phenanthrene	mg/L	0.0004	NG	0.0004		<0.00001		<0.00001		<0.00001
Anthracene	mg/L	0.000012	NG	0.000012		<0.00001		<0.00001		<0.00001
Acridine	mg/L	NG	NG	NG		<0.00001		<0.00001		<0.00001
Fluoranthene	mg/L	0.003	NG	0.00004		<0.00001		<0.00001		<0.00001
Pyrene	mg/L	0.000025	NG	0.000025		<0.00001		0.00002		<0.00001
Benzo(a)anthracene	mg/L	0.000018	NG	0.000018		<0.00001		<0.00001		<0.00001
Chrysene	mg/L	0.0014	NG	0.0014		<0.00001		<0.00001		<0.00001
Benzo(b&j)fluoranthene	mg/L	0.00048	NG	0.00048		<0.00001		<0.00001		<0.00001
Benzo(k)fluoranthene	mg/L	0.00048	NG	0.00048		<0.00001		<0.00001		<0.00001
Benzo(a)pyrene	mg/L	0.000015	0.00001	0.000015		<0.00001		<0.00001		<0.00001
Indeno(1,2,3-cd)pyrene	mg/L	0.00021	NG	0.00021		<0.00001		<0.00001		<0.00001
Dibenzo(a,h)anthracene	mg/L	0.00026	NG	0.00026		<0.00001		<0.00001		<0.00001
Chlorinated Aliphatics										
1,1-Dichloroethene	mg/L	0.014	NG	NG		<0.001		<0.001		<0.001
Methylene Chloride	mg/L	0.05	NG	0.0981		<0.001		<0.001		<0.001
trans-1,2-Dichloroethene	mg/L	NG	NG	NG		<0.001		<0.001		<0.001
1,1-Dichloroethane	mg/L	NG	NG	NG		<0.001		<0.001		<0.001
Chloroform	mg/L	0.0018	NG	0.0018		<0.001		<0.001		<0.001
1,2-Dichloroethane	mg/L	0.005	0.005	0.1		<0.001		<0.001		<0.001
1,1,1-Trichloroethane	mg/L	NG	NG	NG		<0.001		<0.001		<0.001
Carbon Tetrachloride	mg/L	0.00056	0.005	0.0133		<0.001		<0.001		<0.001
Trichloroethene	mg/L	0.005	0.005	0.021		<0.001		<0.001		<0.001
1,2-Dichloropropane	mg/L	NG	NG	NG		<0.001		<0.001		<0.001
cis-1,3-Dichloropropene	mg/L	NG	NG	NG		<0.001		<0.001		<0.001
trans-1,3-Dichloropropene	mg/L	NG	NG	NG		<0.001		<0.001		<0.001
1,1,2-Trichloroethane	mg/L	NG	NG	NG		<0.001		<0.001		<0.001
Tetrachloroethylene	mg/L	0.03	0.03	0.111		<0.001		<0.001		<0.001
1,1,2,2-Tetrachloroethane	mg/L	NG	NG	NG		<0.002		<0.002		<0.002
Dissolved Metals										
Aluminum (Al)	mg/L	NG	0.1	0.1	<0.0050	<0.01	<0.025	<0.01	<0.025	<0.01
Antimony (Sb)	mg/L	0.006	0.006	NG	<0.00010	0.0005	<0.00050	<0.0004	<0.00050	<0.0004
Arsenic (As)	mg/L	0.005	0.010	0.005	0.00133	0.0014	0.00398	0.0034	0.00115	<0.0004
Barium (Ba)	mg/L	1	1	NG	0.329	0.061	0.381	0.420	0.355	0.352
Beryllium (Be)	mg/L	NG	NG	NG	<0.00050	<0.001	<0.0025	<0.001	<0.0025	<0.001
Bismuth (Bi)	mg/L	NG	NG	NG	<0.00050		<0.0025		<0.0025	
Boron (B)	mg/L	5	5	NG	0.016	<0.05	<0.050	<0.05	<0.050	<0.05
Cadmium (Cd)	mg/L	0.005	0.005	0.000097	<0.000050	**<0.0001**	**<0.00025**	**<0.0001**	**<0.00025**	**0.0021**
Chromium (Cr),	mg/L	0.05	0.05	0.21	<0.00050	<0.005	<0.0025	<0.005	<0.0025	<0.005
Cobalt (Co)	mg/L	NG	NG	NG	0.00143	<0.002	0.00188	0.002	0.0018	<0.002
Copper (Cu)	mg/L	1	1	0.026	0.00327	0.003	0.0177	0.004	0.00742	0.009
Iron (Fe)	mg/L	0.3	0.3	0.3	<0.030	<0.005	**2.03**	**1.51**	0.044	0.013
Lead (Pb)	mg/L	0.01	0.01	0.0095	<0.00010	<0.0001	<0.00050	0.0001	<0.00050	0.0002
Lithium (Li)	mg/L	NG	NG	NG		0.536		0.542		0.360
Manganese(Mn)	mg/L	0.05	0.05	NG	**0.259**	**0.538**	**0.294**	**0.636**	**0.226**	0.043
Mercury (Hg)-Dissolved	mg/L	0.001	0.001	NG		<0.00010		<0.00010		<0.00010
Molybdenum (Mo)	mg/L	NG	NG	0.073	0.000868	0.015	0.00095	<0.005	0.00076	<0.005
Nickel (Ni)	mg/L	NG	NG	0.15	0.00183	0.006	0.0033	0.004	0.0028	0.004
Selenium (Se)	mg/L	0.001	0.01	0.001	**0.0108**	**0.0012**	**<0.0050**	0.0006	**<0.0050**	**0.0037**
Silver (Ag)	mg/L	NG	NG	NG	<0.000010	<0.0001	<0.000050	<0.0001	<0.000050	<0.0001
Strontium (Sr)	mg/L	NG	NG	NG	0.272		0.171		0.165	
Thallium (Tl)	mg/L	NG	NG	NG	<0.00010	<0.0001	<0.00050	<0.0001	<0.00050	<0.0001
Tin (Sn)	mg/L	NG	NG	NG	<0.00010	<0.05	<0.00050	<0.05	<0.00050	<0.05
Titanium (Ti)	mg/L	NG	NG	NG	0.0011	0.001	<0.0050	<0.001	<0.0050	<0.001
Uranium (U)	mg/L	0.02	0.02	NG	0.00383	0.0097	0.00354	0.0034	0.00483	0.0053
Vanadium (V)	mg/L	NG	NG	NG	<0.0010	<0.001	<0.0050	<0.001	<0.0050	<0.001
Zinc (Zn)	mg/L	0.03	5.0	0.03	**0.0938**	0.026	**0.061**	0.019	**0.039**	**0.033**
Laboratory Identification No.					L612590-4	L676397-4	L612590-5	L676397-5	L612590-6	L676397-6

Notes:

[1] Alberta Environment (AENV), August 2008. Alberta Tier 1 Soil and Groundwater Remediation Guidelines. Referenced Guidelines apply to coarse texture of soils under residential/parkland land use.

[2] Health Canada. May 2008. Guidelines for Canadian Drinking Water Quality - Summary Table.

[3] Canadian Council of Ministers of the Environment. 2007. Canadian water quality guidelines for the protection of aquatic life - Summary Table. In In Canadian Environmental Quality Guidelines 1999.

NG - No guideline established.

ND - Not detected.

Blank - Not analyzed.

Bold - Greater than lowest referenced guideline.

TABLE 3: GROUNDWATER ANALYTICAL RESULTS

Parameters	Units	Comparative Guidelines[1]	Comparative Guidelines[2]	Comparative Guidelines[3]	Garden River Airstrip					
					08MW10		08MW11		08MW12	
					24-Mar-08	31-Aug-08	24-Mar-08	31-Aug-08	24-Mar-08	31-Aug-08
Routine Parameters										
Combustible Vapour Concentration (field)	ppm	NG	NG	NG		60		50		10
pH (lab)	pH	6.5 to 8.5	6.5 to 8.5	6.5 to 9.0	7.93		7.9		7.92	
pH (field)	pH	NG	NG	NG	6.61	6.96	6.31	6.95	6.37	6.95
Electrical Conductivity (EC) (lab)	µS/cm	NG	NG	NG	647		559		583	
Electrical Conductivity (EC) (field)	µS/cm	NG	NG	NG	737	477	761	565	780	517
Temperature (Field)	Degrees C	NG	NG	NG	1.8	12.8	1.8	12.3	1.5	12.8
Alkalinity Total (as $CaCO_3$)	mg/L	NG	NG	NG	301		299		298	
Total Dissolved Solids	mg/L	500	500	NG	363		311		322	
Hardness	mg/L	NG	NG	NG	322		299		309	
Calcium (Ca)	mg/L	NG	NG	NG	92.8	83.1	82.4	87.6	87.1	
Magnesium (Mg)	mg/L	NG	NG	NG	21.9	15.5	22.7	22.4	22.2	
Potassium (K)	mg/L	NG	NG	NG	4.25	4.8	2.98	2.9	3.16	
Sodium (Na)	mg/L	200	200	NG	7.7	3.2	5.7	4.1	4.7	
Chloride (Cl)	mg/L	230	250	NG	3.9		1.5		1.9	
Sulphate (SO_4)	mg/L	500	500	NG	51.4		16.4		23.3	
Bicarbonate (HCO_3)	mg/L	NG	NG	NG	368		365		363	
Carbonate (CO_3)	mg/L	NG	NG	NG	<5		<5		<5	
Hydroxide	mg/L	NG	NG	NG	<5		<5		<5	
Nitrite + Nitrate - N	mg/L	NG	NG	NG	0.17		0.08		0.1	
Nitrate - N^3	mg/L	3	10	3	0.17		0.08		0.1	
Nitrite - N	mg/L	NG	1	0.018	<0.05		<0.05		<0.05	
Ionic Balance	%	NG	NG	NG	95.2		99		99.4	
Volatile Hydrocarbons										
Benzene	mg/L	0.005	0.005	0.37	<0.00050		<0.00050		<0.00050	
Thiophene	mg/L	NG	NG	NG						
Toluene	mg/L	0.024	0.024	0.002	<0.00050		<0.00050		<0.00050	
Chlorobenzene	mg/L	0.0013	NG	0.0013						
Ethylbenzene	mg/L	0.0024	0.0024	0.09	<0.00050		<0.00050		<0.00050	
Xylenes	mg/L	0.3	0.3	0.18	<0.00050		<0.00050		<0.00050	
Styrene	mg/L	0.072	NG	0.072						
F1 (C_6 to C_{10})	mg/L	0.81	NG	NG	<0.1		<0.1		<0.1	
F2 (C_{10} to C_{16})	mg/L	1.1	NG	NG	<0.05		<0.05		<0.05	
1,3-Dichlorobenzene	mg/L	NG	NG	0.15						
1,4-Dichlorobenzene	mg/L	0.001	0.005	0.026						
1,2-Dichlorobenzene	mg/L	0.0007	0.2	0.0007						
Naphthalene	mg/L	0.0011	NG	0.0011						
Quinoline	mg/L	NG	NG	NG						
Acenaphthene	mg/L	0.0058	NG	0.0058						
Fluorene	mg/L	0.003	NG	0.003						
Phenanthrene	mg/L	0.0004	NG	0.0004						
Anthracene	mg/L	0.000012	NG	0.000012						
Acridine	mg/L	NG	NG	NG						
Fluoranthene	mg/L	0.003	NG	0.00004						
Pyrene	mg/L	0.000025	NG	0.000025						
Benzo(a)anthracene	mg/L	0.000018	NG	0.000018						
Chrysene	mg/L	0.0014	NG	0.0014						
Benzo(b&j)fluoranthene	mg/L	0.00048	NG	0.00048						
Benzo(k)fluoranthene	mg/L	0.00048	NG	0.00048						
Benzo(a)pyrene	mg/L	0.000015	0.00001	0.000015						
Indeno(1,2,3-cd)pyrene	mg/L	0.00021	NG	0.00021						
Dibenzo(a,h)anthracene	mg/L	0.00026	NG	0.00026						
Chlorinated Aliphatics										
1,1-Dichloroethene	mg/L	0.014	NG	NG						
Methylene Chloride	mg/L	0.05	NG	0.0981						
trans-1,2-Dichloroethene	mg/L	NG	NG	NG						
1,1-Dichloroethane	mg/L	NG	NG	NG						
Chloroform	mg/L	0.0018	NG	0.0018						
1,2-Dichloroethane	mg/L	0.005	0.005	0.1						
1,1,1-Trichloroethane	mg/L	NG	NG	NG						
Carbon Tetrachloride	mg/L	0.00056	0.005	0.0133						
Trichloroethene	mg/L	0.005	0.005	0.021						
1,2-Dichloropropane	mg/L	NG	NG	NG						
cis-1,3-Dichloropropene	mg/L	NG	NG	NG						
trans-1,3-Dichloropropene	mg/L	NG	NG	NG						
1,1,2-Trichloroethane	mg/L	NG	NG	NG						
Tetrachloroethylene	mg/L	0.03	0.03	0.111						
1,1,2,2-Tetrachloroethane	mg/L	NG	NG	NG						
Dissolved Metals										
Aluminum (Al)	mg/L	NG	0.1	0.1	<0.025	<0.01	<0.025	<0.01	<0.025	
Antimony (Sb)	mg/L	0.006	0.006	NG	<0.00050	<0.0004	<0.00050	<0.0004	<0.00050	
Arsenic (As)	mg/L	0.005	0.010	0.005	<0.00050	<0.0004	<0.00050	<0.0004	<0.00050	
Barium (Ba)	mg/L	1	1	NG	0.529	0.579	0.372	0.428	0.449	
Beryllium (Be)	mg/L	NG	NG	NG	<0.0025	<0.001	<0.0025	<0.001	<0.0025	
Bismuth (Bi)	mg/L	NG	NG	NG	<0.0025		<0.0025		<0.0025	
Boron (B)	mg/L	5	5	NG	<0.050	<0.05	<0.050	<0.05	<0.050	
Cadmium (Cd)	mg/L	0.005	0.005	0.000097	**<0.00025**	**<0.0001**	**<0.00025**	**<0.0001**	**<0.00025**	
Chromium (Cr),	mg/L	0.05	0.05	0.21	<0.0025	<0.005	<0.0025	<0.005	<0.0025	
Cobalt (Co)	mg/L	NG	NG	NG	0.00058	<0.002	<0.00050	<0.002	0.00054	
Copper (Cu)	mg/L	1	1	0.026	0.0049	0.003	0.00602	0.003	0.00146	
Iron (Fe)	mg/L	0.3	0.3	0.3	<0.030	<0.005	<0.030	<0.005	<0.030	
Lead (Pb)	mg/L	0.01	0.01	0.0095	<0.00050	<0.0001	<0.00050	<0.0001	<0.00050	
Lithium (Li)	mg/L	NG	NG	NG		0.429		0.393		
Manganese(Mn)	mg/L	0.05	0.05	NG	**0.124**	0.010	0.0355	0.013	**0.101**	
Mercury (Hg)-Dissolved	mg/L	0.001	0.001	NG		<0.00010		<0.00010		
Molybdenum (Mo)	mg/L	NG	NG	0.073	0.00236	<0.005	0.00176	<0.005	0.00224	
Nickel (Ni)	mg/L	NG	NG	0.15	<0.0025	<0.002	<0.0025	0.002	<0.0025	
Selenium (Se)	mg/L	0.001	0.01	0.001	**<0.0050**	<0.0004	**0.0061**	**0.0214**	**0.0066**	
Silver (Ag)	mg/L	NG	NG	NG	<0.000050	<0.0001	<0.000050	<0.0001	<0.000050	
Strontium (Sr)	mg/L	NG	NG	NG	0.151		0.225		0.222	
Thallium (Tl)	mg/L	NG	NG	NG	<0.00050	<0.0001	<0.00050	<0.0001	<0.00050	
Tin (Sn)	mg/L	NG	NG	NG	0.00064	<0.05	<0.00050	<0.05	0.00056	
Titanium (Ti)	mg/L	NG	NG	NG	<0.0050	<0.001	<0.0050	<0.001	<0.0050	
Uranium (U)	mg/L	0.02	0.02	NG	0.00232	0.0009	0.00305	0.0040	0.0025	
Vanadium (V)	mg/L	NG	NG	NG	<0.0050	<0.001	<0.0050	<0.001	<0.0050	
Zinc (Zn)	mg/L	0.03	5.0	0.03	**0.066**	0.015	**0.096**	0.013	**0.074**	
Laboratory Identification No.					L612590-10	L676397-9	L612590-11	L676397-10	L612590-12	

Notes:

[1] Alberta Environment (AENV), August 2008. Alberta Tier 1 Soil and Groundwater Remediation Guidelines. Referenced Guidelines apply to coarse texture of soils under residential/parkland land use.

[2] Health Canada. May 2008. Guidelines for Canadian Drinking Water Quality - Summary Table.

[3] Canadian Council of Ministers of the Environment. 2007. Canadian water quality guidelines for the protection of aquatic life - Summary Table. In Canadian Environmental Quality Guidelines 1999.

NG - No guideline established.

ND - Not detected.

Blank - Not analyzed.

Bold - Greater than highest referenced guideline.

GARDEN RIVER LANDFILL (FIGURE 3)

0.97 KM

CUTLINE

GARDEN RIVER AIRSTRIP (FIGURE 7)

AIRSTRIP

CUTLINE

GARDEN RIVER PUBLIC WORKS (FIGURE 6)

LAGOON

GARDEN RIVER OLD DUMP (FIGURE 4)

FORMER SEPTIC TILE FIELD (FIGURE 5)

1.03 KM

FIFTH MERIDIAN MARKET AND HISTORIC NORTHLANDS SCHOOL (FIGURE 8)

PEACE RIVER

CHURCH (FIGURE 9)

GARDEN RIVER TRADING (CHARLIE ROSE) (FIGURE 10)

LEGEND:

– FENCE

– ROAD

0 100 200 300

Scale: 1: 6000 (metres)

\\eba.local\corp\Riverbend\Drafting\C221\C22101178\AutoCAD\C22101178-Fig 2.dwg [FIGURE 2] February 13, 2009 - 10:14:09 am (BY: TIGISTI KIROS)

CLIENT

Public Works and Government Services Canada / Travaux publics et Services gouvernementaux Canada

CONTAMINATED SITE ASSESSMENT
GARDEN RIVER INDIAN RESERVATION, AB

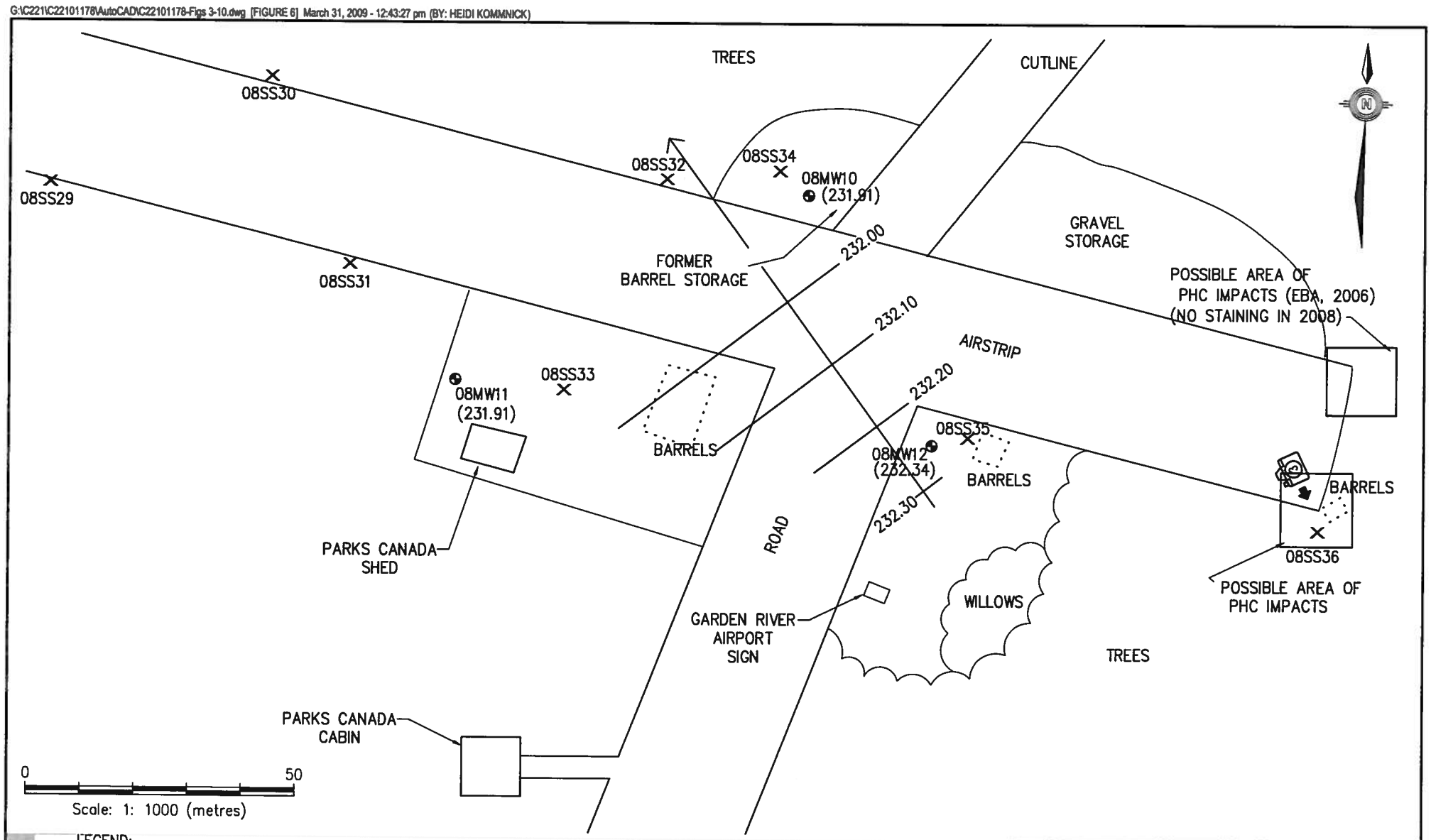
SITE PLAN SHOWING ASSESSMENT AREAS

EBA Engineering Consultants Ltd.

PROJECT NO	DWN	CKD	REV
C22101178	RH/HK	JC/CH	0
OFFICE: RIV	DATE: February 2009		

Figure 2

G:\C221\C22101178\AutoCAD\C22101178-Figs 3-10.dwg [FIGURE 6] March 31, 2009 - 12:43:27 pm (BY: HEIDI KOMMNICK)



LEGEND:

- 08MW## – MONITORING WELL LOCATION
- 08SS## – SHALLOW SOIL SAMPLE LOCATION
- (###.##) – GROUNDWATER ELEVATION
- ###.## GROUNDWATER ELEVATION CONTOUR
- – INTERPRETED LOCAL GROUNDWATER FLOW DIRECTION
- – PHOTO DIRECTION AND NUMBER

NOTE

MONITORING WELL LOCATIONS ARE ON SCALE AND OTHER FEATURES ON THE DRAWING ARE NOT TO SCALE

CLIENT

Public Works and Government Services Canada / Travaux publics et Services gouvernementaux Canada

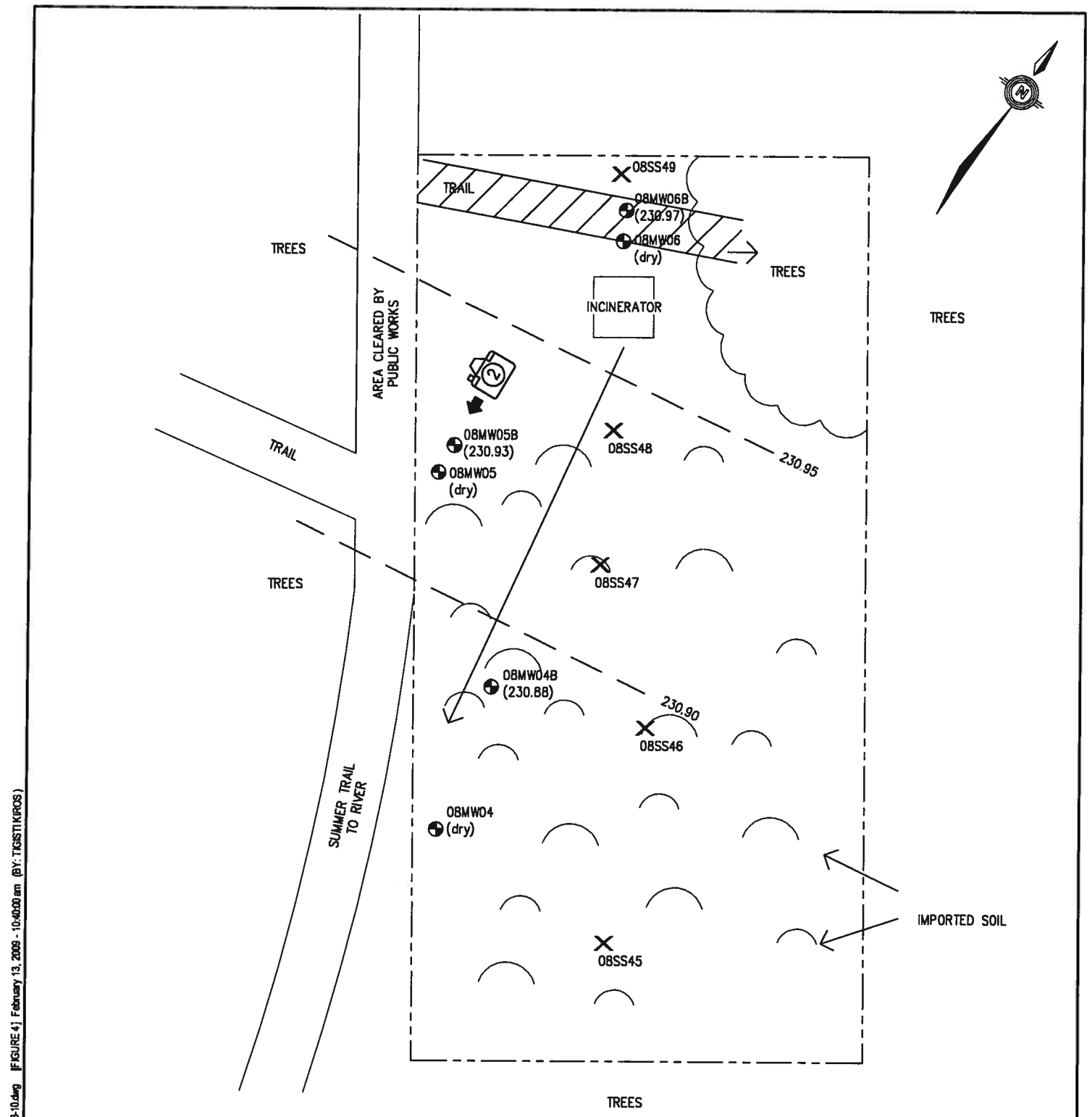
EBA Engineering Consultants Ltd.

CONTAMINATED SITE ASSESSMENT
GARDEN RIVER INDIAN RESERVATION, AB

GARDEN RIVER AIRSTRIP SITE PLAN

PROJECT NO.	DWN	CKD	REV
C22101178	MM/HK	JC/CH	0
OFFICE: RIV	DATE: October 2008		

Figure 6



NOTE

MONITORING WELL LOCATIONS ARE ON SCALE AND OTHER FEATURES ON THE DRAWING ARE NOT TO SCALE

LEGEND:

- 08MW## – MONITORING WELL LOCATION
- 08SS## – SHALLOW SOIL SAMPLE LOCATION
- (###.##) – GROUNDWATER ELEVATION
- ###.## GROUNDWATER ELEVATION CONTOUR
- – INTERPRETED GROUNDWATER FLOW DIRECTION
- – PHOTO DIRECTION AND NUMBER

CLIENT

Public Works and Government Services Canada / Travaux publics et Services gouvernementaux Canada

CONTAMINATED SITE ASSESSMENT GARDEN RIVER INDIAN RESERVATION, AB

GARDEN RIVER OLD DUMP SITE PLAN

EBA Engineering Consultants Ltd.

PROJECT NO	DWN	CKD	REV
C22101178	MM/HK	JC/CH	0
Of I XOL	DATE		
RIV	February 2009		

Figure 4

\\eba.local\corp\Riverbend\Drafting\C22\C22101178\AutoCAD\C22101178-Figs 3-10.dwg [FIGURE 4] February 13, 2009 - 10:40:00 am (BY: TIGISTI KIROS)

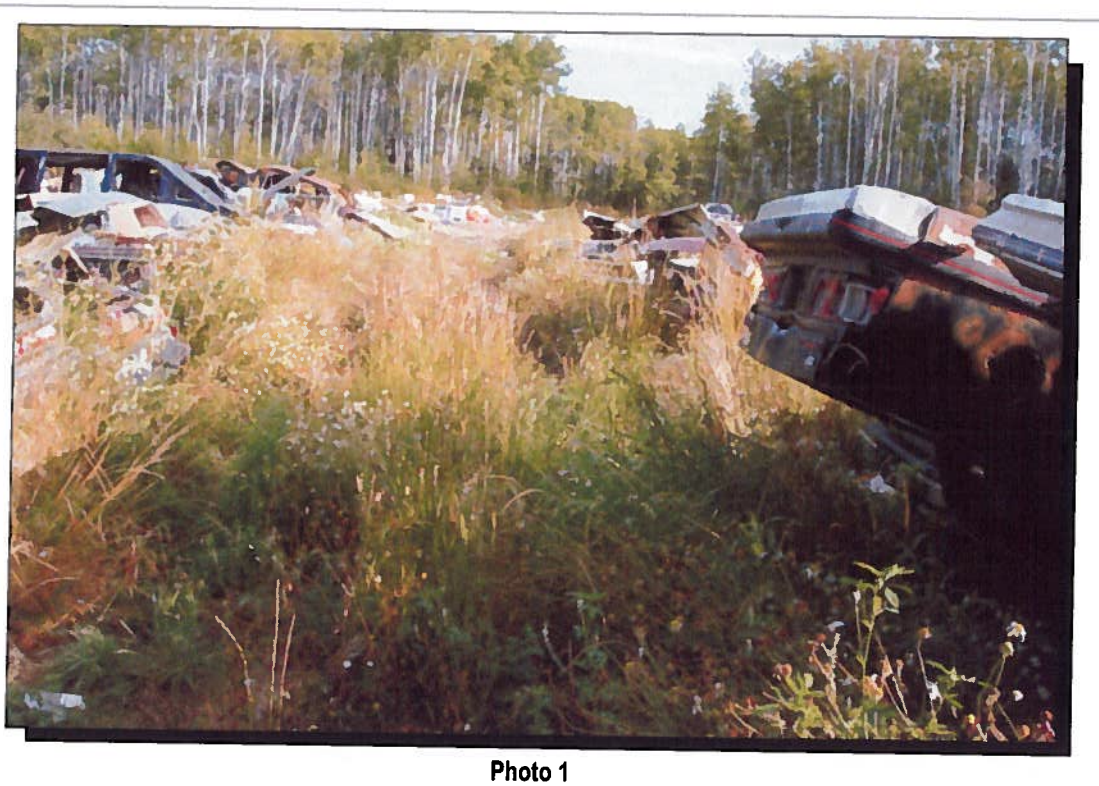


Photo 1
Garden River Landfill looking northeast from 08SS26 (August 26, 2008).

Photo 2
Garden River Old Dump looking south towards 08MW05 area (August 26, 2008)

Photo 3
Garden River Airstrip looking east-southeast at 08SS36 (August 26, 2008).

Photo 4
Garden River Public Works yard looking northeast from 08MW20 (August 26, 2008)

Title:

SITE LOCATION

Project:

DETAILED SITE ASSESSMENT
GARDEN RIVER OLD DUMP

Client:

PARKS CANADA AGENCY

FRANZ ENVIRONMENTAL INC.
CONSULTING ENGINEERING TECHNOLOGIES

COLUMBIA ENVIRONMENTAL

Date:

JANUARY 2011

FIGURE 1

2018-1001/CAD/CB/Figure1.dwg

N

NORTH DEBRIS AREA

EXPOSED METAL DEBRIS

TREES

DRAINAGE (MAN MADE)

2

TREES

2018-10BH-1M
(90.691)

B

TRAIL

TREES

08SS49

08MW06

08MW06B (destroyed)

TRAIL

2018-10SS-4

2018-10SS-3

90.700

2018-10BH-4M
(90.66)

SPARSE TREES

08MW05

08MW05B
(100.00 m) (90.63)
(T.B.M - T.O.C.)

08SS48

TREES

2018-10SS-2

A'

OLD DUMP SITE

2018-10SS-6

08SS47

TREES

2018-10SS-5

2018-10BH-2M
(90.487)

90.600

08MW04

08MW04B
(90.514)

2018-10SS-1

RAVINE BOTTOM

08SS46

DRAINAGE (MAN MADE)

A

2018-10BH-5M
(90.485)

SCATTERED SURFACE DEBRIS

90.500

SPARSE TREES (WILLOW AND POPLAR)

08SS45

TREES

BORROW SOURCE AREA EXTENTS

SOUTH DEBRIS AREA

PIT

TREES

TREES

HALF BURIED SNOWMOBILE

90.400

90.300

TREES

2018-10BH-7M
(90.327)

2018-10BH-3M
(90.149)

B'

90.200

LEGEND

- Site Boundary
- Treeline
- Trails
- Area of Debris
- Incinerator
- Monitoring Well
- Borehole
- X Surface Soil Sample
- Inferred Groundwater Equipotential Line
- Inferred Groundwater Flow Direction
- 322.0 Groundwater Elevation *
- Surfacewater Flow Direction
- Drainage Ditch
- A—A' Cross Section Line

Note:
* Units relative to a temporary bench mark (TBM) of 100m for 08MW05B. All other elevations are relative to this.

Scale 1:1,000
20 15 10 0 10 20
metres

Title: **INVESTIGATION LOCATIONS AND SITE FEATURES**

Project: **DETAILED SITE ASSESSMENT GARDEN RIVER OLD DUMP**

Client: **PARKS CANADA AGENCY**

FRANZ ENVIRONMENTAL INC. CONSULTING ENGINEERING TECHNOLOGIES
COLUMBIA ENVIRONMENTAL

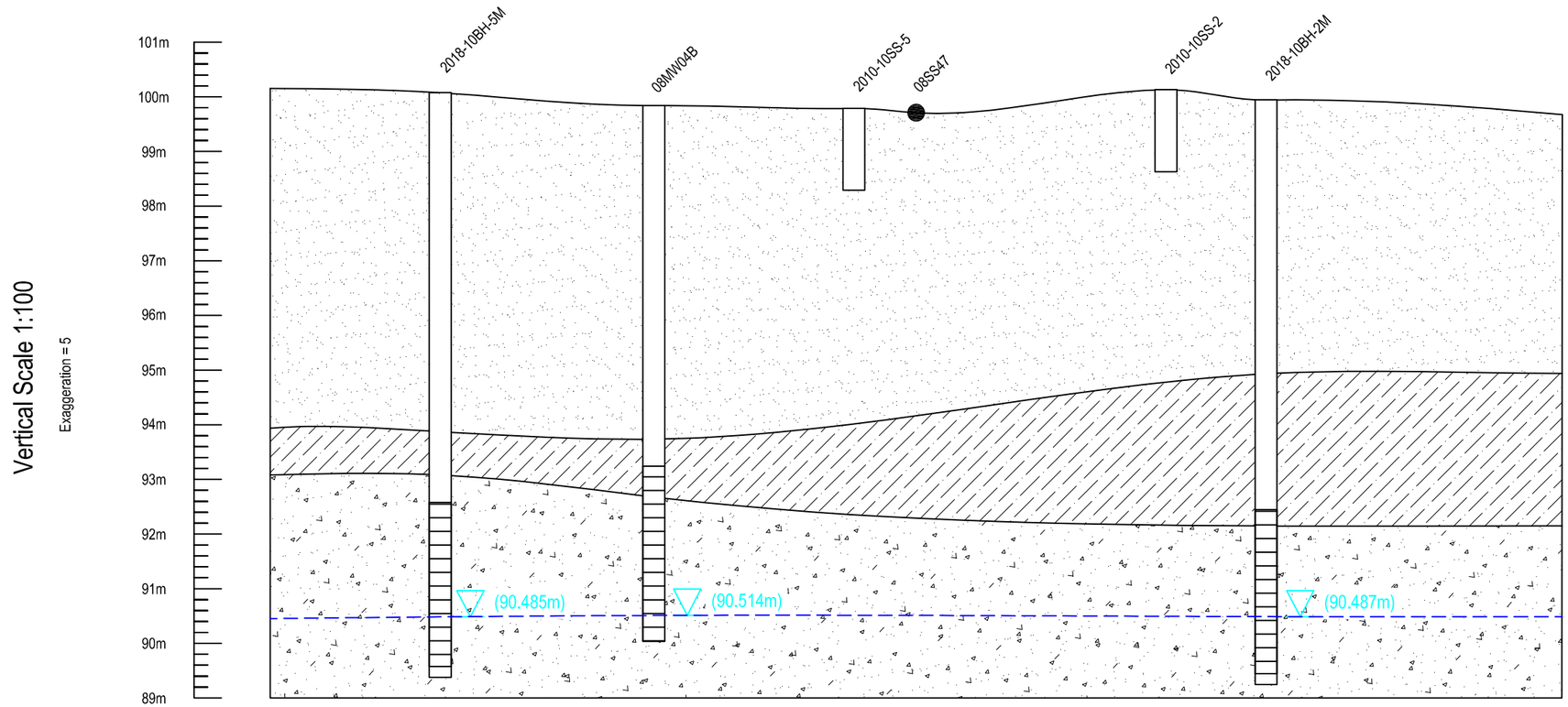
Date: **FEBRUARY 2011**

FIGURE 2

2018-1001 ParksCanada - Garden River Old Dump/CAD/NR/Garden River.dwg

A Southwest

A' Northeast



LEGEND

- Sandy Silt
- Clayey Silt
- Sand and Gravel
- Groundwater Table
- Water Level
- Screen
- Surface Soil Sample

Note:
* Units relative to a temporary bench mark (TBM) of 100m for 08MW05B. All other elevations are relative to this.

Scale 1:500
10 7.5 5 0 5 10
metres

Title: **CROSS SECTION A - A'**

Project: **DETAILED SITE ASSESSMENT GARDEN RIVER OLD DUMP**

Client: **PARKS CANADA AGENCY**

FRANZ ENVIRONMENTAL INC. CONSULTING ENGINEERING TECHNOLOGIES
COLUMBIA ENVIRONMENTAL

Date: **FEBRUARY 2011**

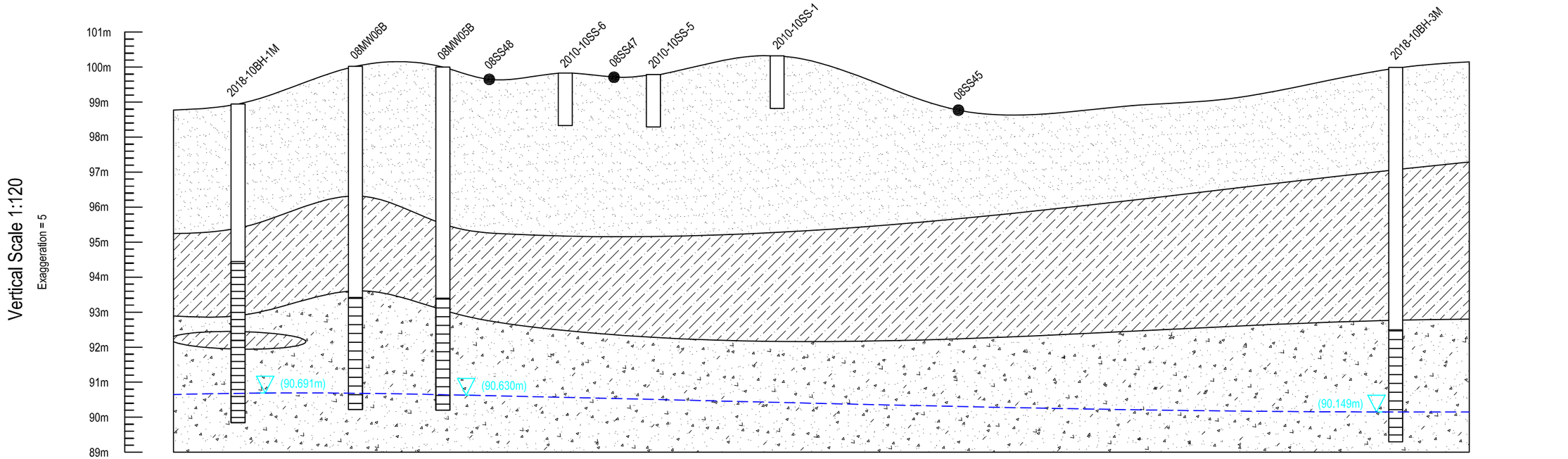
FIGURE 3

** Original in colour : Figures should be interpreted in combination with appropriate site report.*

2018-1001 ParksCanada - Garden RIver Old Dump/CAD/NR/Garden RIver.dwg

B Northwest

B' Southeast



LEGEND

- Sandy Silt
- Clayey Silt
- Sand and Gravel
- Groundwater Table
- Water Level
- Screen
- Surface Soil Sample

Note:
* Units relative to a temporary bench mark (TBM) of 100m for 08MW05B. All other elevations are relative to this.

Scale 1:600
12 9 6 0 6 12
metres

Title: **CROSS SECTION B - B'**

Project: **DETAILED SITE ASSESSMENT GARDEN RIVER OLD DUMP**

Client: **PARKS CANADA AGENCY**

FRANZ ENVIRONMENTAL INC. CONSULTING ENGINEERING TECHNOLOGIES
COLUMBIA ENVIRONMENTAL

Date: **FEBRUARY 2011**

FIGURE 4

** Original in colour : Figures should be interpreted in combination with appropriate site report.*

2018-1001 ParksCanada - Garden RIver Old Dump/CAD/NR/Garden RIver.dwg

Station ID	Units	CCME AL Coarse	08MW04	08MW04B	08MW05	08MW05B	08MW06		08SS45	08SS46	08SS47
Field label			08MW04	08MW04B	08MW05	08MW05B	08MW06	08MW06	08SS45	08SS46	08SS47
Duplicate ID											
Date			19/Mar/08	20/Mar/08	31/Mar/08	20/Mar/08	19/Mar/08	19/Mar/08	28/Aug/08	28/Aug/08	28/Aug/08
Consultant			EBA	EBA	EBA	EBA	EBA	EBA	EBA	EBA	EBA
Lab report ID			L613338	L613338	L613338	L613338	L613338	L613338	676396-202	676396-203	676396-204
Depth (m)			0.8	7.6	0.8	7.6	0.8	7.6	0-0.6	0-0.6	0-0.6
Petroleum Hydrocarbons											
F1 (C6-C10)	ug/g	-	5	5	5	5	5	5	5	5	5
F1 (C6-C10) minus BTEX	ug/g	30 (coarse), 170 (fine)	5	5	5	5	5	5	5	5	5
F2 (C10-C16)	ug/g	150	5	5	5	5	5	5	20	20	20
F3 (C16-C34)	ug/g	300 (coarse), 1300 (fine)	6	10	7	7	7	5	20	20	20
F4 (C34-C50)	ug/g	2800 (coarse), 5600 (fine)	5	5	5	5	5	5	20	20	20
Monocyclic Aromatic Hydrocarbons											
Benzene	ug/g	0.030 (coarse), 0.0068 (fine)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Ethylbenzene	ug/g	0.082 (coarse), 0.018 (fine)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Styrene	ug/g	0.1	-	-	-	-	-	-	-	-	0.01
Toluene	ug/g	0.37 (coarse), 0.08 (fine)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
m+p-Xylene	ug/g	-	-	-	-	-	-	-	-	-	-
o-Xylene	ug/g	-	-	-	-	-	-	-	-	-	-
Xylenes (total)	ug/g	11 (coarse), 2.4 (fine)	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
Polycyclic Aromatic Hydrocarbons											
Acenaphthene	ug/g	0.28(E)	-	-	-	-	-	-	-	-	-
Acenaphthylene	ug/g	320(E)	-	-	-	-	-	-	-	-	-
Anthracene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 2.5(E)	-	-	-	-	-	-	-	-	-
Benzo[a]anthracene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 0.1(E)	-	-	-	-	-	-	-	0.010	-
Benzo[a]pyrene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 20(E)	-	-	-	-	-	-	-	0.010	-
Benzo[b+j]fluoranthene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 0.1(E)	-	-	-	-	-	-	-	0.010	-
Benzo[ghi]perylene	ug/g	5.3 B[a]P TPE, IACR<1.0*	-	-	-	-	-	-	-	-	-
Benzo[k]fluoranthene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 0.1(E)	-	-	-	-	-	-	-	0.010	-
Chrysene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 6.2(E)	-	-	-	-	-	-	-	-	-
Dibenzo[a,h]anthracene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 0.1(E)	-	-	-	-	-	-	-	0.010	-
Fluoranthene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 50(E)	-	-	-	-	-	-	-	-	-
Fluorene	ug/g	0.25(E)	-	-	-	-	-	-	-	-	-
Indeno[1,2,3-cd]pyrene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 0.1(E)	-	-	-	-	-	-	-	0.010	-
2-Methylnaphthalene	ug/g	-	-	-	-	-	-	-	-	-	-
Naphthalene	ug/g	0.013(E)	-	-	-	-	-	-	-	0.010	-
Phenanthrene	ug/g	0.046(E)	-	-	-	-	-	-	-	0.010	-
Pyrene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 0.1(E)	-	-	-	-	-	-	-	0.010	-

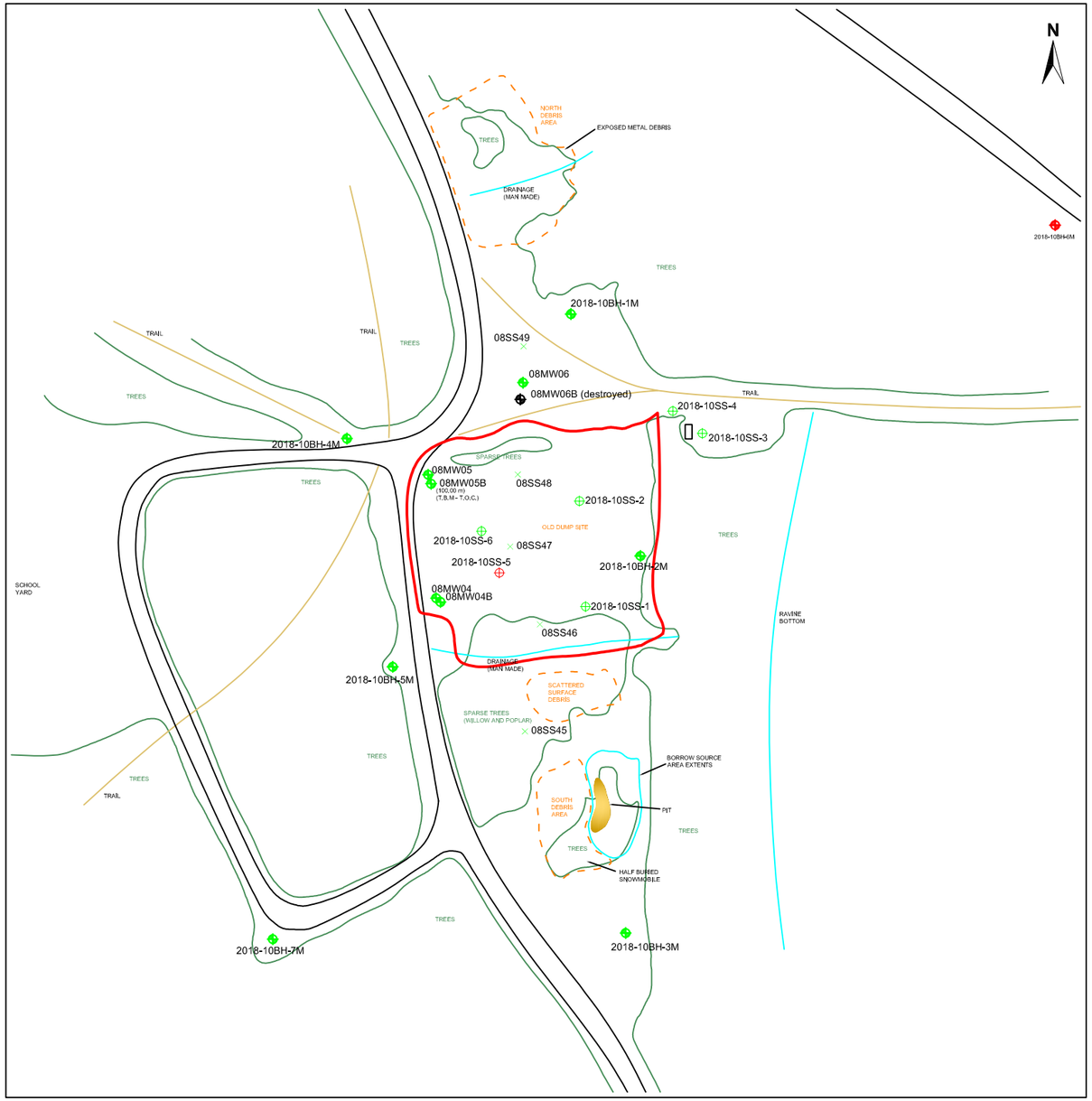
Station ID	Units	CCME AL Coarse	088SS48	08SS49	2018-10BH-1M			2018-10BH-2M			
Field label			08SS48	08SS49	2018-10BH-1M-2	2018-10BH-1M-6	2018-10BH-1M-7	2018-10BH-2M-1	2018-10BH-2M-2	2018-10BH-2M-7	2018-10BH-2M-8
Duplicate ID					2018-10BH-Dup1				2018-10BH-Dup2		
Date			28/Aug/08	28/Aug/08	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10
Consultant			EBA	EBA	Franz	Franz	Franz	Franz	Franz	Franz	Franz
Lab report ID			676396-205	676396-206	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661
Depth (m)			0-0.6	0-0.6	0.8 - 1.5	6.1 - 7.6	7.6 - 9.0	0 - 0.5	0.5 - 1.6	6.1 - 7.7	7.7 - 9.0
Petroleum Hydrocarbons											
F1 (C6-C10)	ug/g	-	5	5	10.00	10.00	10.00	10.00	10.00	10.00	10.00
F1 (C6-C10) minus BTEX	ug/g	30 (coarse), 170 (fine)	5	-	10.00	10.00	10.00	10.00	10.00	10.00	10.00
F2 (C10-C16)	ug/g	150	20	20	10.00	10.00	10.00	10.00	10.00	10.00	10.00
F3 (C16-C34)	ug/g	300 (coarse), 1300 (fine)	20	20	10.00	10.00	120.00	10.00	10.00	29.00	10.00
F4 (C34-C50)	ug/g	2800 (coarse), 5600 (fine)	20	20	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Monocyclic Aromatic Hydrocarbons											
Benzene	ug/g	0.030 (coarse), 0.0068 (fine)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Ethylbenzene	ug/g	0.082 (coarse), 0.018 (fine)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.010	0.010
Styrene	ug/g	0.1	-	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01
Toluene	ug/g	0.37 (coarse), 0.08 (fine)	0.01	0.01	0.05	0.05	0.05	0.05	0.05	0.05	0.05
m+p-Xylene	ug/g	-	-	-	0.01	0.01	0.01	-	0.01	0.01	0.01
o-Xylene	ug/g	-	-	-	0.01	0.01	0.01	-	0.01	0.01	0.01
Xylenes (total)	ug/g	11 (coarse), 2.4 (fine)	0.02	0.02	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Polycyclic Aromatic Hydrocarbons											
Acenaphthene	ug/g	0.28(E)	-	-	0.01	0.01	0.01	-	0.01	0.01	0.01
Acenaphthylene	ug/g	320(E)	-	-	0.01	0.01	0.01	-	0.01	0.01	0.01
Anthracene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 2.5(E)	-	-	0.00	0.00	0.00	-	0.00	0.00	0.00
Benzo[a]anthracene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 0.1(E)	-	0.010	0.03	0.03	0.03	-	0.03	0.03	0.03
Benzo[a]pyrene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 20(E)	-	0.010	0.03	0.03	0.03	-	0.03	0.03	0.03
Benzo[b+j]fluoranthene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 0.1(E)	-	0.010	0.05	0.05	0.05	-	0.05	0.05	0.05
Benzo[ghi]perylene	ug/g	5.3 B[a]P TPE, IACR<1.0*	-	-	0.05	0.05	0.05	-	0.05	0.05	0.05
Benzo[k]fluoranthene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 0.1(E)	-	0.010	0.05	0.05	0.05	-	0.05	0.05	0.05
Chrysene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 6.2(E)	-	-	0.05	0.05	0.05	-	0.05	0.05	0.05
Dibenzo[a,h]anthracene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 0.1(E)	-	0.010	0.005	0.005	0.005		0.005	0.005	0.005
Fluoranthene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 50(E)	-	-	0.03	0.03	0.03	-	0.03	0.03	0.03
Fluorene	ug/g	0.25(E)	-	-	0.02	0.02	0.02	-	0.02	0.02	0.02
Indeno[1,2,3-cd]pyrene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 0.1(E)	-	0.010	0.05	0.05	0.05	-	0.05	0.05	0.05
2-Methylnaphthalene	ug/g	-	-		0.01	0.01	0.01	-	0.01	0.01	0.01
Naphthalene	ug/g	0.013(E)	-	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01
Phenanthrene	ug/g	0.046(E)	-	0.020	0.02	0.02	0.02	-	0.02	0.02	0.02
Pyrene	ug/g	5.3 B[a]P TPE, IACR<1.0* and 0.1(E)	-	0.010	0.03	0.03	0.03	-	0.03	0.03	0.03

Notes

"-" indicates that there is no applicable regulation or analyses were not performed.

Red cells indicates parameter exceeds CCME AL Coarse.

"(E)" are environmental health based guidelines based on non-carcinogenic effects of PAHs (CCME, January 2008)



LEGEND

- Site Boundary
- Treeline
- Trails
- Area of Debris
- Incinerator
- Monitoring Well
- Borehole
- Surface Soil Sample
- Drainage Ditch

One or more analytical parameters are greater than the applicable Soil Guidelines

All analytical parameters are less than the applicable Soil Guidelines

* Coloured stations represent most recent sampling date

**Black stations were not tested for parameters presented in current drawing

Scale 1:1,500

30 22.5 15 0 15 30

metres

Title: **ANALYTICAL RESULTS PHCs IN SOIL**

Project: **DETAILED SITE ASSESSMENT GARDEN RIVER OLD DUMP**

Client: **PARKS CANADA AGENCY**

FRANZ ENVIRONMENTAL INC. — CONSULTING ENGINEERING TECHNOLOGIES

COLUMBIA ENVIRONMENTAL

Date: **FEBRUARY 2011**

FIGURE 5-1

** Original in colour : Figures should be interpreted in combination with appropriate site report.*

2018-1001 ParksCanada - Garden RIver Old Dump/CAD/NR/Garden RIver.dwg

Station ID	Units	CCME AL Coarse	2018-10BH-3M		2018-10BH-4M		2018-10BH-5M		2018-10BH-6M		2018-10BH-7M	
Field label			2018-10BH-3M-1	2018-10BH-3M-7	2018-10BH-4M-1	2018-10BH-4M-8	2018-10BH-5M-1	2018-10BH-5M-7	2018-10BH-6M-1	2018-10BH-6M-8	2018-10BH-7M-1	2018-10BH-7M-7
Duplicate ID				2018-10BH-Dup3								
Date			19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10
Consultant			Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz
Lab report ID			10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661
Depth (m)			0 - 0.7	7.6 - 9.0	0 - 0.7	9.0 - 10.7	0 - 0.5	7.7 - 9.0	0 - 0.5	9.0 - 10.7	0 - 0.5	7.7 - 9.0
Petroleum Hydrocarbons												
F1 (C6-C10)	ug/g	-	10.00	10.00	10.00	10.00	10.00	10	10	10	10	10
F1 (C6-C10) minus BTEX	ug/g	30 (coarse), 170 (fine)	10.00	10.00	10.00	10.00	10.00	10	10	10	10	10
F2 (C10-C16)	ug/g	150	10.00	10.00	10.00	10.00	10.00	10	10	10	10	10
F3 (C16-C34)	ug/g	300 (coarse), 1300 (fine)	10.00	25.00	19.00	10.00	10.00	10	10	87	10	14
F4 (C34-C50)	ug/g	2800 (coarse), 5600 (fine)	10.00	10.00	10.00	10.00	10.00	10	10	24	10	10
Monocyclic Aromatic Hydrocarbons												
Benzene	ug/g	0.030 (coarse), 0.0068 (fine)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Ethylbenzene	ug/g	0.082 (coarse), 0.018 (fine)	0.010	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Styrene	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Toluene	ug/g	0.37 (coarse), 0.08 (fine)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
m+p-Xylene	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
o-Xylene	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Xylenes (total)	ug/g	11 (coarse), 2.4 (fine)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Polycyclic Aromatic Hydrocarbons												
Acenaphthene	ug/g	0.28(E)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Acenaphthylene	ug/g	320(E)	0.01	0.01	0.01	0.01	0.01	0	0	0	0	0
Anthracene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 2.5(E)	0.00	0.00	0.00	0.00	0.00	0.0040	0.0040	0.0040	0.0040	0.0040
Benzo[a]anthracene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 0.1(E)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Benzo[a]pyrene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 20(E)	0.03	0.03	0.03	0.03	0.03	0.0	0.0	0.0	0.0	0.0
Benzo[b+j]fluoranthene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 0.1(E)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.05
Benzo[ghi]perylene	ug/g	5.3 B[a]P TPE, IACR<1.0"	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Benzo[k]fluoranthene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 0.1(E)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Chrysene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 6.2(E)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Dibenzo[a,h]anthracene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 0.1(E)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.008	0.005	0.005
Fluoranthene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 50(E)	0.03	0.03	0.03	0.03	0.03	0.030	0.030	0.040	0.030	0.030
Fluorene	ug/g	0.25(E)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Indeno[1,2,3-cd]pyrene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 0.1(E)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
2-Methylnaphthalene	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.07	0.01	0.01
Naphthalene	ug/g	0.013(E)	0.01	0.01	0.01	0.01	0.01	0.005	0.007	0.029	0.005	0.005
Phenanthrene	ug/g	0.046(E)	0.02	0.02	0.02	0.02	0.02	0.020	0.020	0.050	0.020	0.020
Pyrene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 0.1(E)	0.03	0.03	0.03	0.03	0.03	0.030	0.030	0.030	0.030	0.030

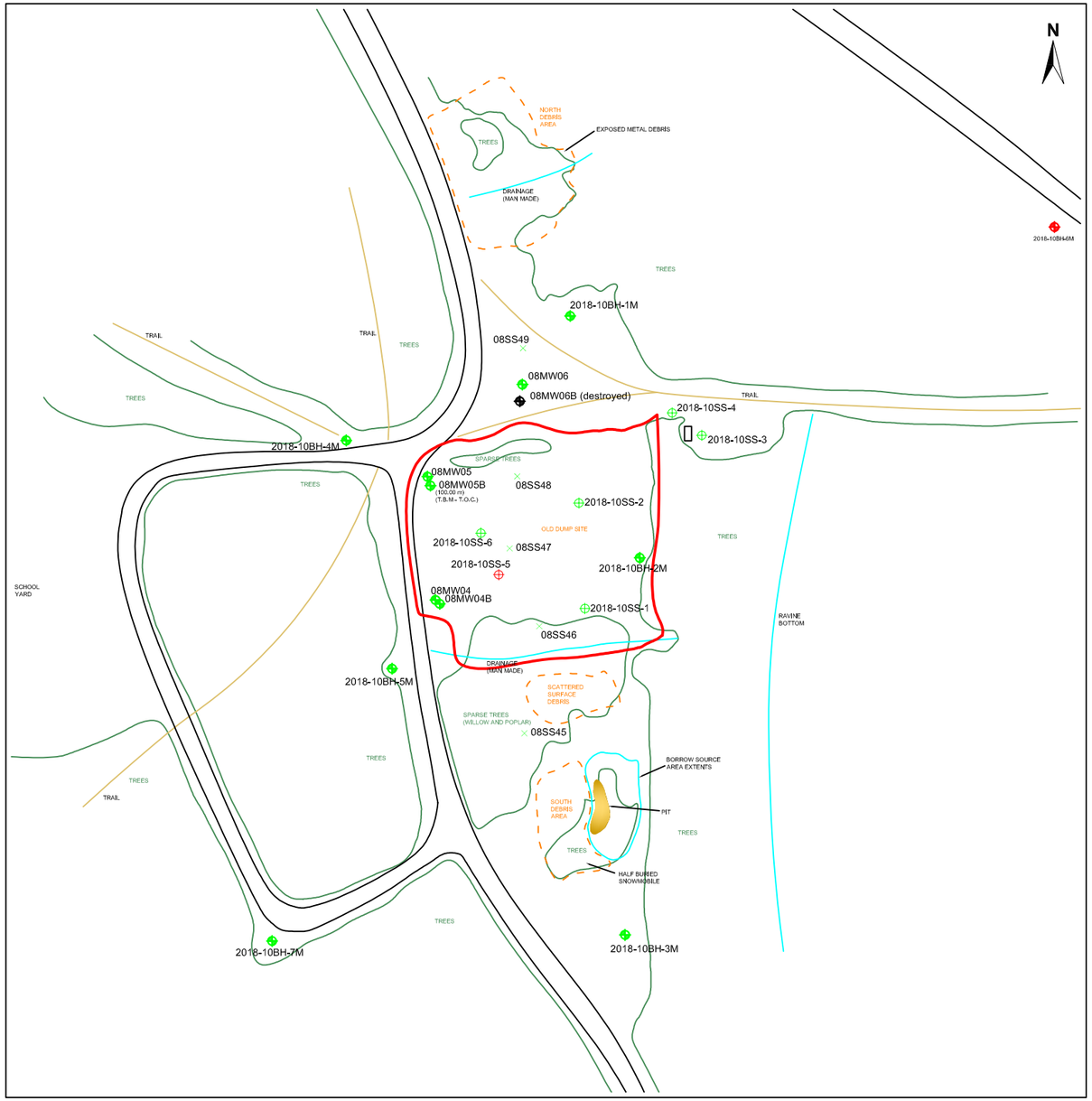
Station ID	Units	CCME AL Coarse	2018-10SS-1	2018-10SS-2	2018-10SS-3	2018-10SS-4	2018-10SS-5	2018-10SS-6
Field label			2018-10SS-1	2018-10SS-2	2018-10SS-3	2018-10SS-4	2018-10SS-5	2018-10SS-6
Duplicate ID								
Date			19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10
Consultant			Franz	Franz	Franz	Franz	Franz	Franz
Lab report ID			10E461661	10E461661	10E461661	10E461661	10E461661	10E461661
Depth (m)			0 - 0.75	0 - 0.75	0 - 0.75	0 - 0.75	0 - 0.9	0 - 0.8
Petroleum Hydrocarbons								
F1 (C6-C10)	ug/g	-	10	10	10	10	10	10
F1 (C6-C10) minus BTEX	ug/g	30 (coarse), 170 (fine)	10	10	10	10	10	10
F2 (C10-C16)	ug/g	150	10	11	10	10	16	10
F3 (C16-C34)	ug/g	300 (coarse), 1300 (fine)	14	18	10	59	83	404
F4 (C34-C50)	ug/g	2800 (coarse), 5600 (fine)	10	10	10	20	29	79
Monocyclic Aromatic Hydrocarbons								
Benzene	ug/g	0.030 (coarse), 0.0068 (fine)	0.005	0.005	0.005	0.005	0.005	0.005
Ethylbenzene	ug/g	0.082 (coarse), 0.018 (fine)	0.01	0.01	0.01	0.01	0.01	0.01
Styrene	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01
Toluene	ug/g	0.37 (coarse), 0.08 (fine)	0.05	0.05	0.05	0.05	0.05	0.05
m+p-Xylene	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01
o-Xylene	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01
Xylenes (total)	ug/g	11 (coarse), 2.4 (fine)	0.05	0.05	0.05	0.05	0.05	0.05
Polycyclic Aromatic Hydrocarbons								
Acenaphthene	ug/g	0.28(E)	0.01	0.01	0.01	0.01	0.01	0.01
Acenaphthylene	ug/g	320(E)	0	0	0	0	0	0
Anthracene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 2.5(E)	0.0040	0.0040	0.0040	0.0040	0.0280	0.0040
Benzo[a]anthracene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 0.1(E)	0.03	0.03	0.03	0.03	0.03	0.03
Benzo[a]pyrene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 20(E)	0.0	0.0	0.0	0.0	0.0	0.0
Benzo[b+j]fluoranthene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 0.1(E)	0.05	0.05	0.05	0.05	0.05	0.05
Benzo[ghi]perylene	ug/g	5.3 B[a]P TPE, IACR<1.0"	0.05	0.05	0.05	0.05	0.05	0.05
Benzo[k]fluoranthene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 0.1(E)	0.05	0.05	0.05	0.05	0.05	0.05
Chrysene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 6.2(E)	0.05	0.05	0.05	0.05	0.05	0.05
Dibenzo[a,h]anthracene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 0.1(E)	0.005	0.005	0.005	0.005	0.006	0.005
Fluoranthene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 50(E)	0.030	0.030	0.030	0.030	0.030	0.030
Fluorene	ug/g	0.25(E)	0.02	0.02	0.02	0.02	0.02	0.02
Indeno[1,2,3-cd]pyrene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 0.1(E)	0.05	0.05	0.05	0.05	0.05	0.05
2-Methylnaphthalene	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01
Naphthalene	ug/g	0.013(E)	0.005	0.005	0.005	0.008	0.024	0.011
Phenanthrene	ug/g	0.046(E)	0.020	0.020	0.020	0.020	0.090	0.020
Pyrene	ug/g	5.3 B[a]P TPE, IACR<1.0" and 0.1(E)	0.030	0.030	0.030	0.030	0.030	0.030

Notes

"-" indicates that there is no applicable regulation or analyses were not performed.

Red cells indicates parameter exceeds CCME AL Coarse.

"(E)" are environmental health based guidelines based on non-carcinogenic effects of PAHs (CCME, January 2008)



LEGEND

- Site Boundary
- Treeline
- Trails
- Area of Debris
- Incinerator
- Monitoring Well
- Borehole
- Surface Soil Sample
- Drainage Ditch

One or more analytical parameters are greater than the applicable Soil Guidelines

All analytical parameters are less than the applicable Soil Guidelines

* Coloured stations represent most recent sampling date

**Black stations were not tested for parameters presented in current drawing

Scale 1:1,500

30 22.5 15 0 15 30 metres

Title: **ANALYTICAL RESULTS PHCs IN SOIL**

Project: **DETAILED SITE ASSESSMENT GARDEN RIVER OLD DUMP**

Client: **PARKS CANADA AGENCY**

FRANZ ENVIRONMENTAL INC. — CONSULTING ENGINEERING TECHNOLOGIES

COLUMBIA ENVIRONMENTAL

Date: **FEBRUARY 2011**

FIGURE 5-2

** Original in colour : Figures should be interpreted in combination with appropriate site report.*

2018-1001 ParksCanada - Garden RIver Old Dump/CAD/NR/Garden RIver.dwg

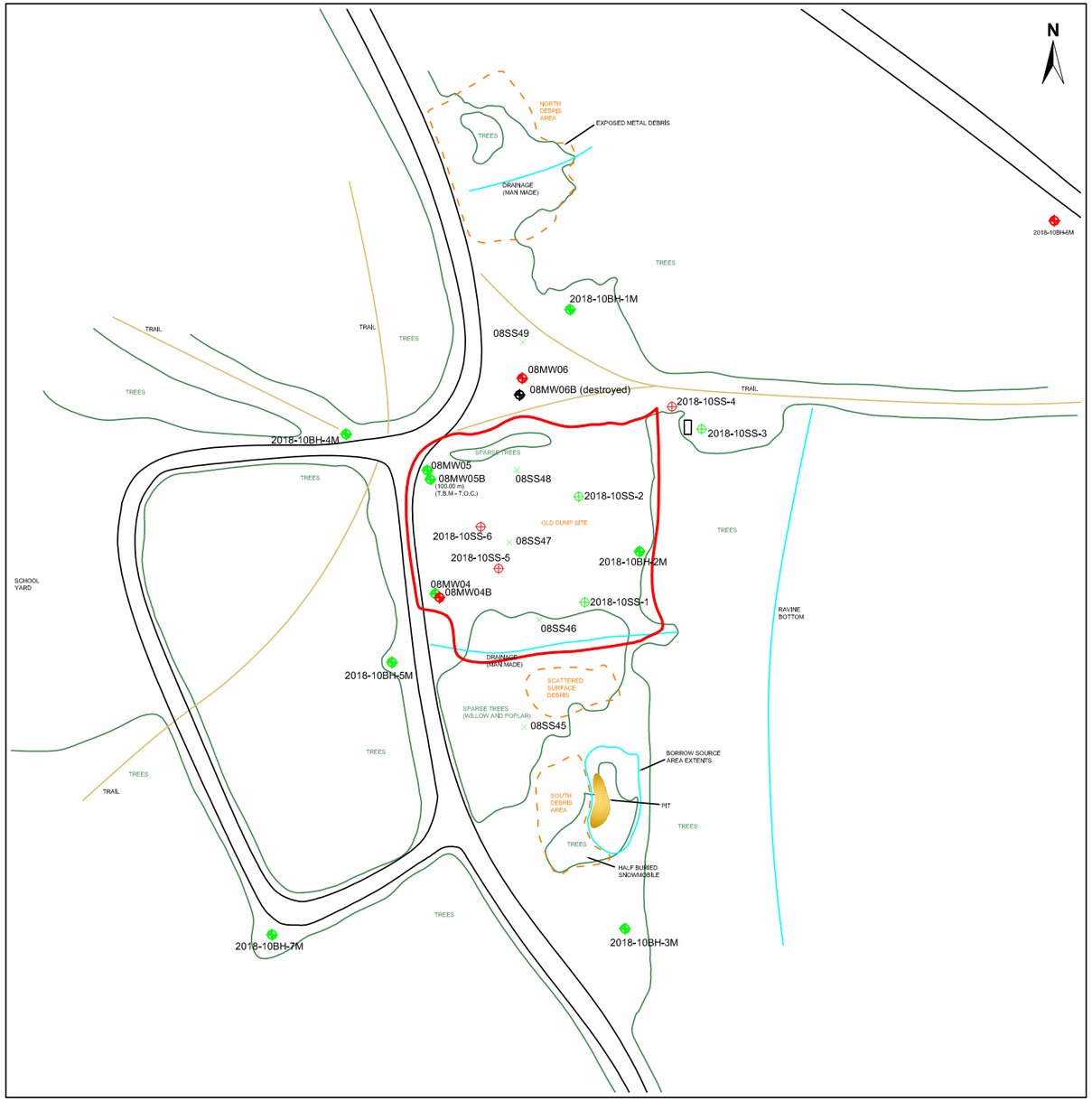
Station ID	Units	CCME AL Coarse	08MW04	08MW04B	08MW05	08MW05B	08MW06		08SS45	08SS46	08SS47	08SS48
Field label			08MW04	08MW04B	08MW05	08MW05B	08MW06	08MW06	08SS45	08SS46	08SS47	08SS48
Duplicate ID												
Date			19/Mar/08	20/Mar/08	31/Mar/08	20/Mar/08	19/Mar/08	19/Mar/08	28/Aug/08	28/Aug/08	28/Aug/08	28/Aug/08
Consultant			EBA	EBA	EBA	EBA	EBA	EBA	EBA	EBA	EBA	EBA
Lab report ID			L613338	L613338	L613338	L613338	L613338	L613338	676396-202	676396-203	676396-204	676396-205
Depth (m)			0.8	7.6	0.8	7.6	0.8	7.6	0-0.6	0-0.6	0-0.6	0-0.6
Conventional												
Moisture content	%	-	11	27	16	10	24	8.8	8.1	7.8	7.8	10
pH		6 to 8	7.12	7.82	7.43	7.89	7.73	8.05	-	-	-	7.30
Metals												
Antimony	ug/g	20	0.20	0.20	0.20	0.20	0.20	0.20	-	0.20	0.20	-
Arsenic	ug/g	12	10.30	7.90	10.40	1.57	9.32	2.71	-	5.8	10.3	-
Barium	ug/g	750	168.00	224.00	250.00	37.80	319.00	54.50	-	270.0	255	-
Boron (Hot water extraction)	ug/g	2	-	-	-	-	-	-	-	-	-	-
Beryllium	ug/g	4	1.00	1.00	1.00	1.00	1.00	1.00	-	1	1	-
Cadmium	ug/g	1.4	0.50	0.50	0.50	0.50	0.50	0.50	-	0.5	0.5	-
Chromium	ug/g	64	12.90	18.30	14.80	4.18	14.70	5.16	-	19.5	20.9	-
Chromium (VI)	ug/g	0.4	-	-	-	-	-	-	-	-	-	-
Cobalt	ug/g	40	7.90	10.80	8.60	1.90	7.90	2.70	-	8	8	-
Copper	ug/g	63	22.80	27.30	26.80	3.10	25.10	5.20	-	12	22	-
Lead	ug/g	70	9.00	10.30	10.70	5.00	9.60	5.00	10	10	11	-
Mercury	ug/g	6.6	0.061	0.056	0.084	0.050	0.068	0.050	-	0.05	0.05	-
Molybdenum	ug/g	5	1.00	1.00	1.00	1.00	1.00	1.00	-	1	1	-
Nickel	ug/g	50	30.20	33.30	29.90	4.80	25.70	7.90	-	16	24	-
Selenium	ug/g	1	0.50	1.58	0.50	0.50	0.50	0.50	-	0.40	0.60	-
Silver	ug/g	20	0.20	0.20	0.23	0.20	0.22	0.20	-	1.0	1.00	-
Thallium	ug/g	1	0.50	0.50	0.50	0.50	0.50	0.50	-	1.0	1.00	-
Tin	ug/g	5	5.00	5.00	5.00	5.00	5.00	5.00	-	5.0	5.0	-
Uranium	ug/g	23	2.00	2.00	2.00	2.00	2.00	2.00	-	2.0	2.0	-
Vanadium	ug/g	130	24.80	28.50	27.50	6.00	27.20	9.20	-	36	40	-
Zinc	ug/g	200	81.10	89.90	83.20	13.30	78.20	22.10	-	90	90	-

Station ID	Units	CCME AL Coarse	08SS49	2018-10BH-1M		2018-10BH-2M		2018-10BH-3M		2018-10BH-4M	
Field label			08SS49	2018-10BH-1M-2	2018-10BH-1M-7	2018-10BH-2M-2	2018-10BH-2M-7	2018-10BH-3M-1	2018-10BH-3M-7	2018-10BH-4M-1	2018-10BH-4M-8
Duplicate ID				2018-10BH-Dup1		2018-10BH-Dup2			2018-10BH-Dup3		
Date			28/Aug/08	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10
Consultant			EBA	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz
Lab report ID			676396-206	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661
Depth (m)			0-0.6	0.8 - 1.5	7.6 - 9.0	0.5 - 1.6	6.1 - 7.7	0 - 0.7	7.6 - 9.0	0 - 0.7	9.0 - 10.7
Conventional											
Moisture content	%	-	11	8.50	18.00	13.00	15.00	28.00	15.00	22.00	17.00
pH		6 to 8	-	7.40	7.60	7.30	7.40	7.00	7.30	7.40	7.50
Metals											
Antimony	ug/g	20	-	0.60	0.50	0.80	0.50	0.70	0.50	0.70	0.50
Arsenic	ug/g	12	-	7.30	2.90	8.40	3.20	8.30	2.30	8.40	1.70
Barium	ug/g	750	-	221.00	49.40	259.00	55.10	212.00	51.00	273.00	42.50
Boron (Hot water extraction)	ug/g	2	-	<0.5	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Beryllium	ug/g	4	-	0.50	0.50	0.60	0.50	0.50	0.50	0.60	0.50
Cadmium	ug/g	1.4	-	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Chromium	ug/g	64	-	14.10	5.10	19.10	5.00	14.80	6.30	17.00	3.40
Chromium (VI)	ug/g	0.4	-	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Cobalt	ug/g	40	-	5.90	2.50	7.80	2.80	7.10	2.80	7.30	1.70
Copper	ug/g	63	-	15.90	4.40	23.70	4.50	19.90	5.30	21.30	2.60
Lead	ug/g	70	10	7.10	2.00	9.30	2.20	8.10	2.20	9.10	1.50
Mercury	ug/g	6.6	-	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Molybdenum	ug/g	5	-	1.30	0.50	1.40	0.60	1.20	0.50	1.30	0.50
Nickel	ug/g	50	-	19.30	7.70	25.00	7.30	24.40	7.50	23.80	5.20
Selenium	ug/g	1	-	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Silver	ug/g	20	-	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Thallium	ug/g	1	-	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Tin	ug/g	5	-	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Uranium	ug/g	23	-	1.0	0.5	0.9	0.50	0.8	0.50	0.9	0.50
Vanadium	ug/g	130	-	26.40	9.40	33.50	8.30	28.00	8.40	29.80	5.40
Zinc	ug/g	200	-	77.00	21.00	91.00	22.00	82.00	22.00	86.00	12.00

Notes

"-" indicates that there is no applicable regulation or analyses were not performed.

Red cells indicates parameter exceeds CCME AL Coarse.



LEGEND

- Site Boundary
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Scale 1:1,500

30 22.5 15 0 15 30 metres

Title: **ANALYTICAL RESULTS METALS IN SOIL**

Project: **DETAILED SITE ASSESSMENT GARDEN RIVER OLD DUMP**

Client: **PARKS CANADA AGENCY**

FRANZ ENVIRONMENTAL INC. CONSULTING ENGINEERING TECHNOLOGIES

COLUMBIA ENVIRONMENTAL

Date: **FEBRUARY 2011**

FIGURE 6-1

** Original in colour : Figures should be interpreted in combination with appropriate site report.*

2018-1001 ParksCanada - Garden RIver Old Dump/CAD/NR/Garden RIver.dwg

Station ID	Units	CCME AL Coarse	2018-10BH-5M		2018-10BH-6M		2018-10BH-7M		2018-10SS-1	2018-10SS-2	2018-10SS-3
Field label			2018-10BH-5M-1	2018-10BH-5M-7	2018-10BH-6M-1	2018-10BH-6M-8	2018-10BH-7M-1	2018-10BH-7M-7	2018-10SS-1	2018-10SS-2	2018-10SS-3
Duplicate ID											
Date			19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10
Consultant			Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz
Lab report ID			´0E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661
Depth (m)			0 - 0.5	7.7 - 9.0	0 - 0.5	9.0 - 10.7	0 - 0.5	7.7 - 9.0	0 - 0.75	0 - 0.75	0 - 0.75
Conventional											
Moisture content	%	-	6.30	10	23	18	14	18	11	12	14
pH		6 to 8	7.30	7.20	7.10	7.50	7.40	7.30	7.40	7.30	7.10
Metals											
Antimony	ug/g	20	0.80	1	1	1	1	1	1	1	1
Arsenic	ug/g	12	9.40	2	10	13	6	3	8	8	11
Barium	ug/g	750	165.00	79	272	56	228	79	241	222	204
Boron (Hot water extraction)	ug/g	2	0.50	0.50	0.60	0.50	0.50	0.50	0.90	0.50	0.50
Beryllium	ug/g	4	0.50	1	1	1	1	1	1	1	1
Cadmium	ug/g	1.4	0.50	1	1	1	1	1	1	1	1
Chromium	ug/g	64	17.10	4	22	7	12	7	18	29	27
Chromium (VI)	ug/g	0.4	0.30	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Cobalt	ug/g	40	7.90	2	11	6	6	4	8	7	10
Copper	ug/g	63	23.40	3	25	7	12	6	26	22	20
Lead	ug/g	70	9.40	2	12	5	6	3	14	15	12
Mercury	ug/g	6.6	0.50	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Molybdenum	ug/g	5	1.30	1	2	1	1	1	1	1	1
Nickel	ug/g	50	28.10	6	31	15	18	11	25	24	28
Selenium	ug/g	1	0.50	0.5	0.8	0.5	0.5	0.5	0.60	0.50	0.70
Silver	ug/g	20	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Thallium	ug/g	1	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Tin	ug/g	5	0.50	0.50	0.50	0.50	0.50	0.50	2.20	2.50	0.50
Uranium	ug/g	23	0.9	0.5	0.9	0.6	0.8	0.5	0.9	0.9	1.1
Vanadium	ug/g	130	30.70	7	35	13	23	12	29	29	43
Zinc	ug/g	200	86.00	17	94	47	60	31	102	99	88

Station ID	Units	CCME AL Coarse	2018-10SS-4	2018-10SS-5	2018-10SS-6
Field label			2018-10SS-4	2018-10SS-5	2018-10SS-6
Duplicate ID					
Date			19/Dec/10	19/Dec/10	19/Dec/10
Consultant			Franz	Franz	Franz
Lab report ID			´0E461661	10E461661	10E461661
Depth (m)			0 - 0.75	0 - 0.9	0 - 0.8
Conventional					
Moisture content	%	-	15	19	19
pH		6 to 8	7.20	7.30	7.40
Metals					
Antimony	ug/g	20	2	2	19
Arsenic	ug/g	12	16	10	9
Barium	ug/g	750	259	343	154
Boron (Hot water extraction)	ug/g	2	3.20	4.30	3.70
Beryllium	ug/g	4	1	1	1
Cadmium	ug/g	1.4	1	1	5
Chromium	ug/g	64	23	25	47
Chromium (VI)	ug/g	0.4	0.3	0.3	0.3
Cobalt	ug/g	40	8	10	6
Copper	ug/g	63	48	38	409
Lead	ug/g	70	14	18	95
Mercury	ug/g	6.6	0.5	0.5	0.5
Molybdenum	ug/g	5	1	2	3
Nickel	ug/g	50	23	32	29
Selenium	ug/g	1	0.80	0.50	0.5
Silver	ug/g	20	0.50	0.50	0.50
Thallium	ug/g	1	0.50	0.50	0.50
Tin	ug/g	5	0.9	2.2	140
Uranium	ug/g	23	1.0	1.0	0.7
Vanadium	ug/g	130	32	40	24
Zinc	ug/g	200	190	152	3950

Notes

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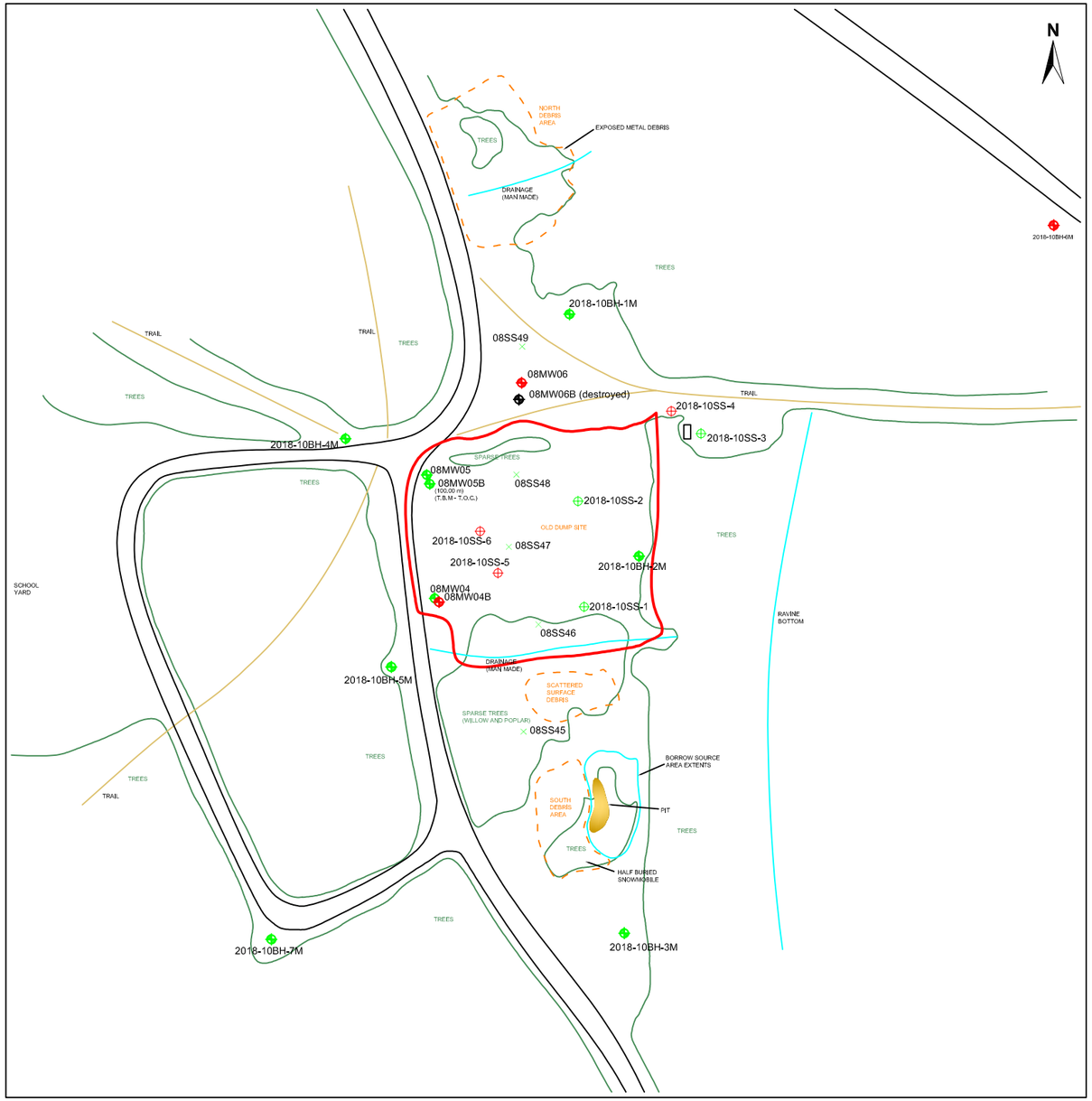
Red cells indicates parameter exceeds CCME AL Coarse.



LEGEND

- Site Boundary
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30 22.5 15 0 15 30 metres

Title: **ANALYTICAL RESULTS METALS IN SOIL**

Project: **DETAILED SITE ASSESSMENT GARDEN RIVER OLD DUMP**

Client: **PARKS CANADA AGENCY**

FRANZ ENVIRONMENTAL INC. — CONSULTING ENGINEERING TECHNOLOGIES — COLUMBIA ENVIRONMENTAL

Date: **FEBRUARY 2011**

FIGURE 6-2

** Original in colour : Figures should be interpreted in combination with appropriate site report.*

2018-1001 ParksCanada - Garden River Old Dump/CAD/NR/Garden River.dwg

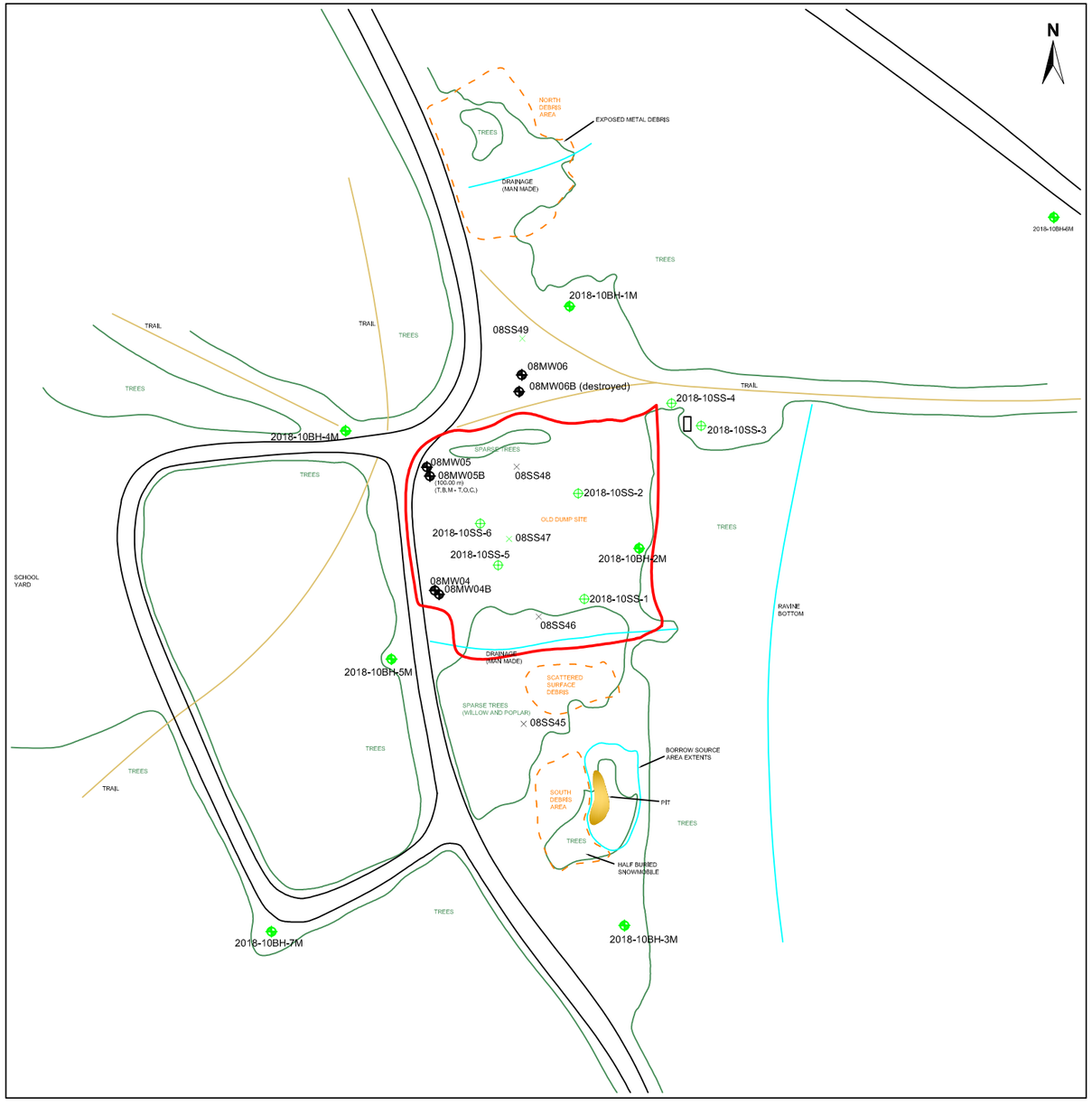
Station ID	Units	CCME AL Coarse	08SS47	08SS49	2018-10BH-1M			2018-10BH-2M			2018-10BH-3M		2018-10BH-4M	
Field label			08SS47	08SS49	2018-10BH-1M-2	2018-10BH-1M-6	2018-10BH-1M-7	2018-10BH-2M-2	2018-10BH-2M-7	2018-10BH-2M-8	2018-10BH-3M-1	2018-10BH-3M-7	2018-10BH-4M-1	2018-10BH-4M-8
Duplicate ID					2018-10BH-Dup1			2018-10BH-Dup2				2018-10BH-Dup3		
Date			28/Aug/08	28/Aug/08	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10
Consultant			EBA	EBA	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz
Lab report ID			676396-204	676396-206	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661
Depth (m)			0-0.6	0-0.6	0.8 - 1.5	6.1 - 7.6	7.6 - 9.0	0.5 - 1.8	6.1 - 7.7	7.7 - 9.0	0 - 0.7	7.6 - 9.0	0 - 0.7	9.0 - 10.7
Volatile Organic Compounds														
Acetone	ug/g	-	-	-	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Bromodichloromethane	ug/g	-	-	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Bromoform	ug/g	-	-	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Bromomethane	ug/g	-	-	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Carbon tetrachloride	ug/g	0.1	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chlorobenzene	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Chlorodibromomethane	ug/g	-	-	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Chloroethane	ug/g	-	-	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Chloroform	ug/g	0.1	0.01	0.01	0.001	0.001	0.002	0.001	0.001	0.001	0.009	0.001	0.001	0.002
Chloromethane	ug/g	-	-	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,2-Dichlorobenzene	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,3-Dichlorobenzene	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,4-Dichlorobenzene	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,1-Dichloroethane	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,2-Dichloroethane	ug/g	0.1	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,1-Dichloroethene	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
cis-1,2-Dichloroethene	ug/g	-	-	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
trans-1,2-Dichloroethene	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Dichloromethane	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,2-Dichloropropane	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
cis-1,3-Dichloropropene	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
trans-1,3-Dichloropropene	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Ethylene dibromide	ug/g	-	-	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
2-Hexanone	ug/g	-	-	-	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methyl ethyl ketone	ug/g	-	-	-	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methyl isobutyl ketone	ug/g	-	-	-	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methyl tert-butyl ether	ug/g	-	-	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,1,1,2-Tetrachloroethane	ug/g	-	-	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,1,2,2-Tetrachloroethane	ug/g	0.1	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Tetrachloroethene	ug/g	0.1	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,2,4-Trichlorobenzene	ug/g	0.05	-	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,1,1-Trichloroethane	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,1,2-Trichloroethane	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Trichloroethene	ug/g	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Trichlorofluoromethane	ug/g	-	-	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Vinyl chloride	ug/g	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Station ID	Units	CCME AL Coarse	2018-10BH-5M		2018-10BH-6M		2018-10BH-7M		2018-10SS-1	2018-10SS-2	2018-10SS-3	2018-10SS-4	2018-10SS-5	2018-10SS-6
Field label			2018-10BH-5M-1	2018-10BH-5M-7	2018-10BH-6M-1	2018-10BH-6M-8	2018-10BH-7M-1	2018-10BH-7M-7	2018-10SS-1	2018-10SS-2	2018-10SS-3	2018-10SS-4	2018-10SS-5	2018-10SS-6
Duplicate ID														
Date			19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10
Consultant			Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz
Lab report ID			10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661
Depth (m)			0 - 0.5	7.7 - 9.0	0 - 0.5	9.0 - 10.7	0 - 0.5	7.7 - 9.0	0 - 0.75	0 - 0.75	0 - 0.75	0 - 0.75	0 - 0.9	0 - 0.8
Volatile Organic Compounds														
Acetone	ug/g	-	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Bromodichloromethane	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Bromoform	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Bromomethane	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Carbon tetrachloride	ug/g	0.1	0.00	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050
Chlorobenzene	ug/g	0.1	0.01	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Chlorodibromomethane	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Chloroethane	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Chloroform	ug/g	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.001	0.040
Chloromethane	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,2-Dichlorobenzene	ug/g	0.1	0.01	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
1,3-Dichlorobenzene	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,4-Dichlorobenzene	ug/g	0.1	0.01	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
1,1-Dichloroethane	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,2-Dichloroethane	ug/g	0.1	0.00	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
1,1-Dichloroethene	ug/g	0.1	0.01	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
cis-1,2-Dichloroethene	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
trans-1,2-Dichloroethene	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Dichloromethane	ug/g	0.1	0.01	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
1,2-Dichloropropane	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
cis-1,3-Dichloropropene	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
trans-1,3-Dichloropropene	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Ethylene dibromide	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
2-Hexanone	ug/g	-	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methyl ethyl ketone	ug/g	-	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methyl isobutyl ketone	ug/g	-	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methyl tert-butyl ether	ug/g	-	0.01	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
1,1,1,2-Tetrachloroethane	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,1,2,2-Tetrachloroethane	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Tetrachloroethene	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,2,4-Trichlorobenzene	ug/g	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,1,1-Trichloroethane	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1,1,2-Trichloroethane	ug/g	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Trichloroethene	ug/g	0.01	0.01	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Trichlorofluoromethane	ug/g	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Vinyl chloride	ug/g	-	0.00	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020

Notes

"-" indicates that there is no applicable regulation or analyses were not performed.

Red cells indicates parameter exceeds CCME AL Coarse.



LEGEND

- Site Boundary
- Treeline
- Trails
- Area of Debris
- Incinerator
- Monitoring Well
- Borehole
- Surface Soil Sample
- Drainage Ditch

One or more analytical parameters are greater than the applicable Soil Guidelines

All analytical parameters are less than the applicable Soil Guidelines

* Coloured stations represent most recent sampling date

**Black stations were not tested for parameters presented in current drawing

Scale 1:1,500

30 22.5 15 0 15 30 metres

Title: **ANALYTICAL RESULTS VOCs IN SOIL**

Project: **DETAILED SITE ASSESSMENT GARDEN RIVER OLD DUMP**

Client: **PARKS CANADA AGENCY**

FRANZ ENVIRONMENTAL INC. CONSULTING ENGINEERING TECHNOLOGIES — COLUMBIA ENVIRONMENTAL

Date: **FEBRUARY 2011**

FIGURE 7

** Original in colour : Figures should be interpreted in combination with appropriate site report.*

2018-1001 ParksCanada - Garden River Old Dump/CAD/NR/Garden River.dwg

Station ID	Units	CCME AL Coarse	08MW04	08MW04B	08MW05	08MW05B	08MW06		08SS45	08SS48	2018-10BH-1M	
Field label			08MW04	08MW04B	08MW05	08MW05B	08MW06	08MW06	08SS45	08SS48	2018-10BH-1M-2	2018-10BH-1M-7
Duplicate ID											2018-10BH-Dup1	
Date			19/Mar/08	20/Mar/08	31/Mar/08	20/Mar/08	19/Mar/08	19/Mar/08	28/Aug/08	28/Aug/08	19/Dec/10	19/Dec/10
Consultant			EBA	EBA	EBA	EBA	EBA	EBA	EBA	EBA	Franz	Franz
Lab report ID			L613338	L613338	L613338	L613338	L613338	L613338	676396-202	676396-205	10E461661	10E461661
Depth (m)			0.8	7.6	0.8	7.6	0.8	7.6	0-0.6	0-0.6	0.8 - 1.5	7.6 - 9.0
Conventional												
Moisture content	%	-	11	27	16	10	24	8.8	8.1	10	8.50	18.00
Sieve Analysis[1] - 75 microns (wet)	%	-	-	-	-	98.0	-	-	12.00	-		95.8
Sieve Texture		-	-	-	-	Coarse	-	-	Fine	-		Coarse
Soil Salinity												
pH		6 to 8	7.12	7.82	7.43	7.89	7.73	8.05	-	7.30	7.40	7.60
Sodium Adsorption Ratio (SAR)	SAR	5	0.42	0.60	0.31	0.47	0.33	0.49	-	0.30	0.55	0.38
Elec. Cond.	dS/m	2	0.19	0.27	0.39	0.23	0.25	0.28	-	0.33	0.50	0.28
Saturation %	%	-	40.70	60.00	50.00	29.30	56.00	27.30	-	44.30	40.00	30.00
Chloride , Soluble	mg/L	-	<20.0	<10.0	<20.0	<20.0	<20.0	<20.0	-	20.00	77.00	9.00
Calcium, Soluble	mg/L	-	24	24.9	63	26.4	37.7	33.6	-	66.00	39.00	33.00
Potassium, Soluble	mg/L	-	3.7	5.6	3.9	4.1	<2.00	5.6	-	2.00	3.00	4.00
Magnesium, Soluble	mg/L	-	6.0	10.8	9.4	6.6	7.9	8.7	-	16.00	20.00	6.00
Sodium, Soluble	mg/L	-	8.9	14.2	10.0	10.4	8.6	12.3	-	10.00	17.00	9.00
Sulfate (S04-S), Soluble	mg/L	-	7	33	36	29.0	7	37.0	-	15.00	14.00	36.00
Calcium, Soluble	ug/g	-	10	15	32	8	21	9	-	29.00	16.00	10.00
Chloride , Soluble (calc.)	ug/g	-	8.0	10.0	10.0	6.0	10.0	5.0	-	9.00	31.00	3.00
Magnesium, Soluble (calc.)	ug/g	-	2.0	6.0	5.0	1.9	4	2	-	7.00	8.00	2.00
Potassium, Soluble (calc.)	ug/g	-	1.5	3.0	2.0	1.2	1.0	1.5	-	0.90	2.00	2.00
Sodium, Soluble (calc.)	ug/g	-	3.6	9.0	5.0	3.0	5.0	3	-	4.50	7.00	3.00
Sulfate (S04-S), Soluble (calc.)	ug/g	-	3	20	18	9	4	10	-	7.00	6.00	11.00
Glycols												
Diethylene glycol	ug/g	-	-	-	-	-	-	-	-	-	10.00	10.00
Ethylene glycol	ug/g	960	-	-	-	-	-	-	-	-	10.00	10.00
Propylene glycol	ug/g	-	-	-	-	-	-	-	-	-	10.00	10.00
Tetraethylene glycol	ug/g	-	-	-	-	-	-	-	-	-	10.00	10.00
Triethylene glycol	ug/g	-	-	-	-	-	-	-	-	-	10.00	10.00

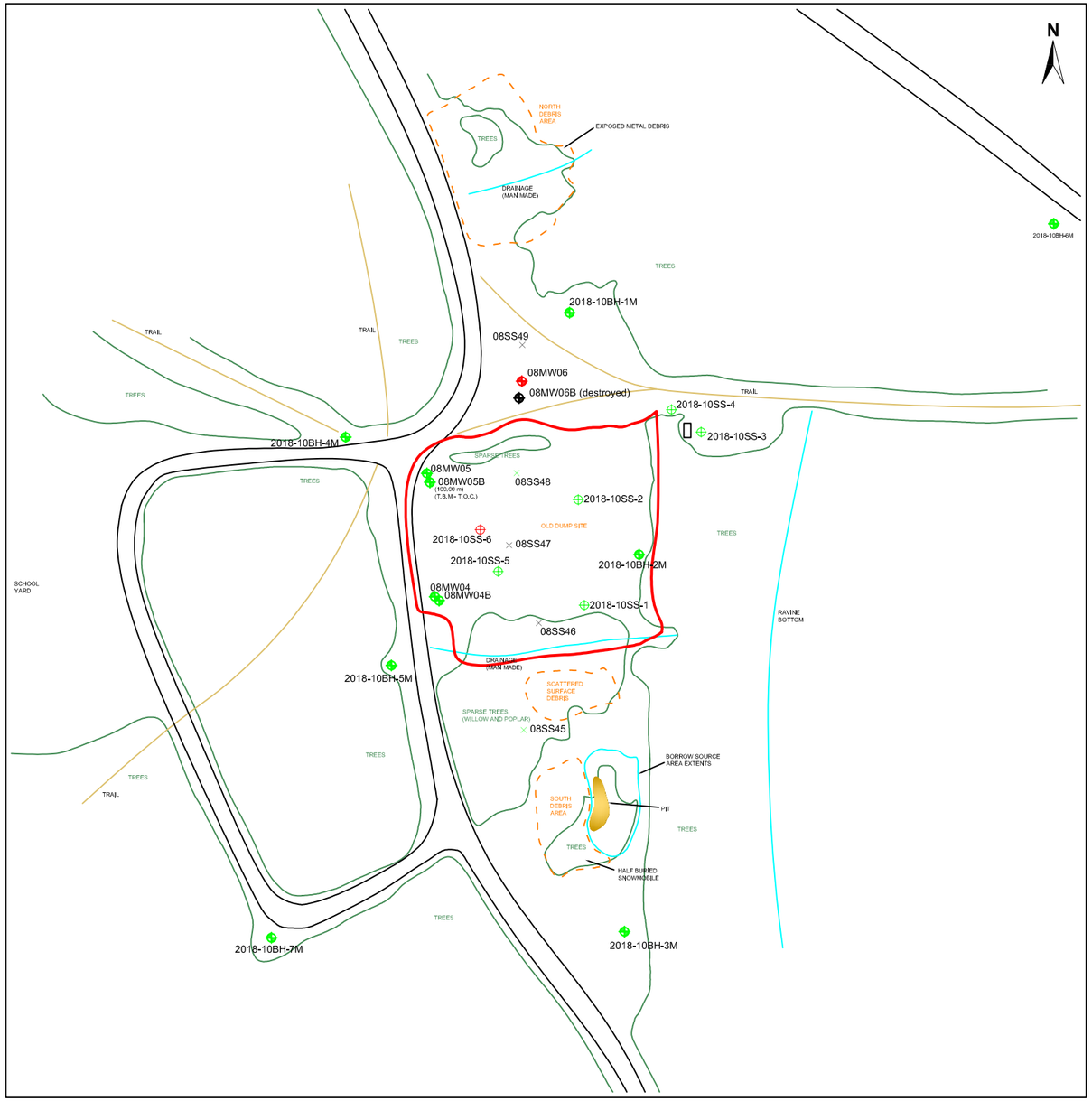
Station ID	Units	CCME AL Coarse	2018-10BH-2M			2018-10BH-3M			2018-10BH-4M		2018-10BH-5M		
Field label			2018-10BH-2M-2	2018-10BH-2M-7	2018-10BH-2M-8	2018-10BH-3M-1	2018-10BH-3M-7	2018-10BH-3M-8	2018-10BH-4M-1	2018-10BH-4M-8	2018-10BH-5M-1	2018-10BH-5M-7	2018-10BH-5M-8
Duplicate ID			2018-10BH-Dup2				2018-10BH-Dup3						
Date			19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10
Consultant			Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz
Lab report ID			10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661
Depth (m)			0.5 - 1.6	6.1 - 7.7	7.7 - 9.0	0 - 0.7	7.6 - 9.0	9.0 - 10.7	0 - 0.7	9.0 - 10.7	0 - 0.5	7.7 - 9.0	9.0 - 10.7
Conventional													
Moisture content	%	-	13.00	15.00	18.00	28.00	15.00		22.00	17.00	6.30	10	
Sieve Analysis[1] - 75 microns (wet)	%	-			98.3			99.0		98.9			98.0
Sieve Texture		-			Coarse			Coarse		Coarse			Coarse
Soil Salinity													
pH		6 to 8	7.30	7.40	-	7.00	7.30	-	7.40	7.50	7.30	7.20	-
Sodium Adsorption Ratio (SAR)	SAR	5	0.16	0.28	-	0.19	0.26	-	0.32	0.34	0.15	0.22	-
Elec. Cond.	dS/m	2	0.27	0.23	-	0.28	0.26	-	0.33	0.28	0.43	0.25	-
Saturation %	%	-	49.00	32.00	-	43.00	31.00	-	48.00	29.00	45.00	27.00	-
Chloride , Soluble	mg/L	-	6.00	6.00	-	9.00	8.00	-	7.00	9.00	7.00	6.00	-
Calcium, Soluble	mg/L	-	35.00	25.00	-	37.00	26.00	-	33.00	31.00	63.00	27.00	-
Potassium, Soluble	mg/L	-	2.00	3.00	-	3.00	3.00	-	3.00	4.00	8.00	4.00	-
Magnesium, Soluble	mg/L	-	8.00	6.00	-	8.00	8.00	-	16.00	7.00	11.00	7.00	-
Sodium, Soluble	mg/L	-	4.00	6.00	-	5.00	6.00	-	9.00	8.00	5.00	5.00	-
Sulfate (S04-S), Soluble	mg/L	-	12.00	15.00	-	8.00	18.00	-	12.00	35.00	15.00	20.00	-
Calcium, Soluble	ug/g	-	17.00	8.00	-	16.00	8.00	-	16.00	9.00	28.00	7.00	-
Chloride , Soluble (calc.)	ug/g	-	3.00	2.00	-	4.00	2.00	-	3.00	3.00	3.00	2.00	-
Magnesium, Soluble (calc.)	ug/g	-	4.00	2.00	-	3.00	2.00	-	8.00	2.00	5.00	2.00	-
Potassium, Soluble (calc.)	ug/g	-	2.00	2.00	-	2.00	2.00	-	2.00	2.00	4.00	2.00	-
Sodium, Soluble (calc.)	ug/g	-	2.00	2.00	-	2.00	2.00	-	4.00	2.00	2.00	2.00	-
Sulfate (S04-S), Soluble (calc.)	ug/g	-	6.00	5.00	-	3.00	6.00	-	6.00	10.00	7.00	5.00	-
Glycols													
Diethylene glycol	ug/g	-	10.00	10.00	-	10.00	10.00	-	10.00	10.00	10.00	10	-
Ethylene glycol	ug/g	960	10.00	10.00	-	10.00	10.00	-	10.00	10.00	10.00	10	-
Propylene glycol	ug/g	-	10.00	10.00	-	10.00	10.00	-	10.00	10.00	10.00	10	-
Tetraethylene glycol	ug/g	-	10.00	10.00	-	10.00	10.00	-	10.00	10.00	10.00	10	-
Triethylene glycol	ug/g	-	10.00	10.00	-	10.00	10.00	-	10.00	10.00	10.00	10	-

Notes

1 Value reported is amount of sample retained on sieve after wash with water and represents proportion by weight particles larger than indicated sieve size.

"-" indicates that there is no applicable regulation or analyses were not performed.

Red cells indicates parameter exceeds CCME AL Coarse.



LEGEND

- Site Boundary
- Treeline
- Trails
- Area of Debris
- Incinerator
- Monitoring Well
- Borehole
- Surface Soil Sample
- Drainage Ditch

One or more analytical parameters are greater than the applicable Soil Guidelines

All analytical parameters are less than the applicable Soil Guidelines

* Coloured stations represent most recent sampling date

**Black stations were not tested for parameters presented in current drawing

Scale 1:1,500

30 22.5 15 0 15 30 metres

Title: **ANALYTICAL RESULTS GLYCOLS, OTHER IN SOIL**

Project: **DETAILED SITE ASSESSMENT GARDEN RIVER OLD DUMP**

Client: **PARKS CANADA AGENCY**

FRANZ ENVIRONMENTAL INC. CONSULTING ENGINEERING TECHNOLOGIES — COLUMBIA ENVIRONMENTAL

Date: **FEBRUARY 2011**

FIGURE 8-1

** Original in colour : Figures should be interpreted in combination with appropriate site report.*

2018-1001 ParksCanada - Garden River Old Dump/CAD/NR/Garden River.dwg

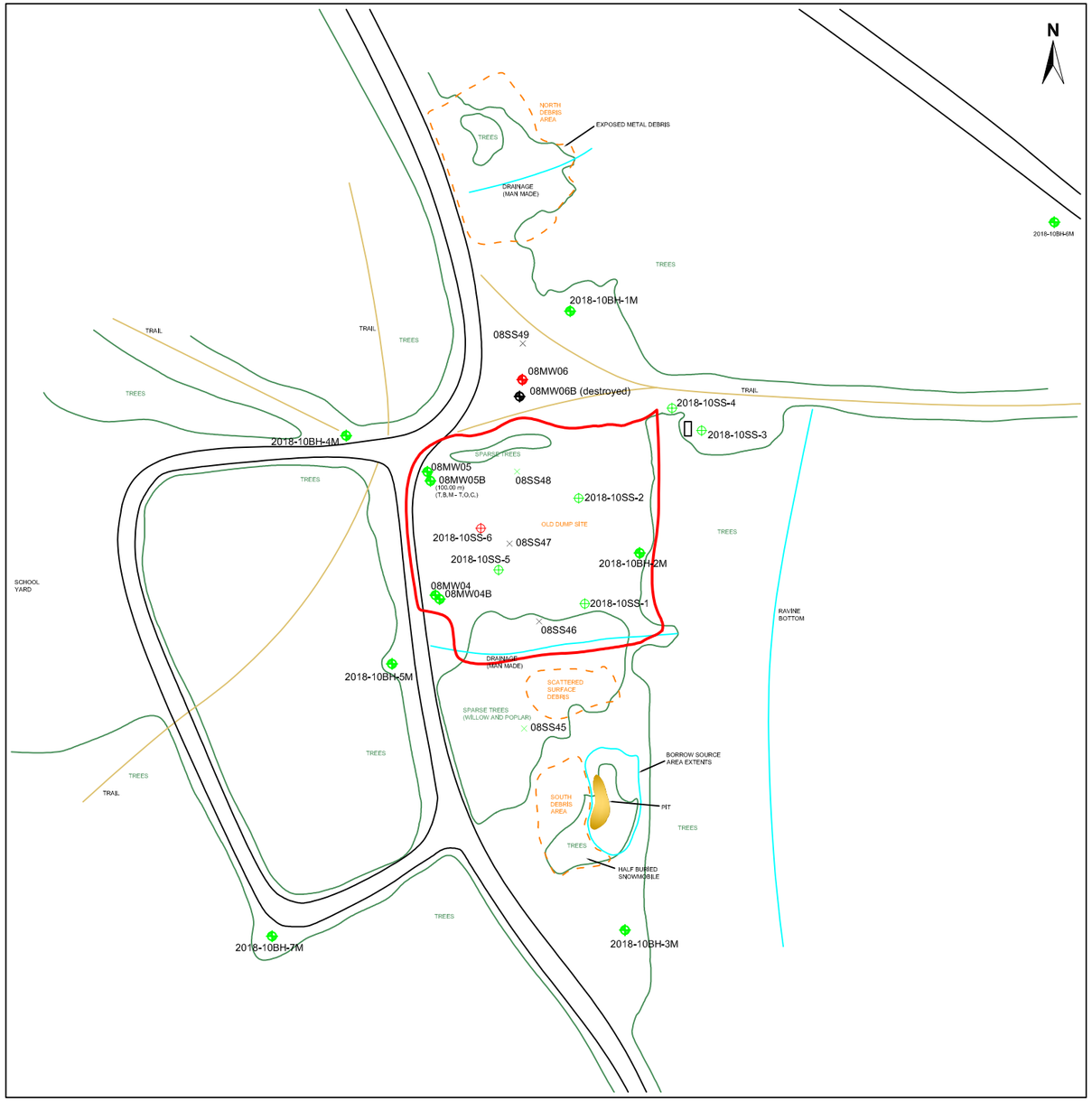
Station ID	Units	CCME AL Coarse	2018-10BH-6M		2018-10BH-7M			2018-10SS-1	2018-10SS-2	2018-10SS-3	2018-10SS-4	2018-10SS-5	2018-10SS-6
Field label			2018-10BH-6M-1	2018-10BH-6M-8	2018-10BH-7M-1	2018-10BH-7M-7	2018-10BH-7M-8	2018-10SS-1	2018-10SS-2	2018-10SS-3	2018-10SS-4	2018-10SS-5	2018-10SS-6
Duplicate ID													
Date			19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10	19/Dec/10
Consultant			Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz	Franz
Lab report ID			10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661
Depth (m)			0 - 0.5	9.0 - 10.7	0 - 0.5	7.7 - 9.0	9.0 - 10.7	0 - 0.75	0 - 0.75	0 - 0.75	0 - 0.75	0 - 0.9	0 - 0.8
Conventional													
Moisture content	%	-	23	18	14	18		11	12	14	15	19	19
Sieve Analysis[1] - 75 microns (wet)	%	-		84.9			98.2	20.9	13.4				29.5
Sieve Texture		-		Coarse			Coarse	Fine	Fine				Fine
Soil Salinity													
pH		6 to 8	7.10	7.50	7.40	7.30	-	7.40	7.30	7.10	7.20	7.30	7.40
Sodium Adsorption Ratio (SAR)	SAR	5	0.18	0.17	0.22	0.20	-	0.58	0.75	1.06	0.42	2.08	5.60
Elec. Cond.	dS/m	2	0.39	0.50	0.34	0.28	-	1.99	0.82	0.16	0.48	0.48	2.16
Saturation %	%	-	64.00	31.00	37.00	29.00	-	46.00	45.00	51.00	70.00	54.00	52.00
Chloride , Soluble	mg/L	-	7.00	25.00	8.00	9.00	-	231.00	60.00	7.00	29.00	49.00	1000.00
Calcium, Soluble	mg/L	-	60.00	72.00	47.00	32.00	-	295.00	94.00	140.00	66.00	366.00	641.00
Potassium, Soluble	mg/L	-	5.00	4.00	6.00	4.00	-	14.00	4.00	6.00	18.00	53.00	74.00
Magnesium, Soluble	mg/L	-	12.00	11.00	6.00	10.00	-	63.00	22.00	26.00	12.00	53.00	265.00
Sodium, Soluble	mg/L	-	6.00	6.00	6.00	5.00	-	42.00	31.00	8.00	14.00	37.00	258.00
Sulfate (S04-S), Soluble	mg/L	-	39.00	172.00	22.00	20.00	-	613.00	186.00	40.00	30.00	960.00	1780.00
Calcium, Soluble	ug/g	-	38.00	22.00	17.00	9.00	-	136.00	42.00	71.00	46.00	198.00	333.00
Chloride , Soluble (calc.)	ug/g	-	4.00	8.00	3.00	3.00	-	106.00	27.00	4.00	20.00	26.00	520.00
Magnesium, Soluble (calc.)	ug/g	-	8.00	3.00	2.00	3.00	-	29.00	10.00	13.00	8.00	29.00	138.00
Potassium, Soluble (calc.)	ug/g	-	3.00	2.00	2.00	2.00	-	6.00	2.00	3.00	13.00	29.00	38.00
Sodium, Soluble (calc.)	ug/g	-	4.00	2.00	2.00	2.00	-	19.00	14.00	4.00	10.00	20.00	134.00
Sulfate (S04-S), Soluble (calc.)	ug/g	-	25.00	53.00	8.00	6.00	-	282.00	84.00	20.00	21.00	518.00	926.00
Glycols													
Diethylene glycol	ug/g	-	10	10	10	10	-	10	10	10	10	10	10
Ethylene glycol	ug/g	960	10	10	10	10	-	10	10	10	10	10	10
Propylene glycol	ug/g	-	10	10	10	10	-	10	10	10	10	10	10
Tetraethylene glycol	ug/g	-	10	10	10	10	-	10	10	10	10	10	10
Triethylene glycol	ug/g	-	10	10	10	10	-	10	10	10	10	10	10

Notes

1 Value reported is amount of sample retained on sieve after wash with water ard represents proportion by weight particles larger than indicated sieve size.

"-" indicates that there is no applicable regulation or analyses were not performed.

Red cells indicates parameter exceeds CCME AL Coarse.



LEGEND

- Site Boundary
- Treeline
- Trails
- Area of Debris
- Incinerator
- Monitoring Well
- Borehole
- Surface Soil Sample
- Drainage Ditch

One or more analytical parameters are greater than the applicable Soil Guidelines

All analytical parameters are less than the applicable Soil Guidelines

* Coloured stations represent most recent sampling date

**Black stations were not tested for parameters presented in current drawing

Scale 1:1,500

30 22.5 15 0 15 30 metres

Title: **ANALYTICAL RESULTS GLYCOLS, OTHER IN SOIL**

Project: **DETAILED SITE ASSESSMENT GARDEN RIVER OLD DUMP**

Client: **PARKS CANADA AGENCY**

FRANZ ENVIRONMENTAL INC. CONSULTING ENGINEERING TECHNOLOGIES

COLUMBIA ENVIRONMENTAL

Date: **FEBRUARY 2011**

FIGURE 8-2

** Original in colour : Figures should be interpreted in combination with appropriate site report.*

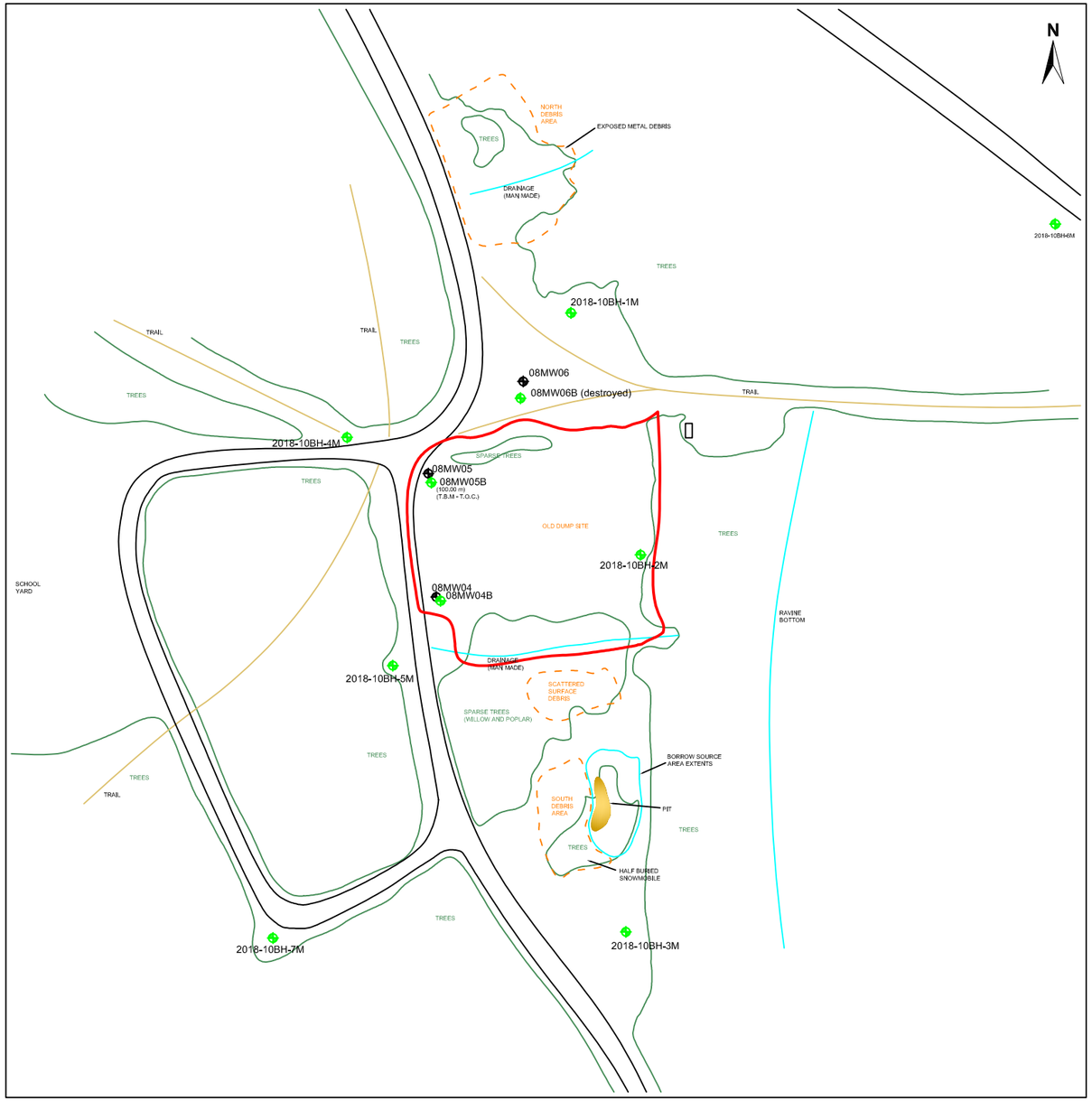
2018-1001 ParksCanada - Garden RIver Old Dump/CAD/NR/Garden RIver.dwg

Station ID	CAS #	Units	FCSAP Tier 1 Interim GW Guidelines for AL	Health Canada Drinking Water Guidelines	08MW04B			08MW05B			08MW06B	
Field label					018 MW04B	018 MW04B	018 MW04B	018 MW05B	018 MW05B	018 MW05B	018MW06B	018MW06B
Duplicate ID												
Date					21/Mar/08	29/Aug/08	18/Dec/10	21/Mar/08	29/Aug/08	18/Dec/10	21/Mar/08	29/Aug/08
Consultant					EBA	EBA	Franz	EBA	EBA	Franz	EBA	EBA
Lab report ID					L612590	L676397	10E461661	L612590	L676397	10E461661	L612590	L676397
Petroleum Hydrocarbons												
F1 (C6-C10)	-	ug/L	810 (coarse), 6500 (fine)	-	<100	-	<100	<100	-	<100	<100	-
F1 (C6-C10) minus BTEX	-	ug/L	810 (coarse), 6500 (fine)	-	<100	-	<100	<100	-	<100	<100	-
F2 (C10-C16)	-	ug/L	1300 (coarse), 1800 (fine)		<50	-	<100	<50	-	<100	<50	-
F3 (C16-C34)	-	ug/L	-		-	-	<100	-	-	<100	-	-
F4 (C34-C50)	-	ug/L	-		-	-	<100	-	-	<100	-	-
Monocyclic Aromatic Hydrocarbons												
Benzene	71-43-2	ug/L	88	5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5C	<0.50
Ethylbenzene	100-41-4	ug/L	3200	2.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5C	<0.50
Styrene	100-42-5	ug/L	72	-	-	<1.0	<1.0	-	<1.0	<1.0	-	<1.0
Toluene	108-88-3	ug/L	83 (coarse), 4900 (fine)	24	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5C	<0.50
m+p-Xylene	-	ug/L	-	-	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5
o-Xylene	95-47-6	ug/L	-	-	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5
Xylenes (total)	1330-20-7	ug/L	3900 (coarse), 13000 (fine)	300	<0.5	-	<0.5	<0.5	-	<0.5	<0.5C	-
Polycyclic Aromatic Hydrocarbons												
Acenaphthene	83-32-9	ug/L	5.8	-	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01
Acenaphthylene	208-96-8	ug/L	46	-	-	-	<0.01	-	-	<0.01	-	-
Acridine	260-94-6	ug/L	0.05	-	-	<0.01	<0.03	-	<0.01	<0.03	-	<0.01
Anthracere	120-12-7	ug/L	0.012	-	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01
Benzo[a]anthracene	56-55-3	ug/L	0.018	-	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01
Benzo[a]pyrene	50-32-8	ug/L	0.015	0.01	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01
Benzo[b+]fluoranthene	-	ug/L	0.48	-	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01
Benzo[ghi]perylene	191-24-2	ug/L	0.17 (coarse), 0.21 (fine)	-	-	-	<0.01	-	-	<0.01	-	-
Benzo[k]fluoranthene	207-08-9	ug/L	0.48	-	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01
Chrysene	218-01-9	ug/L	0.1	-	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01
Dibenzo[a,h]anthracene	53-70-3	ug/L	0.26 (coarse), 0.28 (fine)	-	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01
Fluoranthene	206-44-0	ug/L	0.04	-	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01
Fluorene	86-73-7	ug/L	3	-	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01
Indeno[1,2,3-cd]pyrene	193-39-5	ug/L	0.21 (coarse), 0.23 (fine)	-	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01
2-Methylnaphthalene	91-57-6	ug/L	1500	-	-	-	<0.01	-	-	<0.01	-	-
Naphthalene	91-20-3	ug/L	1.1	-	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01
Phenanthrene	85-01-8	ug/L	0.4	-	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01
Pyrene	129-00-0	ug/L	0.025	-	-	<0.01	<0.01	-	<0.02	<0.01	-	<0.01
Quinoline	91-22-5	ug/L	3.4	-	-	<0.01	<0.1	-	<0.01	<0.1	-	<0.01

Station ID	CAS #	Units	FCSAP Tier 1 Interim GW Guidelines for AL	Health Canada Drinking Water Guidelines	2018-10BH-1M	2018-10BH-2M	2018-10BH-3M	2018-10BH-4M	2018-10BH-5M	2018-10BH-6M	2018-10BH-7M
Field label					2018-10BH-1	2018-10BH-2	2018-10BH-3	2018-10BH-4M	2018-10BH-5M	2018-10BH-6M	2018-10BH-7M
Duplicate ID						2018-10BH-DUP 1					
Date					17/Dec/10	17/Dec/10	17/Dec/10	18/Dec/10	18/Dec/10	18/Dec/10	18/Dec/10
Consultant					Franz	Franz	Franz	Franz	Franz	Franz	Franz
Lab report ID					10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661
Petroleum Hydrocarbons											
F1 (C6-C10)	-	ug/L	810 (coarse), 6500 (fine)	-	<100	<100	<100	<100	<100	<100	<100
F1 (C6-C10) minus BTEX	-	ug/L	810 (coarse), 6500 (fine)	-	<100	<100	<100	<100	<100	<100	<100
F2 (C10-C16)	-	ug/L	1300 (coarse), 1800 (fine)		<100	<100	<100	<100	<100	<100	<100
F3 (C16-C34)	-	ug/L	-		<100	<100	<100	<100	<100	<100	<100
F4 (C34-C50)	-	ug/L	-		<100	<100	<100	<100	<100	<100	<100
Monocyclic Aromatic Hydrocarbons											
Benzene	71-43-2	ug/L	88	5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	100-41-4	ug/L	3200	2.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Styrene	100-42-5	ug/L	72	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	108-88-3	ug/L	83 (coarse), 4900 (fine)	24	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
m+p-Xylene	-	ug/L	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
o-Xylene	95-47-6	ug/L	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes (total)	1330-20-7	ug/L	3900 (coarse), 13000 (fine)	300	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Polycyclic Aromatic Hydrocarbons											
Acenaphthene	83-32-9	ug/L	5.8	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	208-96-8	ug/L	46	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acridine	260-94-6	ug/L	0.05	-	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Anthracere	120-12-7	ug/L	0.012	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo[a]anthracene	56-55-3	ug/L	0.018	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo[a]pyrene	50-32-8	ug/L	0.015	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo[b+]fluoranthene	-	ug/L	0.48	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo[ghi]perylene	191-24-2	ug/L	0.17 (coarse), 0.21 (fine)	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo[k]fluoranthene	207-08-9	ug/L	0.48	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	218-01-9	ug/L	0.1	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo[a,h]anthracene	53-70-3	ug/L	0.26 (coarse), 0.28 (fine)	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	206-44-0	ug/L	0.04	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	86-73-7	ug/L	3	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno[1,2,3-cd]pyrene	193-39-5	ug/L	0.21 (coarse), 0.23 (fine)	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2-Methylnaphthalene	91-57-6	ug/L	1500	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	91-20-3	ug/L	1.1	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	85-01-8	ug/L	0.4	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	129-00-0	ug/L	0.025	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Quinoline	91-22-5	ug/L	3.4	-	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.10

Notes

"-" indicates that there is no applicable regulation or analyses were not performed.



LEGEND

- Site Boundary
- Treeline
- Trails
- Area of Debris
- Incinerator
- Monitoring Well
- Borehole
- Surface Soil Sample
- Drainage Ditch

One or more analytical parameters are greater than the applicable Groundwater Guidelines

All analytical parameters are less than the applicable Groundwater Guidelines

* Coloured stations represent most recent sampling date

**Black stations were not tested for parameters presented in current drawing

Scale 1:1,500

30 22.5 15 0 15 30 metres

Title: **ANALYTICAL RESULTS PHCs IN GROUNDWATER**

Project: **DETAILED SITE ASSESSMENT GARDEN RIVER OLD DUMP**

Client: **PARKS CANADA AGENCY**

FRANZ ENVIRONMENTAL INC. — CONSULTING ENGINEERING TECHNOLOGIES

COLUMBIA ENVIRONMENTAL

Date: **FEBRUARY 2011**

FIGURE 9

** Original in colour : Figures should be interpreted in combination with appropriate site report.*

2018-1001 ParksCanada - Garden River Old Dump/CAD/NR/Garden River.dwg

Station ID	CAS #	Units	FCSAP Tier 1 Interim GW Guidelines for AL	Health Canada Drinking Water Guidelines	08MW04B			08MW05B			08MW06B	
Field label					018 MW04B	018 MW04B	018 MW04B	018 MW05B	018 MW05B	018 MW05B	018MW06B	018MW06B
Duplicate ID												
Date					21/Mar/08	29/Aug/08	18/Dec/10	21/Mar/08	29/Aug/08	18/Dec/10	21/Mar/08	29/Aug/08
Consultant					EBA	EBA	Franz	EBA	EBA	Franz	EBA	EBA
Lab report ID					L612590	L676397	10E461661	L612590	L676397	10E461661	L612590	L676397
Metals												
Hardness (CaCO3)	-	mg/L	-	-	-	-	-	-	-	-	-	-
pH	-		6.5-8.7	6.5-8.5	-	-	-	-	-	-	-	-
Dissolved Aluminum	7429-90-5	ug/L	5000	200	<5	<10	<2	<25	<10	<2	<25	<10
Dissolved Antimony	7440-36-0	ug/L	1600	6	<0.1	<0.5	<1.0	<0.5	<4	<1.0	<0.5	<0.4
Dissolved Arsenic	7440-38-2	ug/L	5	10	1.33	1.4	**6**	3.98	3.4	**10**	1.15	<0.4
Dissolved Barium	7440-39-3	ug/L	2300	1000	329	61	320	381	420	380	355	352
Dissolved Beryllium		ug/L	5.3	-	<0.5	1	<1	<2.5	<1	<1	<2.5	<1
Dissolved Boron	7440-42-8	ug/L	500	5000	16	<50	30	<50	<50	40	<50	<50
Dissolved Cadmium	7440-43-9	ug/L	0.017	5	**<0.05**	**<0.1**	<0.016	**<0.25**	**<0.1**	<0.016	**<0.25**	**2.1**
Dissolved Calcium	7440-70-2	ug/L	1 000 000	-	111 000	78 200	113000	107 000	114 000	112000	110 000	117 000
Dissolved Chromium (Total)	7440-47-3	ug/L	8.9	50	<0.5	<5	<1	<2.5	<5	<1	<2.50	5
Dissolved Cobalt		ug/L	50	-	1.43	<2	<1	1.88	2	<1	1.8	2
Dissolved Copper	7440-50-8	ug/L	6.96 to 13.98	1000	3.27	3	<2	**18**	4	<2	7.42	**9**
Dissolved Iron	7439-89-6	ug/L	300	300	<30	5	**2900**	**2030**	**1510**	**6300**	44	13
Dissolved Lead	7439-92-1	ug/L	15.90 to 44.90	10	<0.1	<0.1	<1	<0.5	0.1	<1	<0.5	0.2
Dissolved Magnesium	7439-95-4	ug/L	-	-	28400	24500	28500	27 700	29 000	27200	30 000	31400
Dissolved Manganese	7439-96-5	ug/L	200	50	**259**	**538**	**384**	**294**	**636**	**398**	**226**	43
Dissolved Mercury		ug/L	0.026	1	-	**<0.1**	<0.022	-	**<0.1**	<0.022	-	**<0.1**
Dissolved Molybdenum	7439-98-7	ug/L	73	-	<0.868	15	<3	0.95	<5	<3	0.76	<5
Dissolved Nickel	7440-02-0	ug/L	200	-	1.83	6	<10	3.30	4	<10	2.8	<4
Dissolved Selenium	7782-49-2	ug/L	1	10	**10.8**	**1.2**	**3**	**<5**	0.6	**2**	**<5**	**<4**
Dissolved Silver	7440-22-4	ug/L	0.1	-	<0.01	<0.1	<0.05	<0.05	<0.1	<0.05	<0.05	<0.1
Dissolved Sodium	7440-23-5	ug/L	-	200 000	8600	55 700	7200	10 600	10700	8600	11 000	12900
Dissolved Thallium	7440-28-0	ug/L	0.8	-	<0.1	<0.1	<0.5	<0.5	<0.1	<0.5	<0.5	<0.1
Dissolved Tin		ug/L	-	-	<0.1	<50	<1	<0.5	<50	<1	<0.5	<50
Dissolved Titanium		ug/L	100	-	1.10	1	<1	<5	<1	<1	<5.0	1
Dissolved Uranium	7440-61-1	ug/L	10	20	3.83	9.70	4	3.54	3.40	1	4.83	5.30
Dissolved Vanadium		ug/L	100	-	<1	1	1	<5	<1	1	<5	1
Dissolved Zinc	7440-66-6	ug/L	30	5000	**93.8**	26	5	**61**	19	1	**39**	**33**

Station ID	CAS #	Units	FCSAP Tier 1 Interim GW Guidelines for AL	Health Canada Drinking Water Guidelines	2018-10BH-1M	2018-10BH-2M	2018-10BH-3M	2018-10BH-4M	2018-10BH-5M	2018-10BH-6M	2018-10BH-7M
Field label					2018-10BH-1	2018-10BH-2	2018-10BH-3	2018-10BH-4M	2018-10BH-5M	2018-10BH-6M	2018-10BH-7M
Duplicate ID						2018-10BH-DUP 1					
Date					17/Dec/10	17/Dec/10	17/Dec/10	18/Dec/10	18/Dec/10	18/Dec/10	´8/Dec/10
Consultant					Franz	Franz	Franz	Franz	Franz	Franz	Franz
Lab report ID					10E461661	10E461661	10E461661	10E461661	10E461361	10E461661	10E461661
Metals											
Hardness (CaCO3)	-	mg/L	-	-	-	-	-	-	-	-	-
pH	-		6.5-8.7	6.5-8.5	-	-	-	-	-	-	-
Dissolved Aluminum	7429-90-5	ug/L	5000	200	**338**	64	30	7	<2	**534**	32
Dissolved Antimony	7440-36-0	ug/L	1600	6	<1	<1	<1	<1	<1	<1	<1
Dissolved Arsenic	7440-38-2	ug/L	5	10	**10**	**7**	**8**	**7**	**14**	**8**	**12**
Dissolved Barium	7440-39-3	ug/L	2300	1000	330	320	410	360	410	210	380
Dissolved Beryllium		ug/L	5.3	-	<1	<1	<1	<1	<1	<1	<1
Dissolved Boron	7440-42-8	ug/L	500	5000	60	60	50	50	50	80	50
Dissolved Cadmium	7440-43-9	ug/L	0.017	5	**0.033**	**0.025**	**0.020**	<0.016	<0.016	**0.085**	<0.016
Dissolved Calcium	7440-70-2	ug/L	1 000 000	-	102000	112000	110000	116000	112000	247000	101000
Dissolved Chromium (Total)	7440-47-3	ug/L	8.9	50	3	<1	<1	<1	<1	<1	<1
Dissolved Cobalt		ug/L	50	-	2	1	2	1	1	2	1
Dissolved Copper	7440-50-8	ug/L	6.96 to 13.98	1000	<2	<2	<2	<2	<2	<2	<2
Dissolved Iron	7439-89-6	ug/L	300	300	**8000**	**6200**	**6800**	<100	**7400**	**51000**	**8000**
Dissolved Lead	7439-92-1	ug/L	15.90 to 44.90	10	<1	<1	<1	<1	<1	2	<1
Dissolved Magnesium	7439-95-4	ug/L	-	-	27500	29400	27600	27800	27600	44600	24700
Dissolved Manganese	7439-96-5	ug/L	200	50	**600**	**428**	**462**	**641**	**444**	**737**	**334**
Dissolved Mercury		ug/L	0.026	1	-	-	<0.022	-	<0.022	<0.022	<0.022
Dissolved Molybdenum	7439-98-7	ug/L	73	-	<3	<3	<3	<3	<3	<3	<3
Dissolved Nickel	7440-02-0	ug/L	200	-	<10	<10	<10	<10	<10	10	<10
Dissolved Selenium	7782-49-2	ug/L	1	10	1	**3**	**3**	<1	<1	<1	<1
Dissolved Silver	7440-22-4	ug/L	0.1	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dissolved Sodium	7440-23-5	ug/L	-	200 000	10400	11300	9300	11500	10800	7700	9700
Dissolved Thallium	7440-28-0	ug/L	0.8	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dissolved Tin		ug/L	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dissolved Titanium		ug/L	100	-	27	9	3	2	1	12	2
Dissolved Uranium	7440-61-1	ug/L	10	20	2	2	2	3	1	<1	1
Dissolved Vanadium		ug/L	100	-	<1.0	<1.0	<1.0	<1.0	<1.0	3	<1.0
Dissolved Zinc	7440-66-6	ug/L	30	5000	4	3	3	2	2	19	2

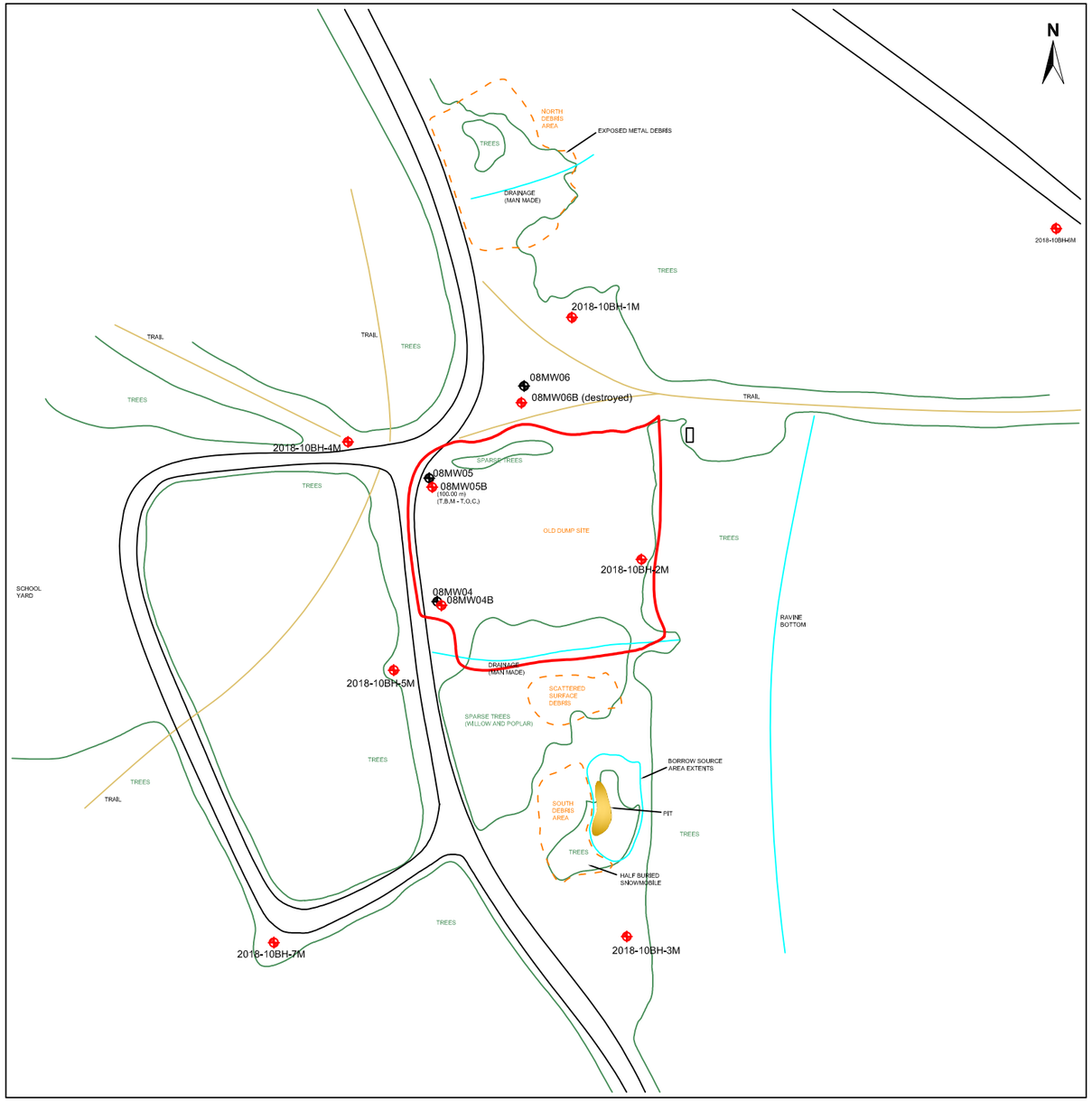
Notes

"-" indicates that there is no applicable regulation or analyses were not performed.

Bold and Red cells indicate parameter exceeds FCSAP Tier 1 Interim GW Guidelines for AL.

Bold and Yellow indicate parameter exceeds Health Canada Drinking Water Guidelines.

Bold and Orange cells indicate parameter exceeds FCSAP Tier 1 GW Guidelines for AL Use and Health Canada Drinking Water Guidelines.



LEGEND

- Site Boundary
- Treeline
- Trails
- Area of Debris
- Incinerator
- Monitoring Well
- Borehole
- Surface Soil Sample
- Drainage Ditch

One or more analytical parameters are greater than the applicable Groundwater Guidelines

All analytical parameters are less than the applicable Groundwater Guidelines

* Coloured stations represent most recent sampling date
**Black stations were not tested for parameters presented in current drawing

Scale 1:1,500
30 22.5 15 0 15 30
metres

Title: **ANALYTICAL RESULTS DISSOLVED METALS IN GROUNDWATER**

Project: **DETAILED SITE ASSESSMENT GARDEN RIVER OLD DUMP**

Client: **PARKS CANADA AGENCY**

FRANZ ENVIRONMENTAL INC. CONSULTING ENGINEERING TECHNOLOGIES | COLUMBIA ENVIRONMENTAL

Date: **FEBRUARY 2011**

FIGURE 10

** Original in colour : Figures should be interpreted in combination with appropriate site report.*

2018-1001 ParksCanada - Garden RIver Old Dump/CAD/NR/Garden RIver.dwg

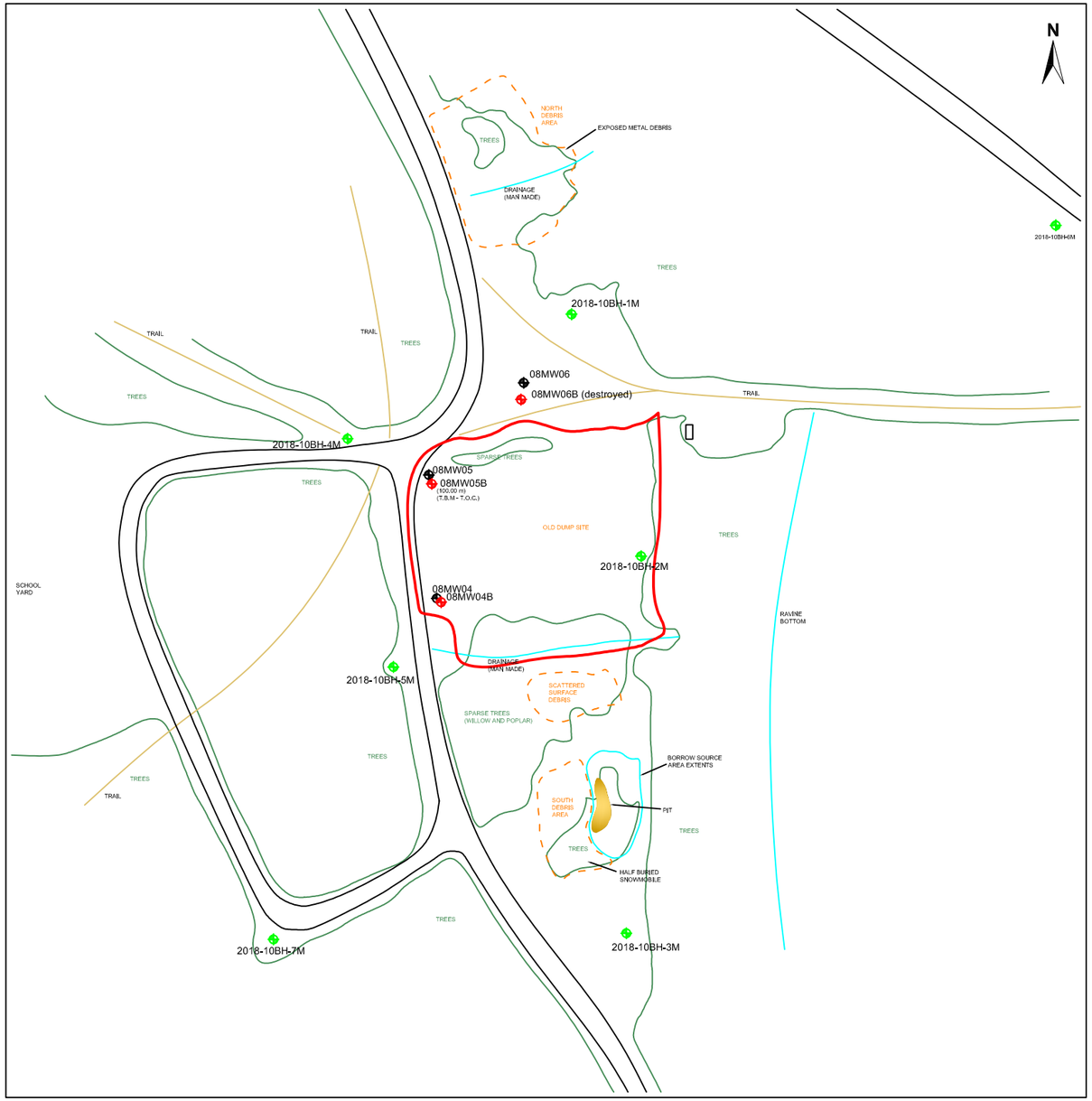
Station ID	CAS #	Units	FCSAP Tier 1 Interim GW Guidelines for AL	Health Canada Drinking Water Guidelines	08MW04B		08MW05B		08MW06B	2018-10BH-1M
Field label					018 MW04B	018 MW04B	018 MW05B	018 MW05B	018MW06B	2018-10BH-1
Duplicate ID										
Date					29/Aug/08	18/Dec/10	29/Aug/08	18/Dec/10	29/Aug/08	17/Dec/10
Consultant					EBA	Franz	EBA	Franz	EBA	Franz
Lab report ID					L676397	10E461661	L676397	10E461661	L676397	10E461661
Volatile Organic Compounds										
Bromodichloromethane	75-27-4	ug/L	67 000	16	-	<1	-	<1	-	<1
Bromoform	75-25-2	ug/L	840 (coarse), 5200 (fine)	100	-	<1	-	<1	-	<1
Bromomethane	74-83-9	ug/L	2 (coarse), 16 (fine)	-	-	<1	-	<1	-	<1
Carbon tetrachloride	56-23-5	ug/L	0.56 (coarse) 5 (fine)	5	**<1.0**	<0.5	**<1.0**	<0.5	**<1.0**	<0.5
Chlorobenzere	108-90-7	ug/L	1.3	30	<1	<1	<1	<1	<1	<1
Chlorodibromomethane	124-48-1	ug/L	100	100	-	<1	-	<1	-	<1
Chloroethane	75-00-3	ug/L	-	-	-	<1	-	<1	-	<1
Chloroform	67-66-3	ug/L	1.8	-	<1	<1	<1	<1	<1	<1
Chloromethane	74-87-3	ug/L	Insufficient data	-	-	<1	-	<1	-	<1
1,2-Dichlorobenzene	95-50-1	ug/L	0.7	200	**<1.0**	<0.5	**<1.0**	<0.5	**<1**	<0.5
1,3-Dichlorobenzene	541-73-1	ug/L	150	-	<1.0	<0.5	<1.0	<0.5	<1	<0.5
1,4-Dichlorobenzene	106-46-7	ug/L	26	5	<1.0	<0.5	<1.0	<0.5	<1	<0.5
1,1-Dichloroethane	75-34-3	ug/L	9000 (coarse), 53 000 (fine)	-	<1	<1	-	<1	<1	<1
1,2-Dichloroethane	107-06-2	ug/L	5	5	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	75-35-4	ug/L	39 (coarse), 680 (fine)	14	<1	<1	<1	<1	<1	<1
cis-1,2-Dichlcroethene	156-59-2	ug/L	12000	-	-	<1	-	<1	-	<1
trans-1,2-Dichloroethene	156-60-5	ug/L	12000	-	<1	<1	<1	<1	<1	<1
Dichloromethane	75-09-2	ug/L	50	50	<1	<1	<1	<1	<1	<1
1,2-Dichloropropane	78-87-5	ug/L	9.3 (coarse), 58 (fine)	-	<1	<1	<1	<1	<1	<1
cis-1,3-Dichlcropropene	10061-01-5	ug/L	3.8 (coarse), 24 (fine)	-	<1	<0.001	<1	<0.001	<1	<0.001
trans-1,3-Dichloropropene	10061-02-6	ug/L	3.8 (coarse), 24 (fine)	-	<1	<0.001	<1	<0.001	<1	<0.001
Ethylene dibromide	106-93-4	ug/L	3.3 (coarse), 21 (fine)	-	-	<0.001	-	<0.001	-	<0.001
Methyl tert-butyl ether	1634-04-4	ug/L	340 (coarse), 5000 (fine)	15	-	<1	-	<1	-	<1
1,1,1,2-Tetrachloroethane	630-20-6	ug/L	6 (coarse), 38 (fine)	-	-	<1	-	<1	-	<1
1,1,2,2-Tetrachloroethane	79-34-5	ug/L	22 (coarse), 140 (fine)	-	<2	<1	<2	<1	<2	<1
Tetrachloroethene	127-18-4	ug/L	110	30	<1	<1	<1	<1	<1	<1
1,1,1-Trichloroethane	71-55-6	ug/L	4200 (coarse), 13 000 (fine)	-	<1	<1	<1	<1	<1	<1
1,1,2-Trichloroethane	79-00-5	ug/L	9400	-	<1	<1	<1	<1	<1	<1
Trichloroethene	79-01-6	ug/L	20 (coarse), 50 (fine)	5	<1	<1	<1	<1	<1	<1
Trichlorofluoromethane	75-69-4	ug/L	-	-	-	<1	-	<1	-	<1
Vinyl chloride	75-01-4	ug/L	1.1 (coarse), 7.8 (fine)	2	-	<1	-	<1	-	<1

Station ID	CAS #	Units	FCSAP Tier 1 Interim GW Guidelines for AL	Health Canada Drinking Water Guidelines	2018-10BH-2M	2018-10BH-3M	2018-10BH-4M	2018-10BH-5M	2018-10BH-6M	2018-10BH-7M
Field label					2018-10BH-2	2018-10BH-3	2018-10BH-4M	2018-10BH-5M	2018-10BH-6M	2018-10BH-7M
Duplicate ID					2C18-10BH-DUP 1					
Date					17/Dec/10	17/Dec/10	18/Dec/10	18/Dec/10	18/Dec/10	18/Dec/10
Consultant					Franz	Franz	Franz	Franz	Franz	Franz
Lab report ID					10E461661	10E461661	10E461661	10E461661	10E461661	10E461661
Volatile Organic Compounds										
Bromodichloromethane	75-27-4	ug/L	67 000	16	<1	<1	<1	<1	<1	<1
Bromoform	75-25-2	ug/L	840 (coarse), 5200 (fine)	100	<1	<1	<1	<1	<1	<1
Bromomethane	74-83-9	ug/L	2 (coarse), 16 (fine)	-	<1	<1	<1	<1	<1	<1
Carbon tetrachloride	56-23-5	ug/L	0.56 (coarse) 5 (fine)	5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorobenzere	108-90-7	ug/L	1.3	30	<1	<1	<1	<1	<1	<1
Chlorodibromomethane	124-48-1	ug/L	100	100	<1	<1	<1	<1	<1	<1
Chloroethane	75-00-3	ug/L	-	-	<1	<1	<1	<1	<1	<1
Chloroform	67-66-3	ug/L	1.8	-	<1	<1	<1	<1	<1	<1
Chloromethane	74-87-3	ug/L	Insufficient data	-	<1	<1	<1	<1	<1	<1
1,2-Dichlorobenzene	95-50-1	ug/L	0.7	200	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3-Dichlorobenzene	541-73-1	ug/L	150	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,4-Dichlorobenzene	106-46-7	ug/L	26	5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1-Dichloroethane	75-34-3	ug/L	9000 (coarse), 53 000 (fine)	-	<1	<1	<1	<1	<1	<1
1,2-Dichloroethane	107-06-2	ug/L	5	5	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	75-35-4	ug/L	39 (coarse), 680 (fine)	14	<1	<1	<1	<1	<1	<1
cis-1,2-Dichlcroethene	156-59-2	ug/L	12000	-	<1	<1	<1	<1	<1	<1
trans-1,2-Dichloroethene	156-60-5	ug/L	12000	-	<1	<1	<1	<1	<1	<1
Dichloromethane	75-09-2	ug/L	50	50	-	<1	<1	<1	<1	<1
1,2-Dichloropropane	78-87-5	ug/L	9.3 (coarse), 58 (fine)	-	<1	<1	<1	<1	<1	<1
cis-1,3-Dichlcropropene	10061-01-5	ug/L	3.8 (coarse), 24 (fine)	-	<1	<1	<1	<1	<1	<1
trans-1,3-Dichloropropene	10061-02-6	ug/L	3.8 (coarse), 24 (fine)	-	<1	<1	<1	<1	<1	<1
Ethylene dibromide	106-93-4	ug/L	3.3 (coarse), 21 (fine)	-	<1	<1	<1	<1	<1	<1
Methyl tert-butyl ether	1634-04-4	ug/L	340 (coarse), 5000 (fine)	15	<1	<1	<1	<1	<1	<1
1,1,1,2-Tetrachloroethane	630-20-6	ug/L	6 (coarse), 38 (fine)	-	<1	<1	<1	<1	<1	<1
1,1,2,2-Tetrachloroethane	79-34-5	ug/L	22 (coarse), 140 (fine)	-	<1	<1	<1	<1	<1	<1
Tetrachloroethene	127-18-4	ug/L	110	30	<1	<1	<1	<1	<1	<1
1,1,1-Trichloroethane	71-55-6	ug/L	4200 (coarse), 13 000 (fine)	-	<1	<1	<1	<1	<1	<1
1,1,2-Trichloroethane	79-00-5	ug/L	9400	-	<1	<1	<1	<1	<1	<1
Trichloroethene	79-01-6	ug/L	20 (coarse), 50 (fine)	5	<1	<1	<1	<1	<1	<1
Trichlorofluoromethane	75-69-4	ug/L	-	-	<1	<1	<1	<1	<1	<1
Vinyl chloride	75-01-4	ug/L	1.1 (coarse), 7.8 (fine)	2	<1	<1	<1	<1	<1	<1

Notes

"-" indicates that there is no applicable regulation or analyses were not performed.

Bold and Red cells indicate parameter exceeds FCSAP Tier 1 Interim GW Guidelines for AL.



LEGEND

- Site Boundary
- Treeline
- Trails
- Area of Debris
- Incinerator
- Monitoring Well
- Borehole
- Surface Soil Sample
- Drainage Ditch

One or more analytical parameters are greater than the applicable Groundwater Guidelines

All analytical parameters are less than the applicable Groundwater Guidelines

* Coloured stations represent most recent sampling date

**Black stations were not tested for parameters presented in current drawing

Scale 1:1,500

30 22.5 15 0 15 30 metres

Title: **ANALYTICAL RESULTS VOCs IN GROUNDWATER**

Project: **DETAILED SITE ASSESSMENT GARDEN RIVER OLD DUMP**

Client: **PARKS CANADA AGENCY**

FRANZ ENVIRONMENTAL INC. CONSULTING ENGINEERING TECHNOLOGIES

COLUMBIA ENVIRONMENTAL

Date: **FEBRUARY 2011**

FIGURE 11

** Original in colour : Figures should be interpreted in combination with appropriate site report.*

2018-1001 ParksCanada - Garden River Old Dump/CAD/NR/Garden River.dwg

Station ID	CAS #	Units	FCSAP Tier I Interim GW Guidelines for AL	Health Canada Drinking Water Guidelines	08MW04B			08MW05B			08MW05B	
Field label					018 MW04B	018 MW04B	018 MW04B	018 MW05B	018 MW05B	018 MW05B	018MW06B	018MW06B
Duplicate ID												
Date					21/Mar/08	29/Aug/08	18/Dec/10	21/Mar/08	29/Aug/08	18/Dec/10	21/Mar/08	29/Aug/08
Consultant					EBA	EBA	Franz	EBA	EBA	Franz	EBA	EBA
Lab report ID					L612590	L676397	10E461661	L612590	L676397	10E461661	L612590	L676397
Conventionals												
Hardness (CaCO3)	-	ug/L	-	-	394 000	-	400 000	381 000	-	392 000	398 000	-
pH	-		6.5 to 8.7	6.5-8.5	7.74	-	8.2	7.71	-	8.2	7.73	-
Conductivity	-	uS/cm	-	-	739	-	727	752	-	733	786	-
Ion balance	-	%	-	-	101	-	100	96.2	-	101	95.6	-
Calculated TDS	-	ug/L	3 000 000	500 000	420000	-	428000	428 000	-	437000	449000	-
Alkalinitys												
Bicarbonate	71-52-3	ug/L	-	-	435 000	-	439000	433 000	-	407000	452 000	-
Carbonate	3812-32-6	ug/L	-	-	<5000	-	<5000	<5000	-	<5000	<5000	-
Hydroxide	14280-30-9	ug/L	-	-	<5000	-	<5000	<5000	-	<5000	<5000	-
Alkalinity, Carbonate	-	ug/L	-	-	356000	-	360000	355 000	-	334000	371000	-
Anions												
Chloride ion	16887-00-6	ug/L	100 000	250 000	4400	-	5000	4700	-	5000	4200.0	-
Fluoride	16984-48-8	ug/L	120	1500	-	-	**200**	-	-	**220**	-	-
Sulphate (SO4)	14808-79-8	ug/L	100 000	500 000	48000	-	53000	57200	-	78000	64 100	-
Glycols												
Diethylene glycol	111-46-6	ug/L	-	-	-	-	<10000	-	-	<10000	-	-
Ethylene glycol	107-21-1	ug/L	192 000	-	-	-	<10000	-	-	<10000	-	-
Propylene glycol	57-55-6	ug/L	500 000	-	-	-	<10000	-	-	<10000	-	-
Tetraethylene glycol	112-60-7	ug/L	-	-	-	-	<10000	-	-	<10000	-	-
Triethylene glycol	112-27-6	ug/L	-	-	-	-	<10000	-	-	<10000	-	-
Nutrients												
Nitrate (as N)	14797-55-8	ug/L	13 000	10 000	550	-	2200	900	-	3300	810.00	-
Nitrate plus Nitrite (as N)	-	ug/L	100 000	10 000	550	-	497	900	-	745	810.00	-
Nitrite (as N)	14797-65-0	ug/L	60	3200	<50	-	<15	<50	-	<15	<50.00	-
Dissolved Potassium	7440-09-7	ug/L	-	-	3730	1300	2900	3330	3800	2600	3320.0	5100.0
Total Kjeldahl Nitrogen	-	ug/L	-	-	-	-	440	-	-	630	-	-
Total Nitrogen	7727-37-9	ug/L	-	-	-	-	940	-	-	1380	-	-

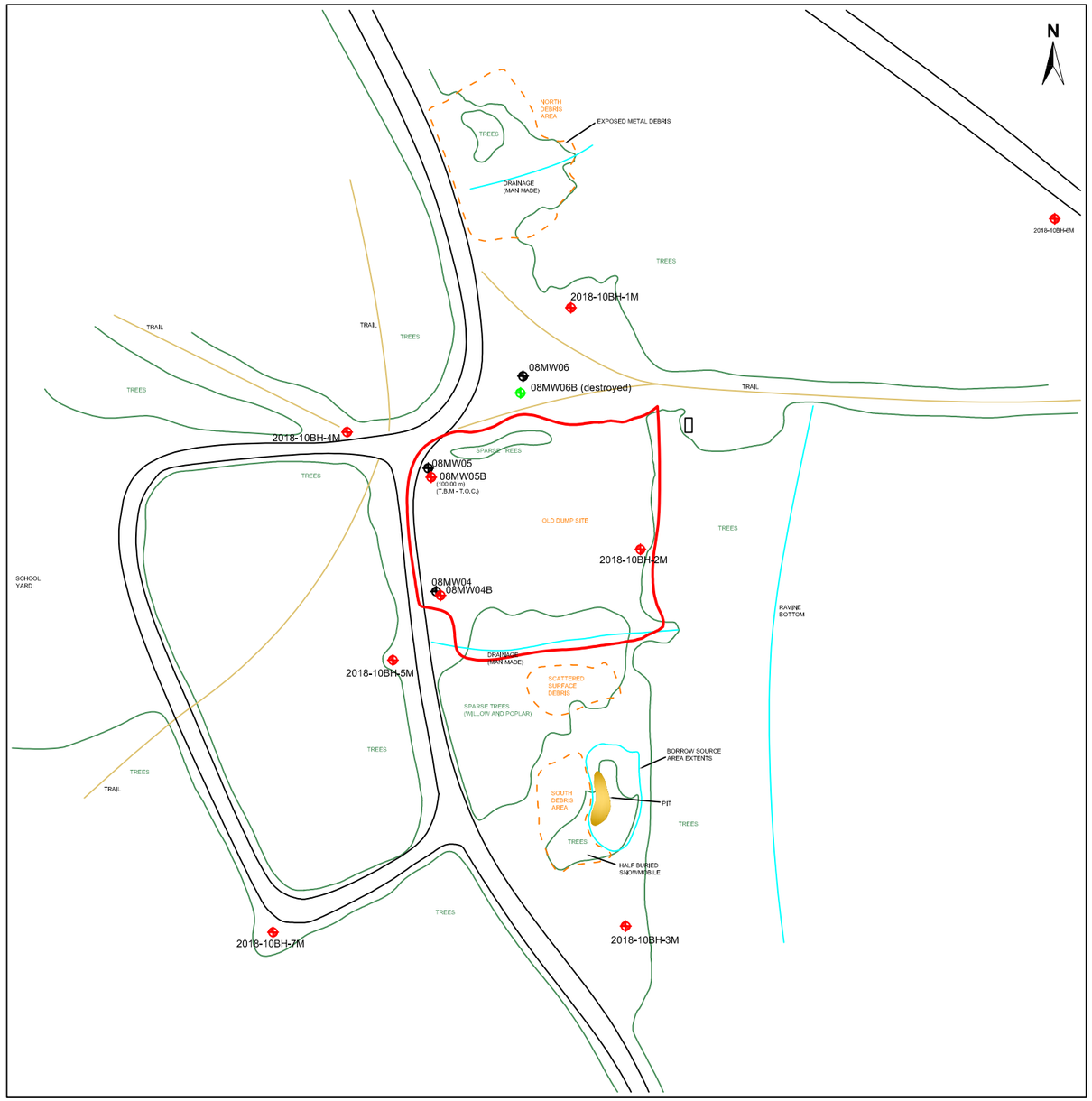
Station ID	CAS #	Units	FCSAP Tier I Interim GW Guidelines for AL	Health Canada Drinking Water Guidelines	2018-10BH-1M	2018-10BH-2M	2018-10BH-3M	2018-10BH-4M	2018-10BH-5M	2018-10BH-6M	2018-10BH-7M
Field label					2018-10BH-1	2018-10BH-2	2018-10BH-3	2018-10BH-4M	2018-10BH-5M	2018-10BH-6M	2018-10BH-7M
Duplicate ID						2018-10BH-DUP 1					
Date					17/Dec/10	17/Dec/10	17/Dec/10	18/Dec/10	18/Dec/10	18/Dec/10	18/Dec/10
Consultant					Franz	Franz	Franz	Franz	Franz	Franz	Franz
Lab report ID					10E461661	10E461661	10E461661	10E461661	10E461661	10E461661	10E461661
Conventionals											
Hardness (CaCO3)	-	ug/L	-	-	368 000	401 000	388 000	404000	393000	800000	354000
pH	-		6.5 to 8.7	6.5-8.5	8	8	8	7.9	8.1	7.9	8.2
Conductivity	-	uS/cm	-	-	755	761	786	769	768	1310	686
Ion balance	-	%	-	-	91.3	97.9	92.1	98.1	97.8	111	99.9
Calculated TDS	-	ug/L	3 000 000	500 000	447000	457000	463000	464000	464000	**823000**	394000
Alkalinitys											
Bicarbonate	71-52-3	ug/L	-	-	428000	439000	433000	409000	391000	899000	409000
Carbonate	3812-32-6	ug/L	-	-	<5000	<5000	<5000	<5000	<5000	<5000	<5000
Hydroxide	14280-30-9	ug/L	-	-	<5000	<5000	<5000	<5000	<5000	<5000	<5000
Alkalinity, Carbonate	-	ug/L	-	-	351000	359000	355000	336000	320000	737000	335000
Anions											
Chloride ion	16887-00-6	ug/L	100 000	250 000	6000	6000	9000	6000	7000	4000	6000
Fluoride	16984-48-8	ug/L	120	1500	**200**	**190**	**180**	**250**	**180**	70	**190**
Sulphate (SO4)	14808-79-8	ug/L	100 000	500 000	88000	75000	90000	96000	**111000**	76000	89000
Glycols											
Diethylene glycol	111-46-6	ug/L	-	-	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Ethylene glycol	107-21-1	ug/L	192 000	-	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Propylene glycol	57-55-6	ug/L	500 000	-	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Tetraethylene glycol	112-60-7	ug/L	-	-	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Triethylene glycol	112-27-6	ug/L	-	-	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Nutrients											
Nitrate (as N)	14797-55-8	ug/L	13 000	10 000	<500	1100	1600	1700	<500	<500	<500
Nitrate plus Nitrite (as N)	-	ug/L	100 000	10 000	<113	248	361	384	<113	<113	<113
Nitrite (as N)	14797-65-0	ug/L	60	3200	<15	<15	<15	<15	<15	<15	<15
Dissolved Potassium	7440-09-7	ug/L	-	-	2700	2700	2500	3400	3000	1900	2900
Total Kjeldahl Nitrogen	-	ug/L	-	-	590	570	890	630	700	2730	680
Total Nitrogen	7727-37-9	ug/L	-	-	590	620	1250	1010	700	2730	680

Notes

"-" indicates that there is no applicable regulation or analyses were not performed.

Bold and Red cells indicate parameter exceeds FCSAP Tier I Interim GW Guidelines for AL.

Bold and Yellow indicate parameter exceeds Health Canada Drinking Water Guidelines.



LEGEND

- Site Boundary
- Treeline
- Trails
- Area of Debris
- Incinerator
- Monitoring Well
- Borehole
- Surface Soil Sample
- Drainage Ditch

One or more analytical parameters are greater than the applicable Groundwater Guidelines

All analytical parameters are less than the applicable Groundwater Guidelines

* Coloured stations represent most recent sampling date

**Black stations were not tested for parameters presented in current drawing

Scale 1:1,500

30 22.5 15 0 15 30

metres

Title: **ANALYTICAL RESULTS GLYCOLS, NUTRIENTS IN GROUNDWATER**

Project: **DETAILED SITE ASSESSMENT GARDEN RIVER OLD DUMP**

Client: **PARKS CANADA AGENCY**

FRANZ ENVIRONMENTAL INC. CONSULTING ENGINEERING TECHNOLOGIES

COLUMBIA ENVIRONMENTAL

Date: **FEBRUARY 2011**

FIGURE 12

** Original in colour : Figures should be interpreted in combination with appropriate site report.*

2018-1001 ParksCanada - Garden River Old Dump/CAD/NR/Garden River.dwg

N

2

NORTH DEBRIS AREA

EXPOSED METAL DEBRIS

TREES

DRAINAGE (MAN MADE)

TREES

2018-10BH-1M

TRAIL

TREES

08SS49

08MW06

08MW06B (destroyed)

TRAIL

2018-10SS-4

2018-10SS-3

2018-10BH-4M

SPARSE TREES

08MW05

08MW05B

(100.00 m)

(T.B.M - T.O.C.)

08SS48

TREES

2018-10SS-2

OLD DUMP SITE

TREES

2018-10SS-6

08SS47

2018-10SS-5

2018-10BH-2M

08MW04

08MW04B

2018-10SS-1

RAVINE BOTTOM

08SS46

DRAINAGE (MAN MADE)

2018-10BH-5M

SCATTERED SURFACE DEBRIS

SPARSE TREES (WILLOW AND POPLAR)

08SS45

TREES

BORROW SOURCE AREA EXTENTS

SOUTH DEBRIS AREA

PIT

TREES

TREES

HALF BURIED SNOWMOBILE

TREES

2018-10BH-7M

2018-10BH-3M

LEGEND

- Site Boundary
- Treeline
- Trails
- Area of Debris
- Incinerator
- Monitoring Well
- Borehole
- Surface Soil Sample
- Geophysical Transect

Note:
* Units relative to a temporary bench mark (TBM) of 100m for 08MW05B. All other elevations are relative to this.

Scale 1:1,000

20 15 10 0 10 20

metres

Title:

GEOPHYSICAL TRANSECTS

Project:

DETAILED SITE ASSESSMENT
GARDEN RIVER OLD DUMP

Client:

PARKS CANADA AGENCY

FRANZ ENVIRONMENTAL INC. CONSULTING ENGINEERING TECHNOLOGIES

COLUMBIA ENVIRONMENTAL

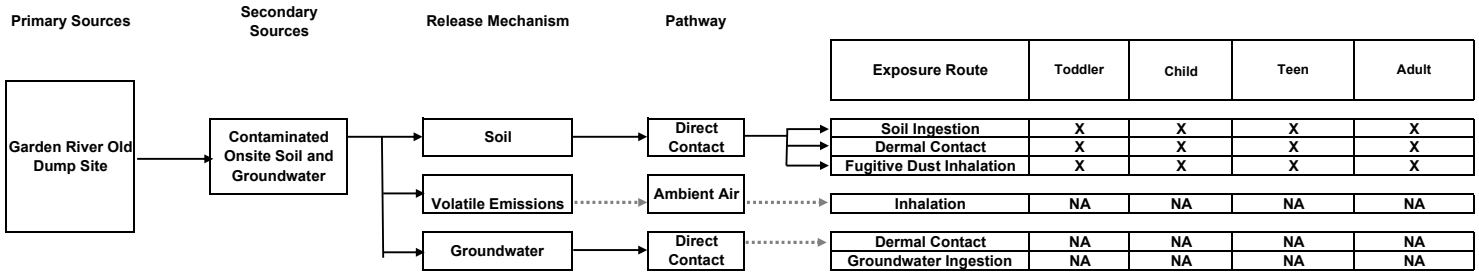
Date: **FEBRUARY 2011**

FIGURE 13

2018-1001 ParksCanada - Garden River Old Dump/CAD/NR/Garden River.dwg

Figure 14
Human Health (PQRA) Conceptual Model for Current "Recreational" Land Use

SCENARIO A: CURRENT "TRANSIENT/RECREATIONAL" SITE USE



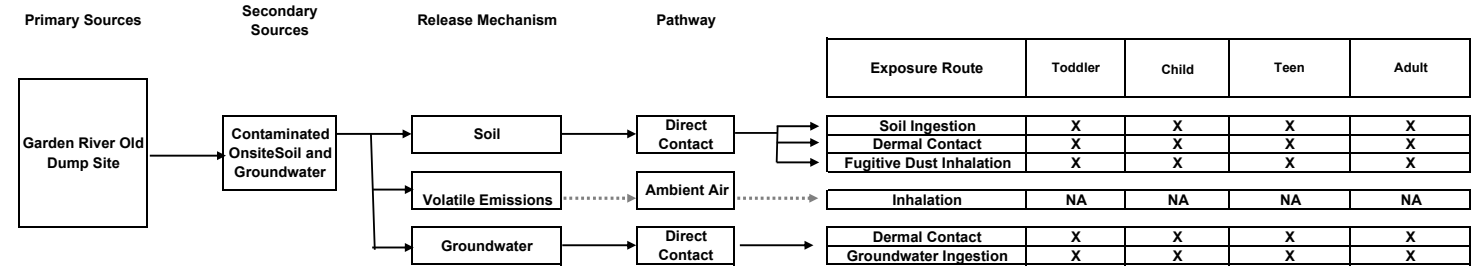
Operable Pathway

Inoperable Pathway

NA Not applicable due to incomplete, insignificant, or un-assessed pathway

Figure 15. Human Health (PQRA) Conceptual Model for Potential Future "Agricultural, Potable GW" Site Use

SCENARIO B: POTENTIAL FUTURE "HOMESTEAD, POTABLE GW" SITE USE



Exposure Route	Toddler	Child	Teen	Adult
Soil Ingestion	X	X	X	X
Dermal Contact	X	X	X	X
Fugitive Dust Inhalation	X	X	X	X
Inhalation	NA	NA	NA	NA
Dermal Contact	X	X	X	X
Groundwater Ingestion	X	X	X	X

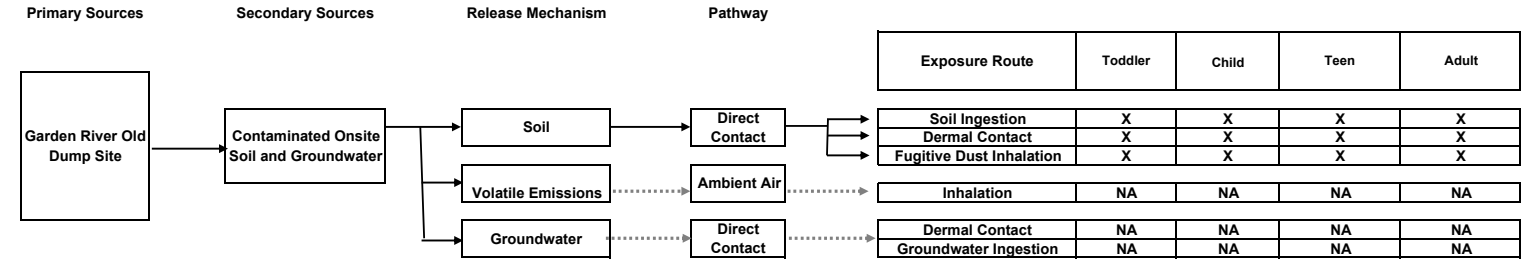
Operable Pathway

Inoperable Pathway

NA Not applicable due to incomplete, insignificant, or un-assessed pathway

Figure 16. Human Health (PQRA) Conceptual Model for Potential Future "Agricultural, Non-Potable GW" Site Use

SCENARIO C: POTENTIAL FUTURE "HOMESTEAD, NON-POTABLE GW" SITE USE

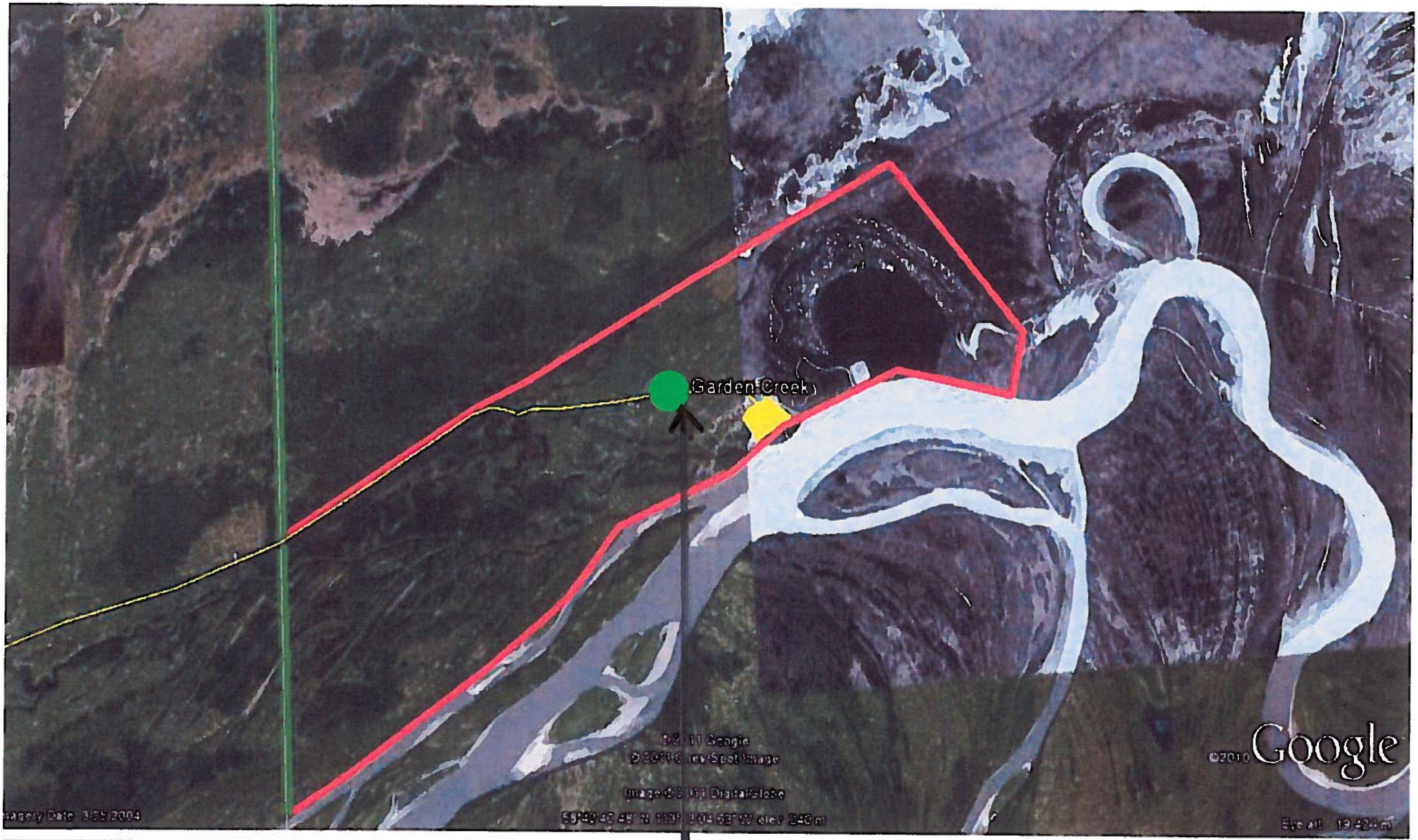


Exposure Route	Toddler	Child	Teen	Adult
Soil Ingestion	X	X	X	X
Dermal Contact	X	X	X	X
Fugitive Dust Inhalation	X	X	X	X
Inhalation	NA	NA	NA	NA
Dermal Contact	NA	NA	NA	NA
Groundwater Ingestion	NA	NA	NA	NA

Operable Pathway

Inoperable Pathway

NA Not applicable due to incomplete, insignifica



Comments/Notes:

New landfill location

Figure 5: Proposed New landfill location 3 Km West of the Community of Garden River

This map is used for demonstration purposes and does not represent the actual proposed reserve boundaries. Lands and Environmental Unit 2011

APPENDIX B

EBA'S ENVIRONMENTAL REPORT – GENERAL CONDITIONS

GENERAL CONDITIONS

GEO-ENVIRONMENTAL REPORT

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

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3.0 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by EBA in its reasonably exercised discretion.

4.0 INFORMATION PROVIDED TO EBA BY OTHERS

During the performance of the work and the preparation of the report, EBA may rely on information provided by persons other than the Client. While EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.