Phase II
Environmental Site Assessment of the Recreation Area Sewage Lagoon and the Administration Area Sewage Lagoon at Elk Island National Park, Alberta

Prepared by

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Prepared for

Parks Canada Agency

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ACKNOWLEDGEMENTS

The environmental investigation of the sewage lagoons at Elk Island National Park, Alberta, was commissioned by Parks Canada Agency. The investigation was performed by the Environmental Sciences Group (ESG) of the Royal Military College of Canada, in Kingston, ON, under the direction of Dr. Ken Reimer.

ESG personnel Shari Reed, Justin Dee and Jeff Donald carried out the field program. ESG staff Kathleen Francis, Jasmine King, Candice Casucci, Melanie Nicholson and Mike DeArruda provided logistical support. Laboratory analyses were carried out by the Analytical Services Unit (ASU) of Queen's University in Kingston, ON, and the Analytical Sciences Group (ASG) of the Royal Military College of Canada, in Kingston, ON.

This report was written by Andrea Ellis, with contributions from Shari Reed (technical review), Viviane Paquin (project management and technical review), Pat Fortin (quality assurance/quality control) and Susie Rance (editing). Bill Duffe produced the graphic design and Jeff Donald produced the maps. Daniela Loock and Nancy Langevin oversaw the financial administration.

EXECUTIVE SUMMARY

A Phase II environmental site assessment (ESA) was conducted in 2001 at various locations in Elk Island National Park, Alberta, to identify areas of potential environmental concern associated with activities being conducted in the Park (O'Connor 2001). The investigations conducted in 2001 assessed the quality of the sediment and water in two sewage lagoons and investigated the potential impacts to a wetland adjacent to the Astotin Lake Recreation Area Lagoon. The investigation of the Administration Area Sewage Lagoon reported exceedances of 1999 Canadian Council of Ministers of the Environment (CCME) soil criteria for inorganic elements and polycyclic aromatic hydrocarbons (PAHs) and of the 1994 Alberta Tier 1 soil criterion for petroleum hydrocarbons in lagoon sediment and exceedances of 1999 CCME drinking water criteria for inorganic elements in lagoon water. The wetland receiving effluent from the Administration Area Lagoon was frozen at the time of sampling so no sampling of the wetland was conducted, and as a result, impacts to the wetland could not be evaluated. The investigation of the Recreation Area Sewage Lagoon reported exceedances of CCME freshwater and drinking water criteria for inorganic elements in water collected from the lagoon and exceedances of CCME freshwater and drinking water criteria for inorganic elements (including mercury) in water in the wetland next to the lagoon discharge point. Concentrations of inorganic elements in sediment from the Recreation Area Sewage Lagoon were below CCME and Alberta Tier 1soil criteria. The report suggested that some of the exceedances of criteria for inorganic elements may have been representative of background concentrations at both lagoons.

In October and November 2013, ESG completed a more comprehensive Phase II ESA at these two sewage lagoons. The lagoon cells are deteriorating and require management action. In order to determine appropriate management actions, a thorough understanding of the nature and extent of contamination is required. The 2013 assessment was thus undertaken to thoroughly assess the environmental quality of the lagoon water and sediments and to determine the degree to which the lagoons have impacted the local groundwater, soil and wetlands surrounding the lagoons.

The Phase II ESA sampling program developed by ESG consisted of collection of 42 sediment samples and eight surface water samples from the lagoons and adjacent wetlands. Sediment and surface water results were compared to the applicable CCME sediment and surface water guidelines or, where absent, CCME soil guidelines or Alberta Tier 1 soil guidelines. Sediment results for the Recreation Area Sewage Lagoon exceeded the CCME sediment guidelines for inorganic elements and pesticides. The same

exceedances were observed for sediments collected from the wetland downgradient from the Recreation Area Sewage Lagoon outlet. Sediment results for the Administration Area Lagoon exceeded applicable CCME sediment guidelines for inorganic elements, PAHs, pesticides and CCME soil guidelines for volatile organic compounds (VOCs). Similar exceedances were observed for sediments collected from the wetland downgradient of the Administration Area Lagoon outlet and from the southern wetland where the lagoon effluent overflows the berm. Sediment samples from the Recreation Area and Administration Area Sewage Lagoons and from the adjacent wetlands indicated levels of boron and sulfur above CCME soil criteria; however, these concentrations are probably naturally occurring, as they were elevated in all samples.

Surface water samples from the Recreation Area Sewage Lagoon exceeded CCME water quality guidelines for inorganic elements and PAHs. Surface water samples could not be collected from the wetland downgradient from the Recreation Area Lagoon outlet as there was no standing water in this area at the time of the sampling event. Surface water collected from the Administration Area Sewage Lagoon and from the wetland downgradient from the lagoon exceeded CCME water quality guidelines for inorganic elements and PAHs.

The results obtained through the Phase II ESA sampling program were used to complete the National Classification System for Contaminated Sites (NCSCS) scoring for each of the two sites. On the basis of the information contained in this report, the Administration Area Lagoon and the Recreation Area Lagoon are currently classified as Class 1 and Class 2 sites (respectively) with insufficient information. Groundwater monitoring wells are scheduled to be installed in late March 2014 and will be sampled later in the spring of 2014. The analytical results for groundwater samples from the monitoring wells and for borehole soil samples collected during well installation will be used to update the NCSCS scoring for both lagoons.

ESG recommends additional sampling of sediment and surface water at the Recreation Area Lagoon along the flow path to determine the extent of the contamination in the receiving wetland according to the contaminants. If the Recreation Area Lagoon is decommissioned, ESG recommends the sediment in the lagoon be disposed of appropriately according to the contaminants.

ESG recommends that the south berm of the Administration Area Lagoon be repaired to prevent future overflow and allow sufficient retention time within the lagoon. Further sampling of sediment and surface water along the flow pathway is also

recommended to determine the extent of the contamination. If the Administration Area Lagoon is decommissioned, ESG recommends the sediment in the lagoon cells be disposed of appropriately according to the contaminants.

In March 2014, groundwater monitoring wells will be installed at the Recreation Area Lagoon and the Administration Area Lagoon and subsequently tested in spring 2014. The soil samples collected from the boreholes will assist in determining contamination in surrounding soils at each site. The soil and groundwater sampling program scheduled for the spring of 2014 will help resolve some of the unknowns in the NCSCS scoring.

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GLOSSARY AND LIST OF ABBREVIATIONS

Administration Area Sewage Lagoon	Administration Area Sewage Lagoon
BOD	biological oxygen demand
CCME	Canadian Council of Ministers of the Environment
Composite sample	a sample comprised of equal volumes of soil or water collected from two or more sample locations
DDD	diphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
Discrete sample	a sample collected from one single sample location
ESA	environmental site assessment
FAL	freshwater aquatic life
INS	insufficient information
ISQGs	Interim Sediment Quality Guidelines (CCME)
NCSCS	National Classification System for Contaminated Sites
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
PEL	probable effect level
PHC	petroleum hydrocarbon
Recreation Area Sewage Lagoon	Astotin Lake Recreation Area Sewage Lagoon
SQGs	Soil Quality Guidelines (CCME)
VOC	volatile organic compound

I. INTRODUCTION

Elk Island National Park is located approximately thirty minutes east of Edmonton, Alberta (Figure 1). The Park plays a vital role in protecting important wildlife habitat and supporting free-roaming populations of plains bison, wood bison, moose, deer and elk as well as over 250 species of birds. The Park also provides visitor services that include a campground, visitor centre and golf course. These park operations are supported by two sewage lagoons constructed in the 1960s: the Astotin Lake Recreation Area Sewage Lagoon (the Recreation Area Sewage Lagoon), located in a forested area across the parkway from the day use and campground area, and the Administration Area Sewage Lagoon, located in a forested area near the warden station and maintenance compound (Appendix A, Maps A-1 and A-2). Inputs to the lagoons are fed by gravity from the various buildings and manholes to the separate lift stations, where they are pumped into the lagoons. Contents of outhouses are also discharged from a vacuum truck into the north end of the Recreation Area Sewage Lagoon. Both lagoons have a control structure that is designed to direct the treated discharge into adjacent wetlands. Groundwater flow for both areas is towards Astotin Lake.

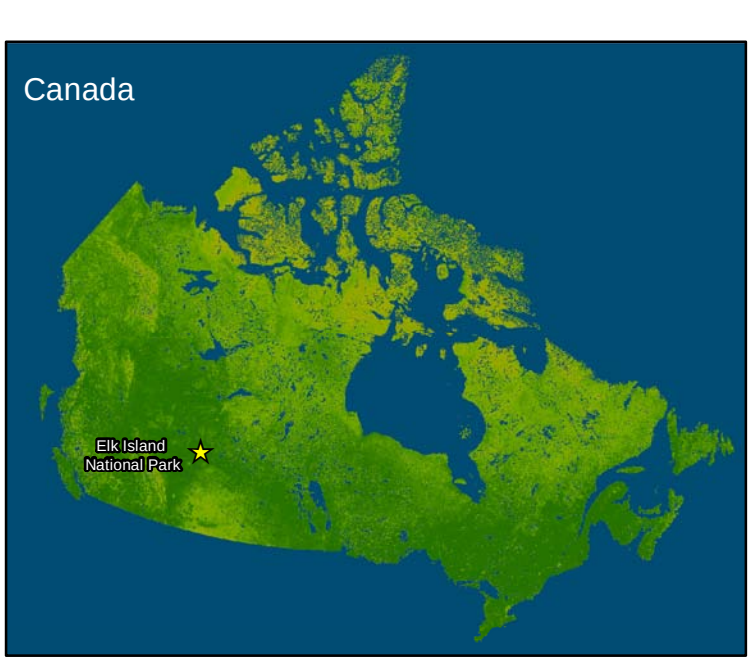
The lagoons are deteriorating, and there is concern that lagoon effluent may be impacting the surrounding environment. Currently, the lagoons receive grey and black water from sinks, showers and toilets from the administration buildings, day use area and campground. Previously, the Administration Area Sewage Lagoon also received waste effluent from the garage; this garage effluent contained various contaminants, including hydrocarbons and inorganic elements. Past inputs into the Recreation Area Sewage Lagoon may have included golf course waste water; however, historical inputs are unknown.

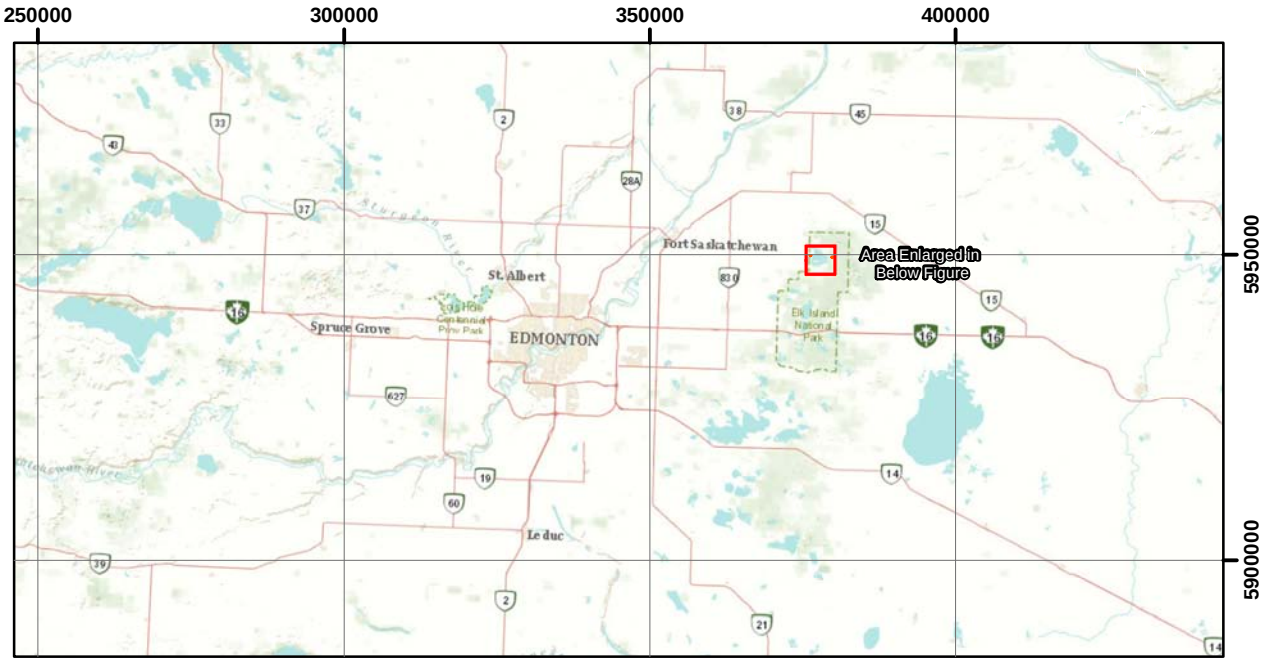
In 2001, Parks Canada procured the services of O'Conner Associates Environmental Inc. to assess the quality of the sediment and water in the lagoons and to assess potential impacts to adjacent wetlands. The investigation conducted at the Administration Area Sewage Lagoon in 2001, referred to as the maintenance area sewage lagoon in the investigation report (O'Connor 2001), reported exceedances of the Canadian Council of Ministers of the Environment (CCME) 1999 soil quality guidelines (agricultural land use) for inorganic elements and polycyclic aromatic hydrocarbons (PAHs) and exceedances of the 1994 Alberta Tier 1 soil criteria (soil assessment and remediation) for petroleum hydrocarbons (PHCs) in lagoon sediments. The investigation also reported exceedances of CCME Canadian Environmental Quality Guidelines (CEQG) for drinking water for inorganic elements in lagoon water. The wetland

receiving effluent from the Administration Area Sewage Lagoon was frozen at the time of sampling so sampling could not be conducted, and as a result, impacts to the administration area wetland could not be evaluated.

The investigation conducted in 2001 at the Recreation Area Sewage Lagoon, referred to as the campground sewage lagoon in the investigation report (O'Connor 2001), reported exceedances of CCME CEQG for both drinking water and freshwater aquatic life for inorganic elements in water collected from the lagoon and exceedances of the CCME CEQG for both drinking water and freshwater aquatic life for inorganic elements (including mercury) in water collected from the wetland next to the lagoon discharge point. There were no exceedances for sediment samples collected from the Recreation Area Sewage Lagoon. The report suggested that some of the exceedances of criteria for inorganic elements may have been representative of background concentrations (O'Connor 2001).

The purpose of the 2013 environmental site assessment was to further assess the environmental quality of the sediment and surface water at the two lagoon sites and adjacent wetlands, and to complete the Phase II Environmental Assessment Report for the site, providing the 2013 results. The information is also being used to prepare the National Classification System for Contaminated Sites (NCSCS) scoring for each of the two sites.





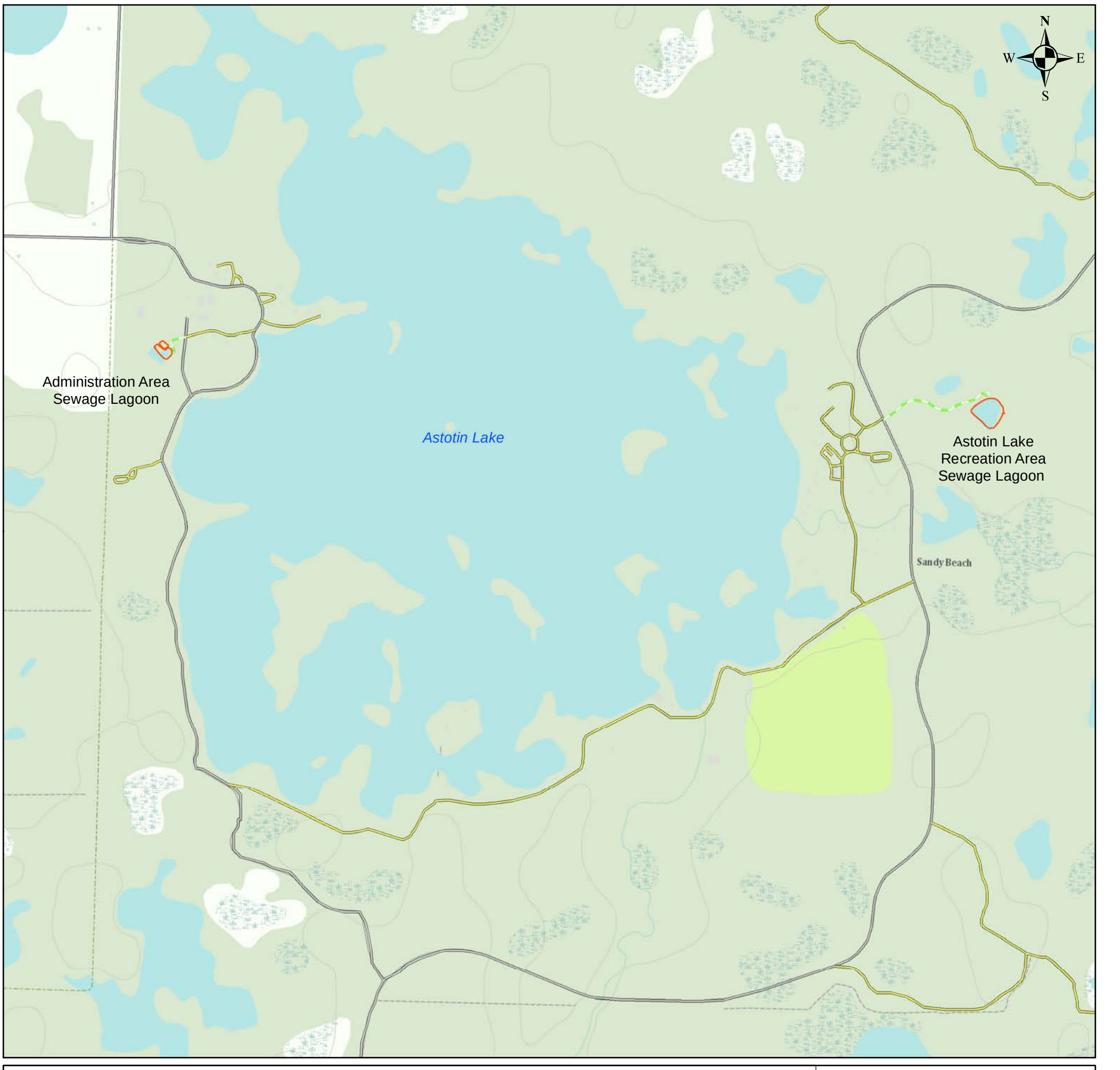


Figure 1: Elk Island National Park - Sewage Lagoon Locations Overview

PHOTO: Elk Island, Alberta PHOTO CREDIT: ALBERTAWOW.COM

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File Path:
J:\Projects\Elk Island - Alberta\ESRI\MXD\Figure-1 Elk Island Overview

Legend

- Main Roadway
- Limited Use Road
- Access Road
- Sewage Lagoon Perimeter

Notes:

SCALE

0 250 500 1,000 Meters

DATA RESOURCES

Original Sources:
Government of Canada
Environmental Sciences Group
ESRI - ArcGIS Base Imagery

Projection:
Universal Transverse Mercator (UTM) - Zone 12N

Datum:
North American Datum 1983 (NAD83)

Software:
ESRI - ArcMAP 10.0

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II. BACKGROUND

A. Sewage Lagoon Descriptions

1. Recreation Area Sewage Lagoon

The Recreation Area Sewage Lagoon was built in 1964 and has not been upgraded since its construction. It consists of a single cell, with a capacity of 22,000 m^3 and a designed depth of 7 m (Parks Canada 2013). Currently, the lagoon receives grey and black water from sinks, showers and toilets from the Astotin day use area and campground. Historical inputs were not documented; however, inputs of waste water from the golf course operations may have been dumped in the lagoon in the past. Input into the lagoon is through an input pipe on the southwest side of the lagoon (Photograph 1). A vacuum truck also discharges contents of various outhouses into the north end of the lagoon. The output control structure, located on the east side of the lagoon, has three valves to control the discharge (Photograph 2). However, the bottom valve is currently seized closed and the middle valve is seized open, maintaining the water level in the lagoon at a constant level as the lagoon discharges when the contents rise above the level of the middle outlet. The discharge from the outlet structure is on the east side of the lagoon (Photograph 3). The discharge flows from the outlet down a narrow channel (Photograph 4), approximately 10 m, to an ephemeral wetland, approximately 30 m by 10 m (Photographs 5 and 6).

Photograph 1: Wide-angle view of Astotin Lake Recreation Area Sewage Lagoon, facing south, with inlet pipe visible at the far right of the photo.

Photograph 2: Close-up of outlet structure on east side of Astotin Lake Recreation Area Sewage Lagoon.

Photograph 3: Outlet pipe from Astotin Lake Recreation Area Sewage Lagoon. Photo taken facing south. Astotin Lake Recreation Area Sewage Lagoon is beyond right-hand edge of photo.

Photograph 4: Flow path from Astotin Lake Recreation Area Sewage Lagoon discharge pipe (at bottom right of photo) towards wetland.

Photograph 5: Ephemeral wetland that receives discharge from Astotin Lake Recreation Area Sewage Lagoon. Wetland was dry during October 2013 visit.

Photograph 6: Wide-angle view of wetland, facing northwest towards Astotin Lake Recreation Area Sewage Lagoon outlet.

2. Administration Area Sewage Lagoon

The Administration Area Sewage Lagoon was built in 1964. In 1977, adjustments were made to the pump house and the pipeline. The lagoon was redesigned in 1984 to convert it from one cell to two. The smaller settling cell has a capacity of 1,000 m^3 and a depth of 1.8 m (Photograph 7), and the larger storage cell has a capacity of 3,000 m^3 and a depth of 3.4 m (Photograph 8) (Parks Canada 2013). Input into the lagoon is through an input pipe in the northern half of the settling cell (Photograph 9). A pipe connects the settling cell and the storage cell at the southern corner of the settling cell, which allows the contents of the settling cell to move to the storage cell after a defined retention period. The output control structure is located towards the western end of the storage cell, along the southwest berm of the lagoon. This control structure is assumed to function as designed; however, it has rarely been used. The control structure discharges into the wetland to the west of the lagoon (Photograph 10).

There is concern for the structural integrity of this facility. The southeast berm has become saturated and has reportedly slumped by approximately 0.6 m (Photograph 11) (Parks Canada 2013). Water overflows this berm into the wetland to the south, downgradient from the lagoon (Photograph 12). Beavers have damaged the interior berms between the settling cell and the storage cell, causing water levels to be even in the two cells (Photograph 13). This raises concern that raw sewage is entering the storage cell after inadequate retention time in the settling cell and is overflowing the southeast berm into the adjacent wetland to the south.

Currently, the Administration Area Sewage Lagoon receives grey and black water from sinks, showers and toilets in the administration buildings and park residence. Historically, the Administration Area Sewage Lagoon also received wastewater from the garage; this wastewater contained various contaminants, including hydrocarbons and inorganic elements.

In the late summer of 2013, the contents of both cells of the Administration Area Sewage Lagoon were sampled and the storage cell was discharged to allow for an engineering inspection of the lagoon.

Photograph 7: Wide-angle view of Administration Area Sewage Lagoon settling cell, facing southeast from the north berm.

Photograph 8: Wide-angle view of the Administration Area Sewage Lagoon storage cell, facing north from south berm. The small settling cell is located behind the berm to the right.

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Photograph 10: Wetland that receives discharge from Administration Area Sewage Lagoon. Photo taken facing west. Discharge outlet is located at base of tree marked with orange flagging tape.

Photograph 11: South berm of Administration Area Sewage Lagoon storage cell, showing areas of slumping. Photo taken facing east.

Photograph 12: Wide-angle view from top of south berm of Administration Area Sewage Lagoon, facing southeast along flow paths into wetland.

Photograph 13: Storage cell of the Administration Area Sewage Lagoon, facing east. Beaver structures are visible in the berm between the storage cell and the settling cell. The blue pipe discharges water from the settling cell into the storage cell.

B. General Approach

Environmental site assessments (ESAs) are performed to investigate a site suspected of environmental contamination, to determine the nature and scope of contamination present. ESAs are normally conducted in an iterative manner, beginning with a Phase I ESA, which determines whether a particular property is or may be subject to potential contamination. This is followed by a Phase II ESA, which seeks to characterize the contaminants of potential concern and compare them to established environmental guidelines. On completion of both phases of the ESA, when specific information is required to develop suitable cleanup options for areas with unacceptable levels of contamination, a Phase III assessment may be conducted.

ESG examined all previous reports regarding the two sewage lagoons to obtain information about potentially contaminating activities and the types of contaminants that may be present. The locations of input and discharge points were used to design a sampling program that would effectively capture all of the information required to make suitable recommendations for the site. Based on the findings of previous assessments and on the history of the two lagoon sites, the analytical suite selected for the sediment samples consisted of a 30-element suite of inorganic elements, PHCs by CCME method,

PAHs, volatile organic compounds, PCBs and chlorinated pesticides (including DDD, DDE and DDT). The analytical suite selected for the surface water samples consisted of all of the parameters used for sediment except the pesticides and PCBs, with additional analyses for water quality parameters such as biological oxygen demand, total suspended solids, total dissolved solids, bacterial analysis and alkalinity.

The sampling program consisted of collecting surface water samples and sediment samples from the lagoons and the wetlands downgradient from the lagoons' discharge points. GPS equipment was used to survey sampling locations in the event that remediation is deemed necessary on the basis of the analytical results.

Groundwater monitoring wells will be installed in March 2014 and the groundwater will be sampled later in the spring. Soil samples from the borehole cores will be collected and analyzed. Results for the groundwater and borehole soil samples will be reported separately. Additional details of the Phase II ESA are provided in Sections II-C and II-D.

III. FIELD PROGRAM DETAILS

The field program outlined in the implementation plans (ESG 2013a and 2013b) proposed two visits to the Park in the fall of 2013. The first trip occurred in October 2013 and involved collection of water samples at the Administration Area Sewage Lagoon and the Recreation Area Sewage Lagoon. Composite surface water samples were collected within the lagoon cells and in the wetlands downgradient from the discharge areas where surface water was present.

The second trip, in November 2013, involved collection of sediment samples at the Administration Area Sewage Lagoon and the Recreation Area Sewage Lagoon and the receiving wetlands and surrounding environment. Sediment sampling efforts in the lagoons focused on the areas of input and output as well as the wetlands downgradient from the discharge locations. As a result of ice more than four inches thick on the surface of both lagoons, the planned sediment sampling method was modified while in the field. The samples were collected by drilling a hole through the ice with a hole saw bit. A long length of two inch PVC pipe was then put through the hole and pushed into the full thickness of the sediment and a rubber seal was placed over the top of the PVC pipe. The PVC pipe was pulled out of the sediment and the sediment was released from the pipe and homogenized prior to sample collection.

Discrete samples at surface and depth from the lagoons were not able to be collected due to the presence of ice at the surface. Ideally a ponar grab would be used to

collect a surface sample from the top 20-30 cm of sediment. However, this was not possible at the time of sampling because it required a larger hole to be drilled through the ice creating a health and safety issue for the team while on the ice. The sediment depth at the sampling locations ranged from 30 to 60 cm. The sediment samples retrieved using the PVC pipe were wet and loose preventing the core samples from being sectioned into different depths. Therefore, only one sediment sample was collected at each location. The overall goal, to determine if contaminants were present inside the lagoon, was achieved using the samples collected.

Sediment samples from the wetlands were collected at surface and at a depth of 30–50 cm when possible, which represents the soil horizon of highest risk (that is, the layer of soil most likely to be in contact with human and ecological receptors).

1. Recreation Area Sewage Lagoon

Two composite water samples were collected from the lagoon. The ephemeral wetland downgradient from the lagoon's discharge point was dry at the time of sample collection, so a surface water sample could not be collected. Sediment sampling in the Recreation Area Sewage Lagoon targeted the inlet in the centre of the lagoon, the north end of the lagoon where the vacuum truck discharges to the lagoon and the outlet on the east side of the lagoon. Sediment samples along the discharge pathway were collected at the discharge point and in the receiving wetland (Appendix A, Map A-3).

2. Administration Area Sewage Lagoon

One composite surface water sample was collected from each of the two lagoon cells. A composite water sample was also collected from the wetlands to the south and to the west. One discrete surface water sample was also collected from the discharge location in the wetland to the west. Sediment sampling in the Administration Area Sewage Lagoon targeted the inlet and the outlet of the settling cell as well as the inlet to the storage cell, the area where the effluent overflows the south side of the storage cell and the outlet at the northwest side of the storage cell. Sediment samples were also collected at the outlet location in the wetland west of the Administration Area Sewage Lagoon and in the wetland to the south, at the point at which the lagoon contents overflow the storage cell berm (Appendix A, Map 4).

A total of 50 samples were collected during the two site visits. Three water samples and 17 sediment samples were collected from the Recreation Area Sewage Lagoon and downgradient wetland. Five water samples and 25 sediment samples were collected from the Administration Area Sewage Lagoon and downgradient wetlands.

3. Reference Guidelines

The appropriate federal guidelines used for comparing and evaluating the laboratory sediment results presented in this report are as follows:

- CCME Sediment Quality Guidelines for the Protection of Aquatic Life (Freshwater) — Interim Sediment Quality Guidelines (ISQGs) (CCME 1999a)
- CCME Sediment Quality Guidelines for the Protection of Aquatic Life (Freshwater) — probable effects levels (PEL) (CCME 1999a)

If sediment guidelines were not available for some parameters, the following soil guidelines for those parameters were used:

- CCME Soil Quality Guidelines for Agricultural Land Use (CCME 1999b)
- Alberta Tier 1 Soil and Groundwater Remediation Guidelines for Natural Areas (Fine Soil) (Alberta 2010)

The CCME freshwater ISQGs are the concentrations below which biological effects are expected to occur rarely and are considered the most protective of aquatic receptors. However, it is not always feasible to clean up a site to these standards, so the PEL, which is the sediment concentration above which adverse effects are expected to occur frequently, was also used to evaluate the sediment results.

The CCME Soil Quality Guidelines (SQGs) are developed on the basis of land use. The CCME SQG for the Agricultural land use was used in evaluating sediment contaminant concentrations if there were no applicable ISQGs or PELs. Agricultural land use, by definition, includes habitat for wildlife and native flora, whereas the Residential/Parkland use specifically excludes national parks. Alberta Tier 1 sediment guidelines for Natural Areas land use were used to evaluate sediment results if there were no applicable federal guidelines. The Natural Areas land use classification, by definition, includes provincial and national parks. The appropriate federal guidelines for comparing and evaluating the surface water laboratory results presented in this report are as follows:

- CCME Water Quality Guidelines for the Protection of Freshwater Aquatic Life (long-term) (CCME 1999d)
- CCME Water Quality Guidelines for the Protection of Agriculture — Livestock (CCME 1999c)

- Alberta Tier 1 Surface Water Quality Guidelines (Livestock) (Alberta 1999)

The CCME Water Quality Guidelines for the Protection of Freshwater Aquatic Life (FAL) provide protection to freshwater life from anthropogenic stressors. This is important to consider, as the surface water and groundwater from both of the lagoons is frequented by wildlife, fish, amphibians and invertebrates (in wetlands and streams) and is assumed to flow into Astotin Lake. The distance of overland flow to the lake is at least 220 m from the Administration Area Sewage Lagoon and 775 m from the Recreation Area Sewage Lagoon. The CCME Water Quality Guidelines for the Protection of Agriculture and the Alberta Tier I Surface Water Quality Guidelines provide protection for livestock and wildlife. This was important to consider, as wildlife in the park may use the downgradient wetlands or rivers as a source of fresh water for consumption.

IV. DISCUSSION OF RESULTS

1. Recreation Area Sewage Lagoon

a. Sediment Assessment

Three samples were collected from the sediment at the bottom of the Recreation Area Sewage Lagoon. One sample was collected near the vacuum truck discharge location on the north side of the lagoon. The second sample was collected near the outlet pipe on the east side of the lagoon. The third sample was collected near the inlet pipe from the lift station near the southwest side of the lagoon (see Map A-3).

One surface sediment sample and one shallow-depth sample were collected east of the lagoon at the outlet of the discharge pipe. Surface and shallow-depth sediment samples were collected from five locations in the wetland at the end of the flow path from the outlet pipe. A total of 17 sediment samples, including two duplicates samples, were collected (see Map A-3).

Ten samples were analyzed for inorganic elements and mercury, four samples were analyzed for PHCs, PAHs, volatile organic compounds (VOCs) and polychlorinated biphenyls (PCBs) and six samples were analyzed for chlorinated pesticides. Results of the analysis are provided in Appendix B, Tables B-1–B-6. A summary table of samples which exceed the CCME Freshwater ISQGs and CCME Freshwater PELs is provided in Table 1. Exceedances of the soil quality guidelines are not included in Table 1.

Results for three sediment samples collected inside the lagoon exceeded the CCME Freshwater ISQGs for copper, cadmium, arsenic and pesticides DDD and DDE.

Two samples from the lagoon exceeded the CCME Freshwater PEL for DDD. Two sediment samples from the discharge location and the wetland exceeded the ISQGs for copper, arsenic, zinc and DDE (Appendix A, Map A-3). No exceedances of the PEL for any of the analytes were observed in the wetland. Zinc which exceeded the ISQG in the wetlands, was also present in lagoon sediment samples; however, the analytical results were below the ISQG criterion.

All results were above the SQGs for boron and results for eight of ten samples were above the SQG for sulfur; these elements are therefore suspected to be naturally elevated in the area.

Table 1: Summary of sediment samples in the Astotin Lake Recreation Area Sewage Lagoon and wetland which had exceedances over the CCME Freshwater ISQGs and CCME Freshwater PELs.

Sample Number	Location	ISQG Exceedances	PEL Exceedances
13-10634	Recreation Area Sewage Lagoon	• arsenic, cadmium, copper	
13-10635	Recreation Area Sewage Lagoon	• DDD, DDE	• DDD
13-10636	Recreation Area Sewage Lagoon	• arsenic, copper, DDD, DDE	• DDD
13-10637	Discharge Location	• copper, zinc, DDE	
13-10639	Eastern Wetland	• arsenic, DDE	

b. Surface Water Assessment

Three surface water samples, including one duplicate sample, were collected in October 2013. The samples were composite samples from four locations in the lagoon cell. Samples were collected from the edge of the lagoon using an extension rod to reach the sample bottle out as far as possible (see Map A-4). Surface water samples could not be collected from the wetland as there was no surface water present at the time of sampling.

All samples were analyzed for inorganic elements, mercury, PHCs, PAHs, VOCs, oil and grease, anions (fluoride, chloride, nitrate, nitrite, sulphate), hardness, biological oxygen demand (BOD), phosphorus, ammonia, total Kjeldahl nitrogen, total dissolved solids, total suspended solids, conductivity and pH. Results of the analysis are provided

in Appendix B, Tables B-13–B-17. A summary table of samples which exceed the CCME Freshwater Aquatic Life criteria is provided in Table 2.

Surface water samples in the Recreation Area Sewage Lagoon were above the CCME FAL criteria for aluminium, chromium, lead, mercury, silver and zinc. Also results from one of the surface water samples were above CCME FAL criteria for three PAHs: anthracene, benzo(a)anthracene and benzo(a)pyrene (Appendix A, Map A-3).

Table 2: Summary of surface water samples in the Astotin Lake Recreation Area Sewage Lagoon which had exceedances over the CCME FAL.

Sample Number	Location	FAL Exceedances
13-10600/01	Recreation Area Sewage Lagoon	• anthracene, benzo(a)anthracene, benzo(a)pyrene
13-10602	Recreation Area Sewage Lagoon	• aluminum, chromium, lead, mercury, silver, zinc

2. Administration Area Sewage Lagoon

a. Sediment Assessment

Two sediment samples were collected from the bottom of the settling cell and three sediment samples were collected from the bottom of the storage cell. Surface and depth samples were collected from five locations in the wetland south of the lagoon, downgradient from where the lagoon contents overflow the south berm. Samples were collected from five locations at the discharge point and in the wetland to the west of the lagoon. Due to the amount of surface water present in the western wetland, depth samples were not able to be collected at three locations (see Map A-4).

Twenty samples were analyzed for inorganic elements, PHCs, PAHs and VOCs, eight samples were analyzed for chlorinated pesticides and four samples were analyzed for mercury and PCBs. Results of the analysis are provided in Appendix B, Tables B-7–B-12. A summary table of sediment samples which exceed the CCME Freshwater ISQGs and CCME Freshwater PELs is provided in Table 3, but exceedances of the soil quality guidelines are not included.

Results for two sediment samples in the settling cell were above the ISQGs for arsenic, cadmium, copper, zinc, DDD, DDE, DDT and PAHs (acenaphthene, naphthalene and phenanthrene). One sample from the settling cell was just below the ISQG for

mercury (criterion was 0.17 ppm and result was 0.16 ppm). Zinc, DDD and DDE results also exceeded the PEL. In cases where no sediment guidelines exist, the results were compared to the CCME SQGs for Agricultural land use. Samples from the settling cell exceeded the SQGs for selenium, tin, toluene and VOCs (1,2-dichlorobenzene and 1,4-dichlorobenzene) and the Alberta Tier 1 guideline for the VOC chlorobenzene. The result for only one sample from the settling cell exceeded the CCME Canada-wide Standards for the F-3 fraction of PHCs (Appendix A, Map A-4).

Results for three sediment samples from the storage cell were above the ISQGs for DDD, DDE, DDT and PAHs (naphthalene, acenaphthene and acenaphthylene) and one sample was above the PEL for DDD and DDE. Results were above the SQGs for selenium, toluene and the Alberta Tier 1 criterion for 1,4-dichlorobenzene (Appendix A, Map A-4).

Results for seven sediment samples from the wetland to the south of the lagoon were above the ISQGs for cadmium, DDD, DDE, DDT and PAHs (acenaphthene, acenaphthylene, fluorene, naphthalene and phenanthrene). Results for three samples were above the PEL for DDD, DDE and DDT. Results were above the SQGs for the VOCs toluene and 1,1,2-trichloroethane (Appendix A, Map A-4). PCBs were detected in the southern wetland but were below all criteria.

In the wetland west of the lagoon, where the discharge pipe is located, four results were above the ISQGs for arsenic, DDE and PAHs (acenaphthene and phenanthrene). No results were above the PELs. SQGs were exceeded for the VOCs toluene (only immediately at the discharge point) and 1,1,2-trichloroethane and for the PAH naphthalene (Appendix A, Map A-4).

All results for sediment in both cells of the lagoon and both wetlands were above the SQGs for boron and sulfur, and these elements are therefore suspected to be naturally elevated in the area. PCBs were detected but below all relevant criteria.

Table 3: Summary of sediment samples in the Administration Area Sewage Lagoon and downgradient wetlands which had exceedances over the CCME ISQG or CWS and CCME PEL.

Sample Number	Location	ISQG/CWS Exceedances	PEL Exceedances
13-10628	Small Settling Cell	• arsenic, cadmium, copper, zinc, acenaphthene, phenanthrene, DDD, DDE, DDT	• zinc, DDD, DDE
13-10629	Small Settling Cell	• copper, acenaphthene, naphthalene, F3	
13-10630/31	Large Storage Cell	• acenaphthylene, naphthalene	
13-10632	Large Storage Cell	• acenaphthene	
13-10633	Large Storage Cell	• acenaphthene, DDD, DDE, DDT	• DDD, DDE
13-10608	Southern Wetland	• cadmium	
13-10610/11	Southern Wetland	• fluorene, DDD, DDE, DDT	• DDD, DDE, DDT
13-10612	Southern Wetland	• phenanthrene, DDD, DDE, DDT	• DDD, DDT
13-10613	Southern Wetland	• cadmium, phenanthrene	
13-10614	Southern Wetland	• acenaphthene, acenaphthylene, phenanthrene	
13-10615	Southern Wetland	• DDD, DDE, DDT	• DDD, DDE
13-10617	Southern Wetland	• acenaphthene, acenaphthylene, naphthalene	
13-10618	Southern Wetland	• acenaphthene	
13-10619	Discharge Location	• arsenic	
13-10620/21	Discharge Location	• arsenic, DDE	
13-10623	Western Wetland	• acenaphthene, phenanthrene	
13-10624	Western Wetland	• acenaphthene, phenanthrene	

b. Surface Water Assessment

One composite effluent sample was collected from four discrete locations in the settling cell, and one composite effluent sample was collected from three discrete locations in the storage cell. Composite samples were composed of equal volumes of water from each discrete location. Samples were collected from the edge of the lagoon using an extension rod to reach the sample bottle out as far as possible. As the lagoon contents had been discharged a few months prior, there was a significantly smaller volume in the lagoon than was normally present.

One composite surface water sample was collected from three discrete locations in the wetland to the south, in the area where the lagoon contents overflow the berm. As little water was present at the time of sampling, this sample contained a significant amount of sediment. Two surface water samples were collected from the wetland to the west and from the discharge location. A discrete sample was collected immediately at the outlet of the discharge pipe, and one composite sample composed of surface water from three discrete locations was collected from further in the wetland. Results of the analysis are provided in Appendix B, Tables B-13–B-17.

All samples were analyzed for inorganic elements, mercury, PHCs, PAHs, VOCs, oil and grease, anions (fluoride, chloride, nitrate, nitrite, sulphate), hardness, BOD, phosphorus, ammonia, total Kjeldahl nitrogen, total dissolved solids, total suspended solids, conductivity and pH (Appendix A, Map A-4). Oil and grease was detectable, however, there is no applicable criteria.

Results for surface water samples collected in the lagoon exceeded the CCME FAL criterion for aluminum. Results for surface water samples from both wetlands exceeded the CCME FAL criteria for aluminum, arsenic, chromium, mercury, zinc and benzo(a)anthracene (Appendix A, Map A-4). A summary table of samples which exceed the CCME Freshwater Aquatic Life criteria is provided in Table 4. Oil and grease were detectable but since there are no applicable criteria for comparison to impacted samples the results for oil and degrease were not evaluated.

Table 4: Summary of surface water samples in the Administration Area Sewage Lagoon and downgradient wetlands which had exceedances over the CCME FAL.

Sample Number	Location	FAL Exceedances
13-10606	Small Settling Cell	• aluminum,
13-10603	Southern Wetland	• aluminum, arsenic, chromium, mercury, zinc, benzo(a)anthracene
13-10604	Discharge Location	• arsenic, benzo(a)anthracene
13-10605	Western Wetland	• aluminum, arsenic, chromium, mercury, zinc

3. NCSCS Scoring

The NCSCS scoring was completed in 2014 on the basis of results from the 2013 sampling program. The NCSCS score for the Administration Area Sewage Lagoon was 74.4, which represents a Class 1 classification. However, because 19% of responses were "do not know," the site is classified as an INS (insufficient information) site.

The NCSCS score for the Recreation Area Sewage Lagoon was 69.5, which represents a Class 2 classification. However, as 17% of responses were "do not know," the site is classified as an INS site.

The groundwater and borehole soil results, when they become available, will be used to update the NCSCS scores. This will reduce the overall number of "do not know" responses.

V. SUMMARY AND RECOMMENDATIONS

In October and November 2013, ESG completed an additional Phase II ESA at the Administration Area Sewage Lagoon and the Recreation Area Sewage Lagoon in Elk Island National Park, AB. The ESA investigated the environmental quality of the sediment and surface water at the two lagoon sites and in the adjacent wetlands. The information was used to complete the Phase II Assessment Report for the site and to initiate the NCSCS scoring for each of the two sites. A total of 50 samples, 42 sediment samples and eight surface water samples, were collected during the two site visits.

A. Recreation Area Sewage Lagoon

Three sediment samples from the Recreation Area Sewage Lagoon exceeded the CCME Freshwater ISQGs for copper, cadmium, arsenic, DDD and DDE. Two samples

from within the lagoon exceeded the CCME Freshwater PEL for DDD. Two results for sediment samples from the discharge location and the wetland exceeded the ISQGs for copper, arsenic, zinc and DDE. All sediment sample results from within the lagoon and the wetland exceeded the SQGs for boron, and results for eight of ten samples were above the SQGs for sulfur. Because of the widespread elevated levels of boron and sulfur in sediment, both are suspected to be naturally elevated in the area. Results for sediment samples from the discharge location and the wetland indicate that exceedances of copper, arsenic and zinc are present only in surface sediment (0–10 cm). The depth sample at the discharge location was not analyzed for DDE, thus it is not known whether this contaminant is present in deeper sediments. The depth sample in the wetland, for the surface sample which exceeded for DDE, was below criteria. Therefore, the contamination in the wetland appears to be in the surface sediments, while it is unknown what depth DDE contamination reaches at the discharge location.

Results for one surface water sample in the Recreation Area Sewage Lagoon were above the CCME FAL criteria for aluminium, chromium, lead, mercury and zinc. The result for one surface water sample from within the lagoon was above CCME FAL criteria for three PAHs (anthracene, benzo(a)anthracene and benzo(a)pyrene).

The NCSCS scoring was completed in 2014 on the basis of the result from the 2013 sampling program. The NCSCS score for the Recreation Area Sewage Lagoon, 69.5, represents a Class 2 site; however, it is classified as an INS site because of insufficient information.

The results for the Recreation Area Sewage Lagoon and the adjacent wetland indicate that lagoon effluents containing DDE and inorganic contaminants are impacting the receiving wetland. Sediment inside the lagoon had contaminant level exceedances of both the ISQGs and the PELs. In the wetland, contaminant levels in the sediment exceeded ISQGs but had no PEL exceedances, an indication that the contamination may be partially contained in the Recreation Area Sewage Lagoon or that contaminant levels are being diluted by being in a less confined environment. Additional sampling of sediment and surface water along the flow path is recommended to determine the extent of the contamination in the receiving wetland and the potential for offsite impacts.

If the Recreation Area Sewage Lagoon is decommissioned, the sediment in the lagoon should be disposed appropriately according to the contaminants.

B. Administration Area Sewage Lagoon

The results for sediment in the Administration Area Sewage Lagoon settling cell exceeded the CCME ISQGs for arsenic, cadmium, copper, zinc, DDD, DDE, DDT and PAHs (acenaphthene, naphthalene and phenanthrene). Only the results for zinc, DDD and DDE also exceeded the CCME PEL. One sediment sample from the settling cell exceeded the CCME Canada-wide Standards for the F-3 fraction of PHCs. Results for sediment in the settling cell exceeded the SQGs for selenium, tin, toluene and VOCs (1,2-dichlorobenzene and 1,4-dichlorobenzene) and the Alberta Tier 1 guideline for one VOC (chlorobenzene).

The sediment results for the Administration Area Sewage Lagoon storage cell exceeded the CCME ISQGs for DDD, DDE, DDT and two PAHs (acenaphthene, naphthalene and acenaphthylene) and the PEL for DDD and DDE. Sample results were above the CCME SQGs for selenium, toluene and the Alberta Tier 1 guideline for one VOC (1,4-dichlorobenzene).

The results of the sediment sample analysis for the wetland south of the Administration Area Sewage Lagoon were above the CCME ISQGs for cadmium, DDD, DDE, DDT and PAHs (acenaphthene, acenaphthylene, fluorene, naphthalene and phenanthrene). Results were above the CCME PEL for DDD, DDE and DDT and were above the CCME SQGs for two VOCs (toluene and 1,1,2-trichloroethane). Analysis of sediment samples from the south wetland indicate that DDD, DDE, DDT, acenaphthene, acenaphthylene, naphthalene, phenanthrene and 1,1,2-trichloroethane are present at surface (0–10 cm) and at depth (30–40 cm). Cadmium, fluorene and toluene were present only in surface sediments (0–10 cm), indicating that a clean depth boundary exists for these three contaminants.

The results of the analysis for sediment samples from the discharge pipe location in the wetland west of the Administration Area Sewage Lagoon were above the ISQGs for arsenic, DDE and PAHs (acenaphthene and phenanthrene). No results were above the PELs. SQGs were exceeded for VOCs toluene and 1,1,2-trichloroethane and for the PAH naphthalene. Analysis of sediment samples from the west wetland indicate that arsenic, acenaphthene, phenanthrene and 1,1,2-trichloroethane are present at surface (0–10 cm) and at depth (30–40 cm). DDE was present only at depth (30–40 cm). Toluene was present only in surface sediments (0–10 cm).

Results for all sediment samples from within the Administration Area Sewage Lagoon and both wetland exceeded the SQGs for boron and sulfur. Given the widespread

elevated levels of boron and sulfur, both are suspected to be naturally elevated in the area and representative of background conditions. A similar observation was made by O'Connor Associates Environmental Inc. (2001).

Surface water samples from within the Administration Area Sewage Lagoon were above the CCME FAL criterion for aluminum. Surface water samples from both wetlands exceeded the CCME FAL criteria for aluminum, arsenic, chromium, mercury, zinc and benzo(a)anthracene.

Results for sediment from within both cells of the lagoon exceeded the ISQGs and the PELs, as they did for sediment from the southern wetland. These results indicate that lagoon contents overflowing the south berm of the lagoon have resulted in contamination of the wetland to the south. Results for sediment in the wetland to the west of the Administration Area Sewage Lagoon exceeded the ISQGs but not the PELs, which indicates that the wetland has been contaminated by discharge events but to a lesser extent.

The NCSCS scoring was completed in 2014 on the basis of the results of the 2013 sampling program. The Administration Area Sewage Lagoon's score of 74.4 represented a Class 1 site; however, it is classified as an INS site because of insufficient information.

It is recommended that the south berm of the lagoon be repaired to prevent future overflow and allow sufficient retention time within the lagoon. It is also recommended that further sampling of sediment and surface water along the flow pathway be completed to determine the extent of the contamination.

If the Administration Area Sewage Lagoon is decommissioned, the sediment inside the lagoon cells should be disposed of appropriately according to the contaminants.

C. Groundwater and Soil Sampling Program

Groundwater monitoring wells will be installed at the Administration Area Sewage Lagoon and the Recreation Area Sewage Lagoon in late March 2014 (see Maps A-1 and A-2 for proposed monitoring well locations). Soil samples will be collected from the borehole cores taken during installation of the wells. A minimum of two samples from each borehole core will be analyzed for the parameters that exceed guidelines. This information will assist in determining the contamination of soils at each site. Additionally, the groundwater sampling program scheduled for the spring of 2014 will help to assess the impacts of the lagoons on local groundwater. Sampling of soils and groundwater will help to resolve some of the unknowns in the NCSCS scoring.

VI. REFERENCES

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Canadian Council of Ministers of the Environment (CCME 1999c). Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses. Winnipeg, MB.

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O'Connor Associates Environmental Inc. (O'Connor 2001). Phase II Environmental Site Assessment, Elk Island National Park, Alberta. May 2001.

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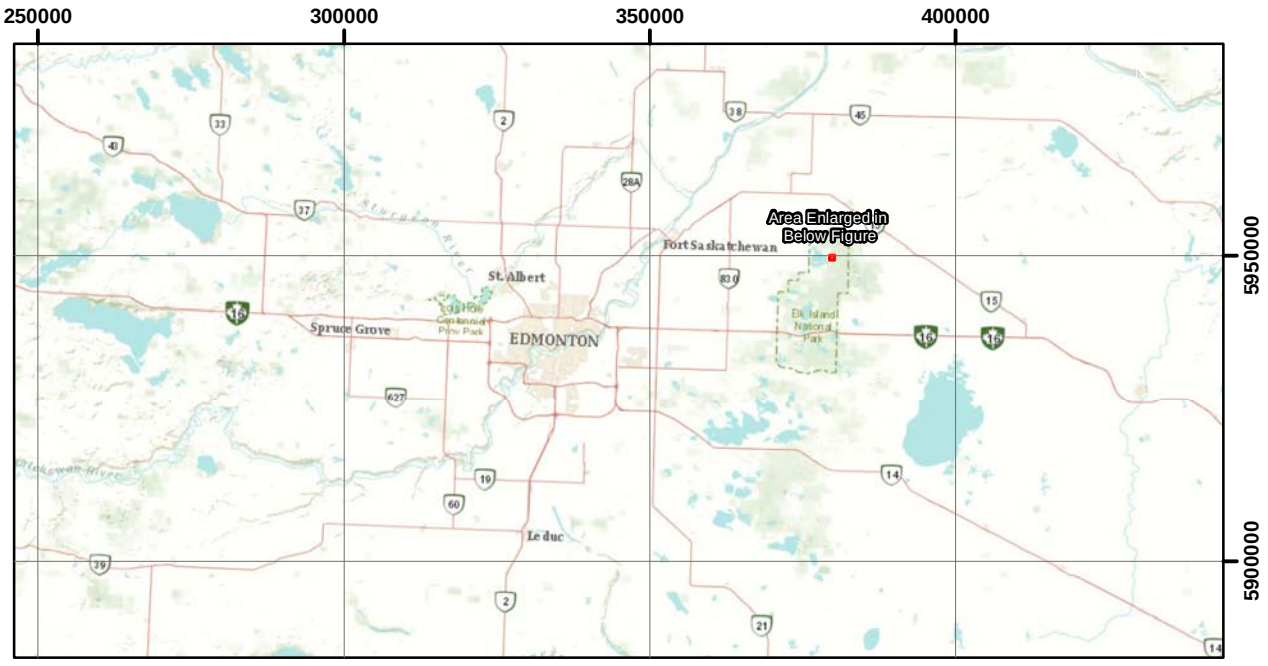
APPENDIX A: MAPS

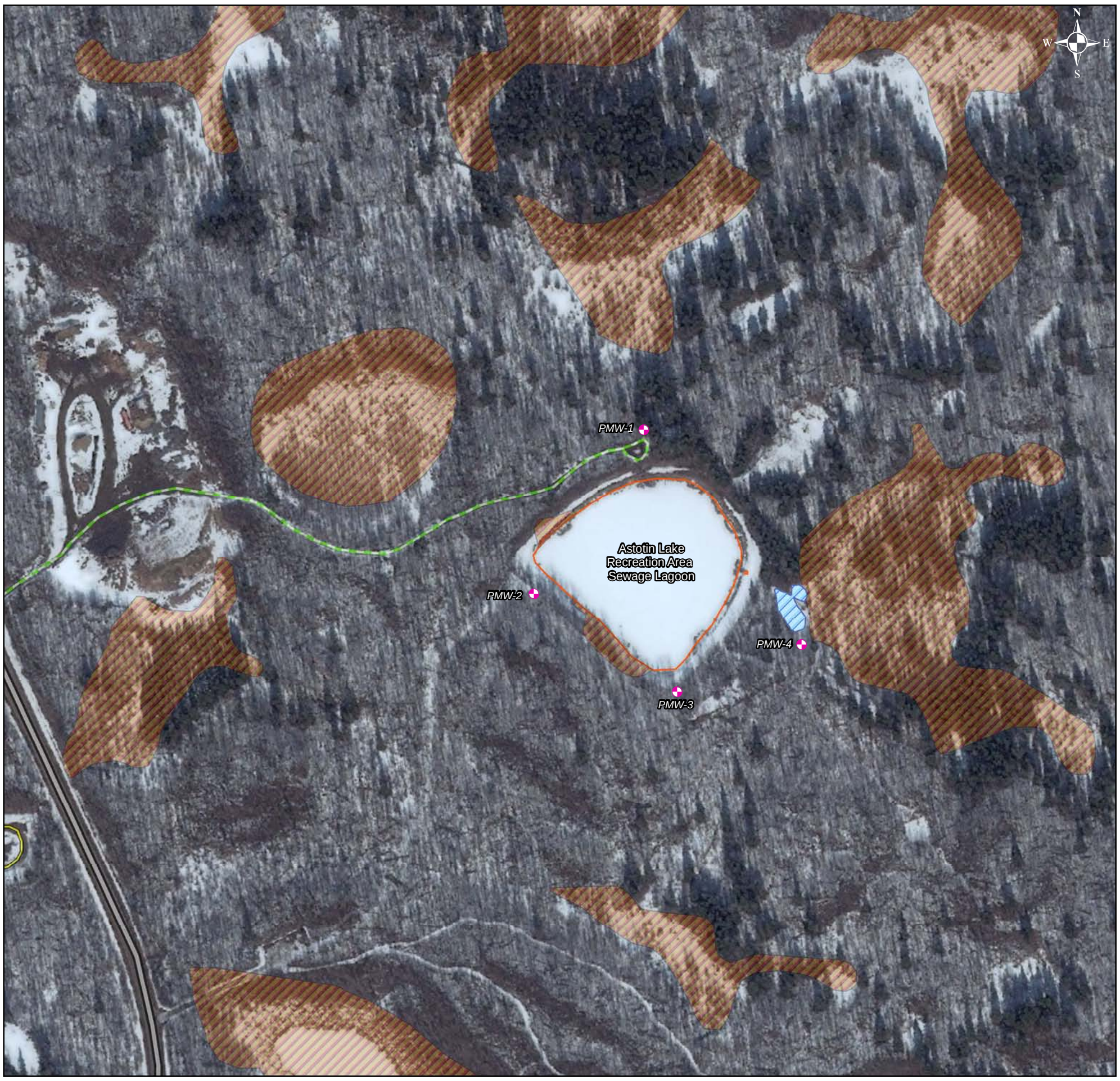
Map A-1: Elk Island National Park — Overview of Recreation Area Sewage Lagoon & Proposed Monitoring Well Locations

Map A-2: Elk Island National Park — Overview of Administration Area Sewage Lagoon & Proposed Monitoring Well Locations

Map A-3: Elk Island National Park — Recreation Area Sewage Lagoon Sample Locations

Map A-4: Elk Island National Park — Administration Area Sewage Lagoon Sample Locations





Map A-1: Elk Island National Park - Overview of Astotin Lake Recreation Area Sewage Lagoon & Proposed Monitoring Well Locations

PHOTO: Elk Island, Alberta PHOTO CREDIT: ALBERTAWOW.COM

PUBLISHED:
REVISED: November 4/2013 Jeff Donald
PRINTED: November 4/2013 GIS Technician

File Path:
J:\Projects\Elk Island - Alberta\ESRI\
MXD\Map A-1-RASL-Roadway

Legend

- Access Road
- Limited Use Road
- Main Roadway
- Sewage Lagoons
- 2014 Proposed Monitoring Well Location
- Marsh Area - Provided By Parks Canada
- Wetland Area - Assessed by ESG

Notes:

PMW (Proposed Monitoring Well)
Distances were measured by the shortest length to the area of interest.

PMW-1:
35 metres from Lagoon

PMW-2:
14 metres from Lagoon

PMW-3:
15 metres from Lagoon

PMW-4:
60 metres from Lagoon

SCALE

0 37.5 75 150
Meters

DATA RESOURCES

Original Sources:
Government of Canada
Environmental Sciences Group
ESRI - ArcGIS Base Imagery

Projection:
Universal Transverse Mercator (UTM) - Zone 12N

Datum:
North American Datum 1983 (NAD83)

Software:
ESRI - ArcMAP 10.0

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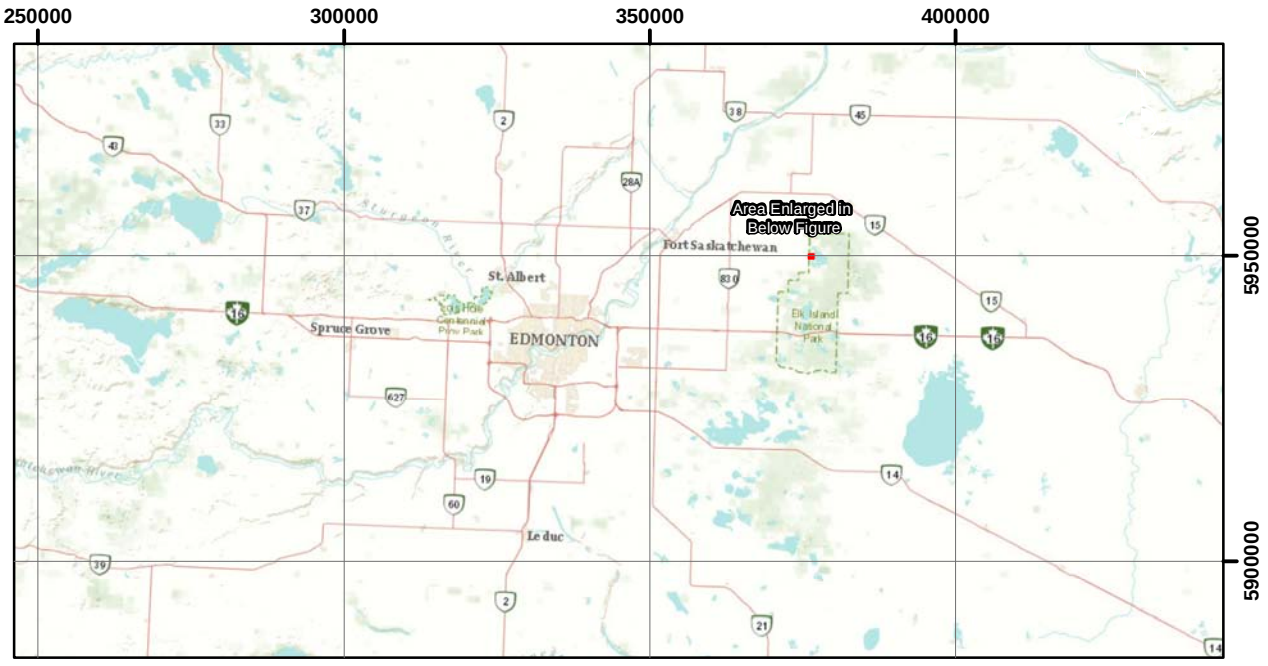

Map A-2: Elk Island National Park - Overview of Administration Area Sewage Lagoon & Proposed Monitoring Well Locations

PHOTO: Elk Island, Alberta PHOTO CREDIT: ALBERTAWOW.COM

PUBLISHED:
REVISED: November 4/2013 Jeff Donald
PRINTED: November 4/2013 GIS Technician

File Path:
J:\Projects\Elk Island - Alberta\ESRI\
MXD\Map-A-2-ASL-Roadway

Legend

- Access Road
- Limited Use Road
- Main Roadway
- Sewage Lagoons
- 2014 Proposed Monitoring Well Location
- Marsh Area - Provided By Parks Canada
- Wetland Area - Assessed by ESG

Notes:

PMW (Proposed Monitoring Well)
Distances were measured by the shortest length to the area of interest.

PMW-5:
11 metres from Lagoon

PMW-6:
11 metres from Lagoon

PMW-7:
7 metres from Lagoon

PMW-8:
75 metres from Lagoon

SCALE

0 25 50 100
Meters

DATA RESOURCES

Original Sources:
Government of Canada
Environmental Sciences Group
ESRI - ArcGIS Base Imagery

Projection:
Universal Transverse Mercator (UTM) - Zone 12N

Datum:
North American Datum 1983 (NAD83)

Software:
ESRI - ArcMAP 10.0

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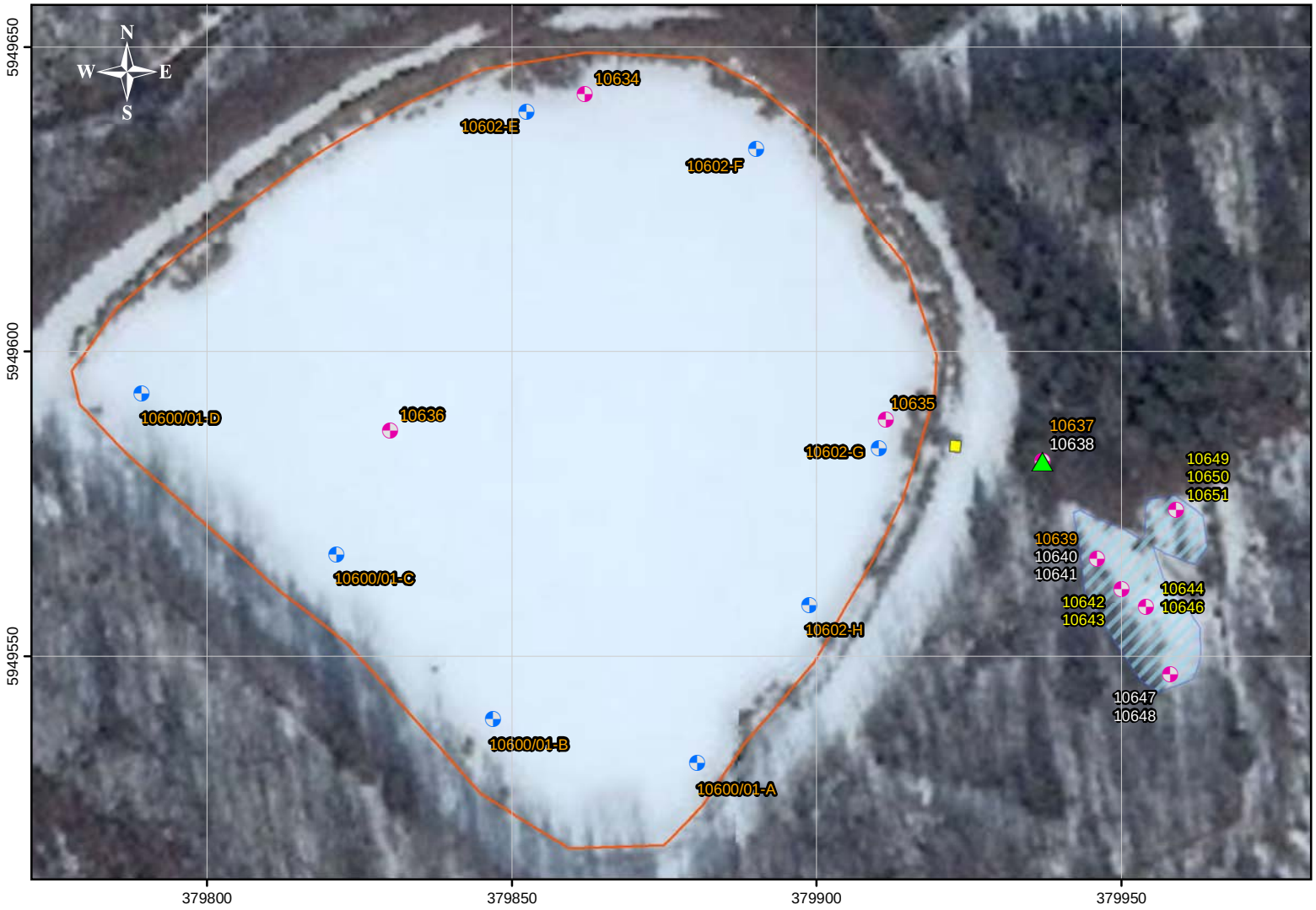

Map A-3: Elk Island National Park Recreation Area Sewage Lagoon Sample Locations

LEGEND

- Discharge Outlet from Lagoon
- Surface Water Sample - October 24 2013
- Sediment Sample - November 19/20 2013
- 106XX — Sample Below Guidelines
- 106XX — Sample Exceeds Guidelines
- 106XX — Sample was not Analyzed
- Control Structure
- Sewage Lagoon Perimeter
- Wetland

NOTES:

Sewage Lagoon Perimeter was accurately surveyed using a differential global positioning system on October 26th 2013

Surface Water Samples:
10600: Composite Sample from discrete locations A, B, C and D
10601: Composite Sample from discrete locations A, B, C and D
10602: Composite Sample from discrete locations E, F, G and H

Sediment Samples:
Results were compared to the CCME Freshwater Interim Sediment Quality Guidelines. If sediment Guidelines did not exist, the results were compared to the CCME Soil Quality Guidelines for Agricultural Landuse.

DATA RESOURCES

Original Sources:
Government of Canada
Environmental Sciences Group
Parks Canada
ESRI - ArcGIS Base Imagery

Datum:
North American Datum 1983 (NAD83)

Projection:
Universal Transverse Mercator (UTM) Zone 12N

Software:
ESRI - ArcMAP 10.0

File Path:
J:\Projects\Elk Island - Alberta\ESRI\MXD\Map A-3 - Recreational Area Sewage Lagoon

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PRINTED: January 14/2014
Jeff Donald GIS Technician

PHOTO: Elk Island, Alberta PHOTO CREDIT: ALBERTAWOW.COM

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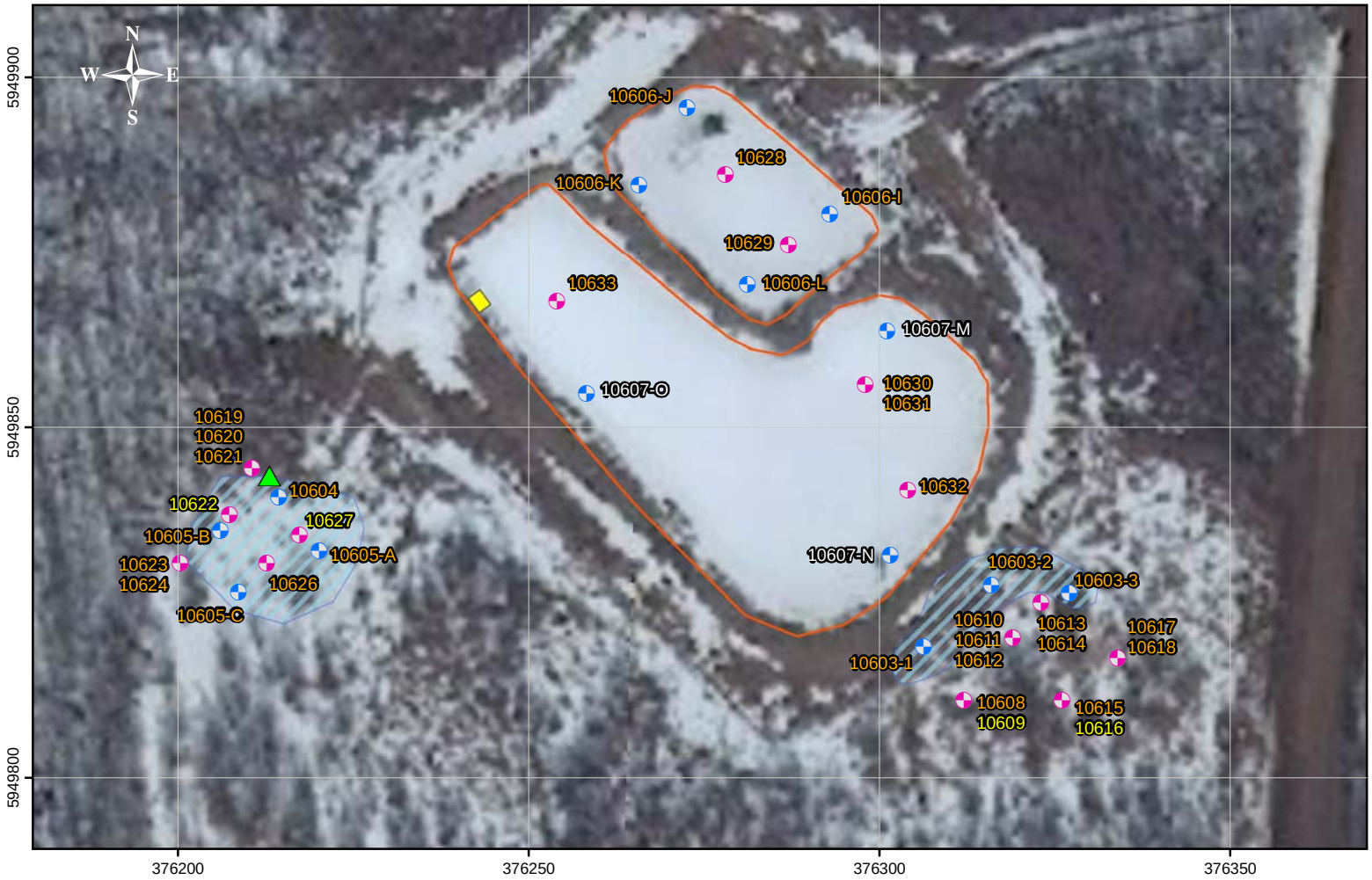
Guideline Description	Sediment Sample – ISQG, PEL, SQG, AB Tier I Exceedances	Surface Water Sample – FAL and PA Exceedances
CCME Sediment Quality Guidelines: Freshwater Interim Sediment Quality Guideline - *(ISQG)*	*10634:* Cd, Cu	*10600:* PAHs - Anthracene, Benzo(a)anthracene, Benzo(a)pyrene
CCME Sediment Quality Guidelines: Freshwater Probable Effect Limit - *(PEL)*	*10635:* DDD, DDE	*10601:* PAHs - Benzo(a)anthracene, Benzo(a)pyrene
CCME Soil Quality Guidelines: Agricultural Land Use - *(SQG)*	*10636:* DDD, DDE, As, Cu	*10602:* Al, Cr, Pb, Hg, Zn
Province of Alberta Guidelines: Alberta Tier I Soil Remediation Guidelines - Natural Area - *(AB)*	*10637:* Zn, Cu, DDE	
CCME Surface Water Quality Guidelines: Protection of Freshwater Aquatic Life - *(FAL)*	*10639:* As, DDE	
CCME Surface Water Quality Guidelines: Protection of Agriculture - Livestock - *(PA)*		



Map A-4: Elk Island National Park Administration Area Sewage Lagoon Sample Locations

LEGEND

- Discharge Outlet from Lagoon
- Surface Water Sample - October 24 2013
- Sediment Sample - November 19/20 2013
- 106XX — Sample Below Guidelines
- 106XX — Sample Exceeds Guidelines
- 106XX — Sample was not Analyzed
- Control Structure
- Sewage Lagoon Perimeter
- Wetland

NOTES:

Sewage Lagoon Perimeter was accurately surveyed using a differential global positioning system on October 26th 2013

Surface Water Samples:
10603: Composite Sample from discrete locations 1, 2 and 3
10605: Composite Sample from discrete locations A, B and C
10606: Composite Sample from discrete locations I, J, K and L
10607: Composite Sample from discrete locations M, N and O

Sediment Samples:
Results were compared to the CCME Freshwater Interim Sediment Quality Guidelines. If sediment Guidelines did not exist, the results were compared to the CCME Soil Quality Guidelines for Agricultural Landuse.

** All samples collected were above SQG and AB criteria for Boron and Sulphur with the exception of depth samples 10638, 10640, and 10648.**

DATA RESOURCES

Original Sources:
Government of Canada
Environmental Sciences Group
Parks Canada
ESRI - ArcGIS Base Imagery

Datum:
North American Datum 1983 (NAD83)

Projection:
Universal Transverse Mercator (UTM) Zone 12N

Software:
ESRI - ArcMAP 10.0

File Path:
J:\Projects\Elk Island - Alberta\ESRI\MXD\Map A-4 - Administration Area Sewage Lagoon

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Jeff Donald GIS Technician

PHOTO: Elk Island, Alberta PHOTO CREDIT: ALBERTAWOW.COM

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Guideline Description	Sediment Sample – ISQG, PEL, SQG, AB Tier I Exceedances	Surface Water Sample – FAL and PA Exceedances
CCME Sediment Quality Guidelines: Freshwater Interim Sediment Quality Guideline - *(ISQG)*	*10608:* Cd, Toluene	*10603:* Al, As, Cr, Hg, Zn / PAH - Benzo(a)anthracene
CCME Sediment Quality Guidelines: Freshwater Probable Effect Limit - *(PEL)*	*106310-12:* DDD, DDE, DDT, PAH - Fluorene, VOCs	*10604:* As, Benzo(a)anthracene
CCME Soil Quality Guidelines: Agricultural Land Use - *(SQG)*	*10613:* Cd, PAHs	*10605:* Al, As, Cr, Hg, Zn/ PAH - Benzo(a)anthracene
Province of Alberta Guidelines: Alberta Tier I Soil Remediation Guidelines - Natural Area - *(AB)*	*10614:* PAHs	*10606:* Al
CCME Surface Water Quality Guidelines: Protection of Freshwater Aquatic Life - *(FAL)*	*10615:* DDD, DDE, DDT	
CCME Surface Water Quality Guidelines: Protection of Agriculture - Livestock - *(PA)*	*10617-18:* PAHs, VOCs	
	10619: As, Toluene / *10620:* PAHs, DDE / *10621:* As, DDE	
	10623-24: PAHs, VOCs	
	10626: PAHs, VOCs	
	10628: Se, Tin, Cd, As, Zn, Cu, PAH, DDD, DDE, DDT, Toluene, VOCs	
	10629: Cu, As, F3, PAH, Toluene, VOCs	
	10630-31: Se, PAH, Toluene, VOCs	
	10632: PAH, Toluene	

APPENDIX B: DATA TABLES

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Table B-2: Recreation Area Lagoon & Wetland, Polychlorinated Biphenyl (PCB) Sediment Sample Analytical Results

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Table B-4: Recreation Area Lagoon & Wetland, VOC and BTEX Sediment Sample Analytical Results

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Table B-9: Administration Area Lagoon & Wetlands, Petroleum Hydrocarbon (PHC) Sediment Sample Analytical Results

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Table B-12: Administration Area Lagoon & Wetlands, Pesticide Sediment Sample Analytical Results

Table B-13: Surface Water Sample Inorganic Element Analytical Results

Table B-14: Surface Water Sample Hydrocarbon Analytical Results

Table B-15: Surface Water Sample Polycyclic Aromatic Hydrocarbons (PAH) Analytical Results

Table B-16: Surface Water Sample VOC Analytical Results

Table B-17: Surface Water Sample Bacterial, Nutrients, and Other Parameters Analytical Results

Table B-1: Recreation Area Lagoon & Wetland, Inorganic Element Sediment Sample Analytical Results

Sample #	Location	Date	Depth (cm)	Aluminum (Al)	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Boron * (B)	Cadmium (Cd)	Calcium (Ca)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Magnesium (Mg)	Manganese (Mn)	Mercury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Phosphorus (P)	Potassium (K)	Selenium (Se)	Silver (Ag)	Sodium (Na)	Strontium (Sr)	Sulphur (S)	Thalium (Tl)	Tin (Sn)	Titanium (Ti)	Uranium (U)	Vanadium (V)	Zinc (Zn)
				[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]
CCME Sediment Quality Guidelines - Freshwater ISQG				**NG**	**NG**	**5.9**	**NG**	**NG**	**NG**	**0.6**	**NG**	**37.3**	**NG**	**35.7**	**NG**	**35**	**NG**	**NG**	**0.17**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**123**
CCME Sediment Quality Guidelines - Freshwater PEL				***NG***	***NG***	***17***	***NG***	***NG***	***NG***	***3.5***	***NG***	***90***	***NG***	***197***	***NG***	***91.3***	***NG***	***NG***	***0.486***	***NG***	***NG***	***NG***	***NG***	***NG***	***NG***	***NG***	***NG***	***NG***	***NG***	***NG***	***NG***	***NG***	***315***
CCME Soil Quality Guidelines - Agricultural				NG	20	12	750	4.0	2	1.4	NG	64	40	63	NG	70	NG	NG	6.6	5	50	NG	NG	1	20	NG	NG	500	1	5	NG	23	130	200
Alberta Tier I Soil Remediation Guidelines - Natural Areas				NG	20	17	750	5.0	2	3.8	NG	64	20	63	NG	70	NG	NG	12	4	50	NG	NG	1	20	NG	NG	NG	1	5	NG	33	130	200
13-10634	Recreation Lagoon	19-Nov	0-20	17000	<10	**7.7**	200	<4.0	24	**0.7**	20000	29	9.2	**57**	24000	20	6600	400	0.14	<2.0	26	1200	2400	0.85	<2.0	300	64	5500	0.27	3.6	250	<10	50	110
13-10635	Recreation Lagoon	19-Nov	0-25	13000	<10	4.2	120	<4.0	21	0.29	15000	21	7.7	30	16000	<10	6100	230	0.090	<2.0	20	770	2000	0.54	<2.0	230	44	4000	0.20	<2.0	230	<10	40	64
13-10636	Recreation Lagoon	19-Nov	0-30	15000	<10	**9.2**	170	<4.0	17	0.43	21000	25	9.0	**47**	24000	12	5800	380	0.14	<2.0	24	1100	2100	0.79	<2.0	260	62	5600	0.24	4.4	220	<10	46	86
13-10637	Discharge Location	19-Nov	0-10	9600	<10	1.9	110	<4.0	17	0.12	6300	26	5.1	**97**	18000	15	3700	220	<0.090	<2.0	18	780	1500	0.41	<2.0	160	33	660	0.14	2.2	180	<10	29	**130**
13-10638	Discharge Location	19-Nov	10-30	12000	<10	3.6	97	<4.0	12	0.11	13000	<20	7.0	17	18000	<10	5100	250	<0.090	<2.0	17	520	1600	0.49	<2.0	160	37	130	0.15	<2.0	330	<10	39	43
13-10639	Eastern Wetland	19-Nov	0-10	13000	<10	**7.1**	250	<4.0	41	0.20	5200	<20	10	20	25000	<10	3200	420	<0.090	<2.0	19	4400	1700	0.62	<2.0	270	42	1600	0.18	<2.0	270	<10	35	62
13-10640/41	Eastern Wetland	19-Nov	10-30	15000	<10	3.5	170	<4.0	16	0.14	4200	22	7.5	15	17000	<10	3400	220	<0.090	<2.0	17	910	1800	0.57	<2.0	240	33	530	0.19	<2.0	330	<10	36	59
13-10642	Eastern Wetland	20-Nov	0-10																															
13-10643	Eastern Wetland	20-Nov	10-30																															
13-10644	Eastern Wetland	20-Nov	0-10																															
13-10646	Eastern Wetland	20-Nov	10-30																															
13-10647	Eastern Wetland	20-Nov	0-10	14000	<10	1.1	140	<4.0	11	0.13	4900	20	5.9	19	13000	<10	3700	190	<0.090	<2.0	15	530	2100	0.32	<2.0	180	33	910	0.20	<2.0	200	<10	34	59
13-10648	Eastern Wetland	20-Nov	25-30	18000	<10	1.8	180	<4.0	13	0.071	3900	23	7.4	11	18000	11	4000	180	<0.090	<2.0	17	500	2200	<0.25	3.7	200	30	380	0.20	<2.0	320	<10	38	56
13-10649	Eastern Wetland	20-Nov	0-10																															
13-10650/51	Eastern Wetland	20-Nov	25-30																															

* <5 ppm detection limit is the lowest limit achievable by ICP-OES.

NG - Not Given

Table B-2: Recreation Area Lagoon & Wetland, Polychlorinated Biphenyl (PCB) Sediment Sample Analytical Results

Sample #	Location	Date	Depth (cm)	PCB		Total PCBs
				Aroclor 1254	Aroclor 1260	
				[ug/kg]	[ug/kg]	[ug/kg]
CCME Sediment Quality Guidelines - Freshwater ISQG				**60**	NG	NG
CCME Sediment Quality Guidelines - Freshwater PEL				***340***	NG	NG
CCME Soil Quality Guidelines - Agricultural				NG	NG	50
Alberta Tier 1 Soil Remediation Guidelines - Natural Areas				NG	NG	1300
13-10634	Recreation Lagoon	19-Nov	0-20			
13-10635	Recreation Lagoon	19-Nov	0-25	< 3.0	<3.0	<3.0
13-10636	Recreation Lagoon	19-Nov	0-30	< 3.0	<3.0	<3.0
13-10637	Discharge Location	19-Nov	0-10			
13-10638	Discharge Location	19-Nov	10-30			
13-10639	Eastern Wetland	19-Nov	0-10			
13-10640/41	Eastern Wetland	19-Nov	10-30	< 3.0	<3.0	<3.0
13-10642	Eastern Wetland	20-Nov	0-10			
13-10643	Eastern Wetland	20-Nov	10-30			
13-10644	Eastern Wetland	20-Nov	0-10			
13-10646	Eastern Wetland	20-Nov	10-30			
13-10647	Eastern Wetland	20-Nov	0-10			
13-10648	Eastern Wetland	20-Nov	25-30			
13-10649	Eastern Wetland	20-Nov	0-10			
13-10650/51	Eastern Wetland	20-Nov	25-30			

NG - Non Given

* Fine - grained guidelines

Table B-3: Recreation Area Lagoon & Wetland, Petroleum Hydrocarbon (PHC) Sediment Sample Analytical Results

Sample #	Location	Date	Depth (cm)	Moisture (%)	PHC			
					F1 (C6-C10)	F2 (C10-C16)	F3 (C16-C34)	F4 (C34- C50)
					[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]
Canada Wide Standards - Agricultural *					**210**	**150**	**1300**	**5600**
Alberta Tier 1 Soil Remediation Guidelines - Natural Areas					210	150	1300	5600
13-10634	Recreation Lagoon	19-Nov	0-20					
13-10635	Recreation Lagoon	19-Nov	0-25	62	< 10	<4.0	40	33
13-10636	Recreation Lagoon	19-Nov	0-30	66	< 10	18	71	25
13-10637	Discharge Location	19-Nov	0-10					
13-10638	Discharge Location	19-Nov	10-30					
13-10639	Eastern Wetland	19-Nov	0-10					
13-10640/41	Eastern Wetland	19-Nov	10-30	52	< 10	4.0	31	29
13-10642	Eastern Wetland	20-Nov	0-10					
13-10643	Eastern Wetland	20-Nov	10-30					
13-10644	Eastern Wetland	20-Nov	0-10					
13-10646	Eastern Wetland	20-Nov	10-30					
13-10647	Eastern Wetland	20-Nov	0-10					
13-10648	Eastern Wetland	20-Nov	25-30					
13-10649	Eastern Wetland	20-Nov	0-10					
13-10650/51	Eastern Wetland	20-Nov	25-30					

NG - Non Given

* Fine - grained guidelines

Table B-4: Recreation Area Lagoon & Wetland, VOC and BTEX Sediment Sample Analytical Results

Sample #	Location	Date	Depth (cm)	Benzene	Toluene	Ethyl-benzene	o-Xylene	m+p-Xylene	Xylenes (Total)	1,1,1,2-Tetrachloroethane	1,1,1-Trichloroethane	1,1,2,2-Tetrachloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,1-Dichloropropene	1,2,3-Trichlorobenzene	1,2,3-Trichloropropane	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,2-Dibromo-3-chloropropane	1,2-Dibromoethane	1,2-Dichlorobenzene	1,2-Dichloroethane	1,2-Dichloropropane	1,3,5-Trimethylbenzene	1,3-Dichlorobenzene	1,3-Dichloropropane	1,4-Dichlorobenzene	2,2-Dichloropropane	2-Chlorotoluene	4-Chlorotoluene	Bromobenzene
				[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]
CCME Soil Quality Guidelines - Agricultural				0.0068	0.080	0.018	NG	NG	2.4	NG	0.10	0.10	0.10	0.10	0.10	NG	0.050	NG	0.050	NG	NG	NG	0.10	0.10	0.10	NG	0.10	NG	0.10	NG	NG	NG	NG
Alberta Tier 1 Soil Remediation Guidelines - Natural Areas				0.046	0.52	0.11	NG	NG	15.0	NG	NG	NG	NG	NG	0.15	NG	0.26	NG	0.78	NG	NG	NG	0.097	0.025	NG	NG	NG	NG	0.051	NG	NG	NG	NG
13-10634	Recreation Lagoon	19-Nov	0-20																														
13-10635	Recreation Lagoon	19-Nov	0-25	< 0.0050	<0.020	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.034	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
13-10636	Recreation Lagoon	19-Nov	0-30	< 0.0050	<0.020	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.042	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
13-10637	Discharge Location	19-Nov	0-10																														
13-10638	Discharge Location	19-Nov	10-30																														
13-10639	Eastern Wetland	19-Nov	0-10																														
13-10640/41	Eastern Wetland	19-Nov	10-30	< 0.0050	<0.020	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.024	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
13-10642	Eastern Wetland	20-Nov	0-10																														
13-10643	Eastern Wetland	20-Nov	10-30																														
13-10644	Eastern Wetland	20-Nov	0-10																														
13-10646	Eastern Wetland	20-Nov	10-30																														
13-10647	Eastern Wetland	20-Nov	0-10																														
13-10648	Eastern Wetland	20-Nov	25-30																														
13-10649	Eastern Wetland	20-Nov	0-10																														
13-10650/51	Eastern Wetland	20-Nov	25-30																														

NG - Non Given

Table B-4: Recreation Area Lagoon & Wetland, VOC and BTEX Sediment Sample Analytical Results, cont'd

Sample #	Location	Date	Depth (cm)	Bromochloromethane	Bromodichloromethane	Bromoform	Bromomethane	Carbon Tetrachloride	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	cis-1,2-Dichloroethene	cis-1,3-Dichloropropene	Dibromochloromethane	Dibromomethane	Dichlorodifluoromethane	Hexachlorobutadiene	Isopropylbenzene	Methyl tert-butyl ether	Methylene chloride	Naphthalene	n-butylbenzene	n-Propylbenzene	p-Isopropyltoluene	sec-Butylbenzene	Styrene	tert-Butylbenzene	Tetrachloroethene	trans-1,2-Dichloroethene	trans-1,3-Dichloropropene	Trichloroethene	Trichlorofluoromethane	Vinyl chloride
				[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]
CCME Soil Quality Guidelines - Agricultural				NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	0.013	NG	NG	NG	NG	0.10	NG	NG	NG	NG	NG	NG	NG
Alberta Tier 1 Soil Remediation Guidelines - Natural Areas				NG	NG	NG	NG	0.059	0.61	NG	0.0029	NG	NG	NG	0.91	NG	NG	NG	NG	NG	0.10	NG	NG	NG	NG	NG	0.68	NG	0.69	NG	NG	0.054	NG	0.014
13-10634	Recreation Lagoon	19-Nov	0-20																															
13-10635	Recreation Lagoon	19-Nov	0-25	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10636	Recreation Lagoon	19-Nov	0-30	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10637	Discharge Location	19-Nov	0-10																															
13-10638	Discharge Location	19-Nov	10-30																															
13-10639	Eastern Wetland	19-Nov	0-10																															
13-10640/41	Eastern Wetland	19-Nov	10-30	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10642	Eastern Wetland	20-Nov	0-10																															
13-10643	Eastern Wetland	20-Nov	10-30																															
13-10644	Eastern Wetland	20-Nov	0-10																															
13-10646	Eastern Wetland	20-Nov	10-30																															
13-10647	Eastern Wetland	20-Nov	0-10																															
13-10648	Eastern Wetland	20-Nov	25-30																															
13-10649	Eastern Wetland	20-Nov	0-10																															
13-10650/51	Eastern Wetland	20-Nov	25-30																															

NG - Non Given

Table B-5: Recreation Area Lagoon & Wetland, Polycyclic Aromatic Hydrocarbons (PAH) Sediment Sample Analytical Results

Sample #	Location	Date	Depth (cm)	Moisture (%)	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenzo(ah)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene
					[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]
CCME Sediment Quality Guidelines - Freshwater ISQG					**0.00671**	**0.00587**	**0.0469**	**0.0317**	**0.0319**	**NG**	**NG**	**NG**	**0.0571**	**0.00622**	**0.111**	**0.0212**	**NG**	**0.0346**	**0.0419**	**0.053**
CCME Sediment Quality Guidelines - Freshwater PEL					***0.0889***	***0.128***	***0.245***	***0.385***	***0.782***	***NG***	***NG***	***NG***	***0.8620***	***0.135***	***2.355***	***0.144***	***NG***	***0.391***	***0.515***	***0.875***
CCME Soil Quality Guidelines - Agricultural					NG	NG	2.5	0.10	20	0.10	NG	0.10	NG	0.10	50.00	NG	0.10	0.013	0.046	0.10
Alberta Tier 1 Soil Remediation Guidelines - Natural Areas					0.32	5.0	0.0046	0.070	0.60	NG	NG	6.2	6.2	7.4	NG	NG	NG	0.016	0.051	0.034
13-10634	Recreation Lagoon	19-Nov	0-20																	
13-10635	Recreation Lagoon	19-Nov	0-25		<0.0050	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	<0.011	<0.040	<0.029
13-10636	Recreation Lagoon	19-Nov	0-30		<0.0050	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	<0.011	<0.040	<0.029
13-10637	Discharge Location	19-Nov	0-10																	
13-10638	Discharge Location	19-Nov	10-30																	
13-10639	Eastern Wetland	19-Nov	0-10																	
13-10640/41	Eastern Wetland	19-Nov	10-30		<0.0050	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	<0.011	<0.040	<0.029
13-10642	Eastern Wetland	20-Nov	0-10																	
13-10643	Eastern Wetland	20-Nov	10-30																	
13-10644	Eastern Wetland	20-Nov	0-10																	
13-10646	Eastern Wetland	20-Nov	10-30																	
13-10647	Eastern Wetland	20-Nov	0-10																	
13-10648	Eastern Wetland	20-Nov	25-30																	
13-10649	Eastern Wetland	20-Nov	0-10																	
13-10650/51	Eastern Wetland	20-Nov	25-30																	

NG - Non Given

* Detection limits varied for some parameters due to varying moisture content in the samples

Table B-6: Recreation Area Lagoon & Wetland, Pesticide Sediment Sample Analytical Results

Sample #	Location	Date	Depth (cm)	aldrin	alpha-BHC*	beta-BHC	gamma-BHC	delta-BHC	DDD (Total)	DDE (Total)	DDT (Total)	Total DDTs (Sum of DDD, DDE, DDT)	dieldrin*	endosulfan I	Endosulfan II	endosulfan sulfate	endrin	endrin aldehyde	heptachlor	Heptachlor epox iso B	methoxychlor
				[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]
CCME Sediment Quality Guidelines - Freshwater ISQG				**NG**	**NG**	**NG**	**NG**	**NG**	**3.54**	**1.42**	**1.19**	**NG**	**2.85**	**NG**	**NG**	**NG**	**2.67**	**NG**	**0.60**	**NG**	**NG**
CCME Sediment Quality Guidelines - Freshwater PEL				***NG***	***NG***	***NG***	***NG***	***NG***	***8.51***	***6.75***	***4.77***	***NG***	***6.67***	***NG***	***NG***	***NG***	***62.4***	***NG***	***2.74***	***NG***	***NG***
CCME Soil Quality Guidelines - Agricultural				NG	NG	NG	NG	NG	NG	NG	NG	700	NG	NG	NG	NG	NG	NG	NG	NG	NG
Alberta Tier I Soil Remediation Guidelines - Natural Areas				5900	NG	NG	NG	NG	NG	NG	NG	15	11		1.30		7.5	NG	39	NG	46
13-10634	Recreation Lagoon	19-Nov	0-20																		
13-10635	Recreation Lagoon	19-Nov	0-25	<2.0	<10*	<2.0	<50*	<50*	***46***	**4.6**	<1.0	51	<5.0*	<1.0	<1.0	<2.0	<2.0	<5.0	<1.0	<2.0	<2.0
13-10636	Recreation Lagoon	19-Nov	0-30	<2.0	<10*	<2.0	<2.0	<50*	***21***	**5.7**	<1.0	27	<5.0*	<1.0	<1.0	<2.0	<2.0	<5.0	<1.0	<2.0	<2.0
13-10637	Discharge Location	19-Nov	0-10						<1.0	**2.4**	<1.0	2.4									
13-10638	Discharge Location	19-Nov	10-30																		
13-10639	Eastern Wetland	19-Nov	0-10						<1.0	**2.7**	<1.0	2.7									
13-10640/41	Eastern Wetland	19-Nov	10-30	<2.0	<10*	<2.0	<50*	<2.0	<1.0	<1.0	<1.0	<1.0	<5.0*	<1.0	<1.0	<2.0	<2.0	<5.0	<1.0	<2.0	<2.0
13-10642	Eastern Wetland	20-Nov	0-10																		
13-10643	Eastern Wetland	20-Nov	10-30																		
13-10644	Eastern Wetland	20-Nov	0-10																		
13-10646	Eastern Wetland	20-Nov	10-30																		
13-10647	Eastern Wetland	20-Nov	0-10																		
13-10648	Eastern Wetland	20-Nov	25-30																		
13-10649	Eastern Wetland	20-Nov	0-10																		
13-10650/51	Eastern Wetland	20-Nov	25-30																		

NG - Non Given

* Detection limits increased due to interferences - (GC/MC results reported)

Table B-7: Administration Area Lagoon & Wetlands, Inorganic Element Sediment Sample Analytical Results

Sample #	Location	Date	Depth (cm)	Aluminum (Al)	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Boron * (B)	Cadmium (Cd)	Calcium (Ca)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Magnesium (Mg)	Manganese (Mn)	Mercury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Phosphorus (P)	Potassium (K)	Selenium (Se)	Silver (Ag)	Sodium (Na)	Strontium (Sr)	Sulphur (S)	Thalium (Tl)	Tin (Sn)	Titanium (Ti)	Uranium (U)	Vanadium (V)	Zinc (Zn)
				[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]
CCME Sediment Quality Guidelines - Freshwater				**NG**	**NG**	**5.9**	**NG**	**NG**	**NG**	**0.6**	**NG**	**37.3**	**NG**	**35.7**	**NG**	**35**	**NG**	**NG**	**0.17**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**123**
CCME Sediment Quality Guidelines - Freshwater PEL				***NG***	***NG***	***17***	***NG***	***NG***	***NG***	***3.5***	***NG***	***90***	***NG***	***197***	***NG***	***91.3***	***NG***	***NG***	***0.486***	***NG***	***NG***	***NG***	***NG***	***NG***	***NG***	***NG***	***NG***	***NG***	***NG***	***NG***	***NG***	***NG***	***315***
CCME Soil Quality Guidelines - Agricultural				NG	20	12	750	4.0	2	1.4	NG	64	40	63	NG	70	NG	NG	6.6	5	50	NG	NG	1	20	NG	NG	500	1	5	NG	23	130	200
Alberta Tier I Soil Remediation Guidelines - Natural				NG	20	17	750	5.0	2	3.8	NG	64	20	63	NG	70	NG	NG	12	4	50	NG	NG	1	20	NG	NG	NG	1	5	NG	33	130	200
13-10608	Southern Wetland	18-Nov	0-10	3100	<10	3.1	73	<4.0	73	**0.62**	34000	<20	<5.0	12	8200	<10	4600	270		<2.0	14	1200	520	0.73	<2.0	770	140	10000	0.073	<2.0	53	<10	10	110
13-10609	Southern Wetland	18-Nov	30-40																															
13-10610/11**	Southern Wetland	18-Nov	0-10	2400	<10	1.6	77	<4.0	70	0.36	58000	<20	<5.0	9.6	7000	<10	4700	790	<0.090	<2.0	12	1100	350	0.71	<2.0	720	200	12000	0.066	<2.0	43	16	<10	91
13-10612	Southern Wetland	18-Nov	30-40	4900	<10	1.4	52	<4.0	32	0.21	24000	<20	<5.0	8.7	3600	<10	4100	88		<2.0	9.9	640	320	0.70	<2.0	970	100	17000	0.073	<2.0	55	<10	12	25
13-10613	Southern Wetland	18-Nov	0-10	2500	<10	1.4	47	<4.0	46	**0.61**	29000	<20	<5.0	11	5900	<10	3300	170		<2.0	12	970	440	0.44	<2.0	380	130	6300	0.048	<2.0	48	<10	<10	120
13-10614	Southern Wetland	18-Nov	30-40	10000	<10	2.8	100	<4.0	19	0.44	20000	<20	<5.0	17	11000	<10	3700	120		<2.0	20	570	750	0.70	<2.0	330	96	8600	0.12	<2.0	60	<10	27	72
13-10615	Southern Wetland	18-Nov	0-10																															
13-10616	Southern Wetland	18-Nov	30-40																															
13-10617	Southern Wetland	18-Nov	0-10	2900	<10	1.2	34	<4.0	29	0.24	22000	<20	<5.0	10	4700	<10	4000	100		<2.0	11	1100	530	0.53	<2.0	430	93	13000	0.068	<2.0	38	<10	<10	110
13-10618	Southern Wetland	18-Nov	30-40	1100	<10	<1.0	24	<4.0	23	0.11	17000	<20	<5.0	<5.0	3100	<10	3400	42		<2.0	5.0	600	140	0.64	<2.0	730	75	13000	<0.025	<2.0	19	<10	<10	32
13-10619	Discharge Location	18-Nov	0-10	12000	<10	**8.8**	140	<4.0	19	0.50	11000	<20	5.3	25	12000	<10	3000	120		<2.0	18	640	1200	0.85	<2.0	220	58	5100	0.15	<2.0	140	<10	30	78
13-10620/21	Discharge Location	18-Nov	40-50	13000	<10	**6.6**	150	<4.0	13	0.21	5200	22	5.8	18	16000	<10	3300	82		<2.0	17	530	1500	0.71	<2.0	200	43	1400	0.17	<2.0	170	<10	38	58
13-10622	Western Wetland	18-Nov	10-15																															
13-10623	Western Wetland	18-Nov	0-10	2300	<10	<1.0	52	<4.0	25	0.58	19000	<20	<5.0	12	3100	<10	2900	250		<2.0	9.7	950	450	0.66	<2.0	260	83	11000	0.067	<2.0	44	<10	<10	100
13-10624	Western Wetland	18-Nov	30-40	2200	<10	2.1	54	<4.0	27	0.56	22000	<20	<5.0	15	5300	<10	3300	220		<2.0	11	990	440	0.67	<2.0	340	91	16000	0.052	<2.0	37	<10	<10	110
13-10626	Western Wetland	18-Nov	45-60	1700	<10	1.1	33	<4.0	34	0.31	19000	<20	<5.0	9.8	3500	<10	3500	130		<2.0	7.6	860	340	0.80	<2.0	630	82	17000	0.051	<2.0	29	<10	<10	97
13-10627	Western Wetland	18-Nov	50-60																															
13-10628	Small Settling Cell	19-Nov	0-35	26000	<10	**7.5**	380	<4.0	120	**1.9**	22000	33	9.5	**180**	24000	24	5600	430	0.16	3.5	28	6900	2200	2.7	<2.0	530	180	11000	0.21	9.0	54	<10	49	***350***
13-10629	Small Settling Cell	19-Nov	0-60	19000	<10	5.7	220	<4.0	25	0.44	11000	30	9.5	**42**	23000	14	5600	250		<2.0	25	990	2200	1.2	<2.0	310	62	4700	0.23	<2.0	190	<10	52	110
13-10630/31	Large Storage Cell	19-Nov	0-45	19000	<10	5.1	220	<4.0	28	0.33	19000	29	11	32	24000	13	6400	330		<2.0	28	860	2400	1.0	<2.0	330	87	7300	0.25	<2.0	120	<10	52	83
13-10632	Large Storage Cell	19-Nov	0-45	19000	<10	3.2	190	<4.0	23	0.27	13000	26	8.5	20	21000	11	5000	290		<2.0	22	750	2600	0.62	<2.0	310	67	6400	0.23	<2.0	150	<10	42	82
13-10633	Large Storage Cell	19-Nov	0-45	20000	<10	5.5	220	<4.0	35	0.39	36000	30	11	30	25000	13	7800	410	0.13	<2.0	28	850	2700	0.90	<2.0	350	110	14000	0.28	<2.0	220	<10	56	78

* <5 ppm detection limit is the lowest limit achievable by ICP-OES.

** Only one sample from the field duplicate analyzed. Result is not averaged.

NG - Not Given

Table B-8: Administration Area Lagoon & Wetlands, Polychlorinated Biphenyl (PCB) Sediment Sample Analytical Results

Sample #	Location	Date	Depth (cm)	PCB		Total PCBs
				Aroclor 1254	Aroclor 1260	
				ug/kg	ug/kg	ug/kg
CCME Sediment Quality Guidelines - Freshwater ISQG				**60**	NG	NG
CCME Sediment Quality Guidelines - Freshwater PEL				***340***	NG	NG
CCME Soil Quality Guidelines - Agricultural				NG	NG	50
Alberta Tier 1 Soil Remediation Guidelines - Natural Areas				NG	NG	1300
13-10608	Southern Wetland	18-Nov	0-10			
13-10609	Southern Wetland	18-Nov	30-40			
13-10610/11	Southern Wetland	18-Nov	0-10	6.5	< 3.0	< 3.0
13-10612	Southern Wetland	18-Nov	30-40			
13-10613	Southern Wetland	18-Nov	0-10			
13-10614	Southern Wetland	18-Nov	30-40			
13-10615	Southern Wetland	18-Nov	0-10			
13-10616	Southern Wetland	18-Nov	30-40			
13-10617	Southern Wetland	18-Nov	0-10			
13-10618	Southern Wetland	18-Nov	30-40			
13-10619	Discharge Location	18-Nov	0-10			
13-10620/21	Discharge Location	18-Nov	40-50			
13-10622	Western Wetland	18-Nov	10-15			
13-10623	Western Wetland	18-Nov	0-10			
13-10624	Western Wetland	18-Nov	30-40			
13-10626	Western Wetland	18-Nov	45-60			
13-10627	Western Wetland	18-Nov	50-60			
13-10628	Small Settling Cell	19-Nov	0-35	< 3.0	< 3.0	< 3.0
13-10629	Small Settling Cell	19-Nov	0-60			
13-10630/31	Large Storage Cell	19-Nov	0-45			
13-10632	Large Storage Cell	19-Nov	0-45			
13-10633	Large Storage Cell	19-Nov	0-45	< 3.0	< 3.0	< 3.0

NG - Non Given

* Fine - grained guidelines

Table B-9: Administration Area Lagoon & Wetlands, Petroleum Hydrocarbon (PHC) Sediment Sample Analytical Results

Sample #	Location	Date	Depth (cm)	Moisture (%)	PHC			
					F1 (C6-C10)	F2 (C10-C16)	F3 (C16-C34)	F4 (C34- C50)
					[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]
Canada Wide Standards - Agricultural *					**210**	**150**	**1300**	**5600**
Alberta Tier 1 Soil Remediation Guidelines - Natural Areas					210	150	1300	5600
13-10608	Southern Wetland	18-Nov	0-10	89	< 10	<4.0	440	290
13-10609	Southern Wetland	18-Nov	30-40					
13-10610/11**	Southern Wetland	18-Nov	0-10	86	< 10	10	99	73
13-10612	Southern Wetland	18-Nov	30-40	84	< 10	<4.0	64	52
13-10613	Southern Wetland	18-Nov	0-10	84	< 10	4.5	41	72
13-10614	Southern Wetland	18-Nov	30-40	83	< 10	<4.0	61	84
13-10615	Southern Wetland	18-Nov	0-10					
13-10616	Southern Wetland	18-Nov	30-40					
13-10617	Southern Wetland	18-Nov	0-10	85	< 10	4.1	74	48
13-10618	Southern Wetland	18-Nov	30-40	84	< 10	4.2	42	59
13-10619	Discharge Location	18-Nov	0-10	65	< 10	4.8	22	34
13-10620/21	Discharge Location	18-Nov	40-50	36	< 10	<4.0	<9.0	12
13-10622	Western Wetland	18-Nov	10-15					
13-10623	Western Wetland	18-Nov	0-10	85	< 10	<4.0	40	42
13-10624	Western Wetland	18-Nov	30-40	85	< 10	4.3	80	85
13-10626	Western Wetland	18-Nov	45-60	87	< 10	18	320	210
13-10627	Western Wetland	18-Nov	50-60					
13-10628	Small Settling Cell	19-Nov	0-35	66	< 10	110	700	140
13-10629	Small Settling Cell	19-Nov	0-60	63	< 10	140	**1600**	460
13-10630/31	Large Storage Cell	19-Nov	0-45	67	12	<4.0	120	38
13-10632	Large Storage Cell	19-Nov	0-45	60	< 10	<4.0	73	43
13-10633	Large Storage Cell	19-Nov	0-45	65	< 10	<4.0	28	27

NG - Non Given

* Fine - grained guidelines

** Only one sample from the field duplicate analyzed. Result is not averaged.

Table B-10: Administration Area Lagoon & Wetlands, VOC and BTEX Sediment Sample Analytical Results

Sample #	Location	Date	Depth (cm)	Benzene	Toluene	Ethyl-benzene	o-Xylene	m+p-Xylene	Xylenes (Total)	1,1,1,2-Tetrachloroethane	1,1,1-Trichloroethane	1,1,2,2-Tetrachloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,1-Dichloropropene	1,2,3-Trichlorobenzene	1,2,3-Trichloropropane	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,2-Dibromo-3-chloropropane	1,2-Dibromoethane	1,2-Dichlorobenzene	1,2-Dichloroethane	1,2-Dichloropropane	1,3,5-Trimethylbenzene	1,3-Dichlorobenzene	1,3-Dichloropropane	1,4-Dichlorobenzene	2,2-Dichloropropane	2-Chlorotoluene	4-Chlorotoluene	Bromobenzene
				[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]
CCME Soil Quality Guidelines - Agricultural				0.0068	0.080	0.018	NG	NG	2.4	NG	0.10	0.10	0.10	0.10	0.10	NG	0.050	NG	0.050	NG	NG	NG	0.10	0.10	0.10	NG	0.10	NG	0.10	NG	NG	NG	NG
Alberta Tier 1 Soil Remediation Guidelines - Natural Areas				0.046	0.52	0.11	NG	NG	15.0	NG	NG	NG	NG	NG	0.15	NG	0.26	NG	0.78	NG	NG	NG	0.097	0.025	NG	NG	NG	NG	0.051	NG	NG	NG	NG
13-10608	Southern Wetland	18-Nov	0-10	<0.0050	1.8	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
13-10609	Southern Wetland	18-Nov	30-40																														
13-10610/11*	Southern Wetland	18-Nov	0-10	< 0.0050	<0.020	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.18	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
13-10612	Southern Wetland	18-Nov	30-40	< 0.0050	<0.020	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.14	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
13-10613	Southern Wetland	18-Nov	0-10	< 0.0050	<0.020	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.11	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
13-10614	Southern Wetland	18-Nov	30-40	< 0.0050	<0.020	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.14	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
13-10615	Southern Wetland	18-Nov	0-10																														
13-10616	Southern Wetland	18-Nov	30-40																														
13-10617	Southern Wetland	18-Nov	0-10	< 0.0050	<0.020	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.095	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
13-10618	Southern Wetland	18-Nov	30-40	< 0.0050	<0.020	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.12	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
13-10619	Discharge Location	18-Nov	0-10	< 0.0050	2.1	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.037	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
13-10620/21	Discharge Location	18-Nov	40-50	< 0.0050	<0.020	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.028	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
13-10622	Western Wetland	18-Nov	10-15																														
13-10623	Western Wetland	18-Nov	0-10	< 0.0050	<0.020	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.092	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
13-10624	Western Wetland	18-Nov	30-40	< 0.0050	<0.020	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.14	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
13-10626	Western Wetland	18-Nov	45-60	< 0.0050	<0.020	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.18	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
13-10627	Western Wetland	18-Nov	50-60																														
13-10628	Small Settling Cell	19-Nov	0-35	< 0.0050	0.64	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.078	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	0.17	< 0.10	< 0.020	0.14	< 0.010	< 0.020	0.036	< 0.020	< 0.020	0.33	< 0.020	< 0.020	< 0.020	< 0.020
13-10629	Small Settling Cell	19-Nov	0-60	< 0.0050	0.19	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.073	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	1.6	1.1	< 0.020	0.64	< 0.010	< 0.020	0.52	0.048	< 0.020	0.98	< 0.020	< 0.020	< 0.020	< 0.020
13-10630/31	Large Storage Cell	19-Nov	0-45	< 0.0050	2.0	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.042	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	0.044	< 0.020	< 0.020	< 0.020	< 0.020
13-10632	Large Storage Cell	19-Nov	0-45	< 0.0050	2.0	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.053	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	0.033	< 0.020	< 0.020	< 0.020	< 0.020
13-10633	Large Storage Cell	19-Nov	0-45	< 0.0050	4.3	<0.011	<0.020	<0.020	<0.020	< 0.020	< 0.020	< 0.020	0.041	< 0.020	< 0.080	< 0.020	< 0.030	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.010	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020

NG - Non Given

* Only one sample from the field duplicate analyzed. Result is not averaged.

Table B-10: Administration Area Lagoon & Wetlands, VOC and BTEX Sediment Sample Analytical Results, cont'd

Sample #	Location	Date	Depth (cm)	Bromochloromethane	Bromodichloromethane	Bromoform	Bromomethane	Carbon Tetrachloride	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	cis-1,2-Dichloroethene	cis-1,3-Dichloropropene	Dibromochloromethane	Dibromomethane	Dichlorodifluoromethane	Hexachlorobutadiene	Isopropylbenzene	Methyl tert-butyl ether	Methylene chloride	Naphthalene	n-butylbenzene	n-Propylbenzene	p-Isopropyltoluene	sec-Butylbenzene	Styrene	tert-Butylbenzene	Tetrachloroethene	trans-1,2-Dichloroethene	trans-1,3-Dichloropropene	Trichloroethene	Trichlorofluoromethane	Vinyl chloride
				[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]
CCME Soil Quality Guidelines - Agricultural				NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	0.013	NG	NG	NG	NG	0.10	NG	NG	NG	NG	NG	NG	NG
Alberta Tier 1 Soil Remediation Guidelines - Natural Areas				NG	NG	NG	NG	0.059	0.61	NG	0.0029	NG	NG	NG	0.91	NG	NG	NG	NG	NG	0.10	NG	NG	NG	NG	NG	0.68	NG	0.69	NG	NG	0.054	NG	0.014
13-10608	Southern Wetland	18-Nov	0-10	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.009
13-10609	Southern Wetland	18-Nov	30-40																															
13-10610/11*	Southern Wetland	18-Nov	0-10	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10612	Southern Wetland	18-Nov	30-40	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10613	Southern Wetland	18-Nov	0-10	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10614	Southern Wetland	18-Nov	30-40	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10615	Southern Wetland	18-Nov	0-10																															
13-10616	Southern Wetland	18-Nov	30-40																															
13-10617	Southern Wetland	18-Nov	0-10	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10618	Southern Wetland	18-Nov	30-40	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10619	Discharge Location	18-Nov	0-10	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10620/21	Discharge Location	18-Nov	40-50	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10622	Western Wetland	18-Nov	10-15																															
13-10623	Western Wetland	18-Nov	0-10	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10624	Western Wetland	18-Nov	30-40	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10626	Western Wetland	18-Nov	45-60	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10627	Western Wetland	18-Nov	50-60																															
13-10628	Small Settling Cell	19-Nov	0-35	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	0.11	0.051	0.34	0.35	< 0.020	0.18	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10629	Small Settling Cell	19-Nov	0-60	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	0.65	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	1.1	0.82	25	24	< 0.020	0.32	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10630/31	Large Storage Cell	19-Nov	0-45	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	0.022	0.060	0.060	< 0.020	0.023	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10632	Large Storage Cell	19-Nov	0-45	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090
13-10633	Large Storage Cell	19-Nov	0-45	< 0.020	< 0.020	< 0.020	< 0.10	< 0.020	< 0.020	< 0.10	< 0.0019	< 0.10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.10	< 0.020	< 0.020	< 0.080	< 0.0099	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.10	< 0.0090

NG - Non Given

* Only one sample from the field duplicate analyzed. Result is not averaged.

Table B-11: Administration Area Lagoon & Wetlands, Polycyclic Aromatic Hydrocarbons (PAH) Sediment Sample Analytical Results

Sample #	Location	Date	Depth (cm)	Moisture (%)	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenzo(ah)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene
					[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]
CCME Sediment Quality Guidelines - Freshwater ISQG					**0.00671**	**0.00587**	**0.0469**	**0.0317**	**0.0319**	**NG**	**NG**	**NG**	**0.0571**	**0.00622**	**0.111**	**0.0212**	**NG**	**0.0346**	**0.0419**	**0.053**
CCME Sediment Quality Guidelines - Freshwater PEL					***0.0889***	***0.128***	***0.245***	***0.385***	***0.782***	***NG***	***NG***	***NG***	***0.8620***	***0.135***	***2.355***	***0.144***	***NG***	***0.391***	***0.515***	***0.875***
CCME Soil Quality Guidelines - Agricultural					NG	NG	2.5	0.10	20	0.10	NG	0.10	NG	0.10	50.00	NG	0.10	0.013	0.046	0.10
Alberta Tier 1 Soil Remediation Guidelines - Natural Areas					0.32	5.0	0.0046	0.070	0.60	NG	NG	6.2	6.2	7.4	NG	NG	NG	0.016	0.051	0.034
13-10608	Southern Wetland	18-Nov	0-10		<0.0050	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	<0.011	<0.040	<0.050
13-10609	Southern Wetland	18-Nov	30-40																	
13-10610/11**	Southern Wetland	18-Nov	0-10		<0.0050	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	**0.13**	<0.10	<0.011	<0.040	<0.050
13-10612	Southern Wetland	18-Nov	30-40		<0.0050	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	<0.011	**0.050**	<0.050
13-10613	Southern Wetland	18-Nov	0-10		<0.0050	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	0.020	**0.050**	<0.050
13-10614	Southern Wetland	18-Nov	30-40		**0.020**	**0.010**	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	0.020	**0.050**	<0.050
13-10615	Southern Wetland	18-Nov	0-10																	
13-10616	Southern Wetland	18-Nov	30-40																	
13-10617	Southern Wetland	18-Nov	0-10		**0.020**	**0.010**	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	**0.070**	<0.040	<0.050
13-10618	Southern Wetland	18-Nov	30-40		**0.020**	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	<0.011	<0.040	<0.050
13-10619	Discharge Location	18-Nov	0-10		<0.0050	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	<0.011	<0.040	<0.050
13-10620/21	Discharge Location	18-Nov	40-50		0.0063	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	<0.011	<0.040	<0.050
13-10622	Western Wetland	18-Nov	10-15																	
13-10623	Western Wetland	18-Nov	0-10		**0.020**	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	<0.011	**0.050**	<0.050
13-10624	Western Wetland	18-Nov	30-40		**0.020**	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	<0.011	**0.050**	<0.050
13-10626	Western Wetland	18-Nov	45-60		<0.0050	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	0.020	0.040	<0.050
13-10627	Western Wetland	18-Nov	50-60																	
13-10628	Small Settling Cell	19-Nov	0-35		**0.020**	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	0.020	<0.10	<0.011	**0.10**	<0.050
13-10629	Small Settling Cell	19-Nov	0-60		**0.020**	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	**0.070**	0.040	<0.050
13-10630/31	Large Storage Cell	19-Nov	0-45		0.010	**0.0063**	<0.0040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0060	0.10	<0.020	<0.10	**0.055**	0.090	<0.050
13-10632	Large Storage Cell	19-Nov	0-45		**0.010**	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	<0.011	<0.040	<0.050
13-10633	Large Storage Cell	19-Nov	0-45		**0.010**	<0.0050	<0.040	<0.030	<0.030	<0.050	<0.030	<0.050	<0.050	<0.0050	<0.050	<0.020	<0.10	<0.011	<0.040	<0.050

NG - Non Given

* Detection limits varied for some parameters due to varying moisture content in the samples

** Only one sample from the field duplicate analyzed. Result is not averaged.

Table B-12: Administration Area Lagoon & Wetlands, Pesticide Sediment Sample Analytical Results

Sample #	Location	Date	Depth (cm)	aldrin	alpha-BHC*	beta-BHC	gamma-BHC	delta-BHC	DDD (Total)	DDE (Total)	DDT (Total)	Total DDTs (Sum of DDD, DDE, DDT)	dieldrin*	endosulfan I	Endosulfan II	endosulfan sulfate	endrin	endrin aldehyde	heptachlor	Heptachlor epox iso B	methoxychlor
				[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]	[ug/kg]
CCME Sediment Quality Guidelines - Freshwater ISQG				**NG**	**NG**	**NG**	**NG**	**NG**	**3.54**	**1.42**	**1.19**	**NG**	**2.85**	**NG**	**NG**	**NG**	**2.67**	**NG**	**0.60**	**NG**	**NG**
CCME Sediment Quality Guidelines - Freshwater PEL				***NG***	***NG***	***NG***	***NG***	***NG***	***8.51***	***6.75***	***4.77***	***NG***	***6.67***	***NG***	***NG***	***NG***	***62.4***	***NG***	***2.74***	***NG***	***NG***
CCME Soil Quality Guidelines - Agricultural				NG	NG	NG	NG	NG	NG	NG	NG	700	NG	NG	NG	NG	NG	NG	NG	NG	NG
Alberta Tier I Soil Remediation Guidelines - Natural Areas				5900	NG	NG	NG	NG	NG	NG	NG	15	11	1.30			7.5	NG	39	NG	46
13-10608	Southern Wetland	18-Nov	0-10																		
13-10609	Southern Wetland	18-Nov	30-40																		
13-10610/11	Southern Wetland	18-Nov	0-10	<2.0	<10*	<2.0	<2.0	<50*	***20***	***47***	***5.8***	72	<5.0*	<50*	<1.0	<2.0	<2.0	<5.0	<1.0	<2.0	<2.0
13-10612	Southern Wetland	18-Nov	30-40						***14***	**1.6**	***5.5***	21									
13-10613	Southern Wetland	18-Nov	0-10																		
13-10614	Southern Wetland	18-Nov	30-40																		
13-10615	Southern Wetland	18-Nov	0-10						***24***	***20***	**4.6**	48									
13-10616	Southern Wetland	18-Nov	30-40																		
13-10617	Southern Wetland	18-Nov	0-10																		
13-10618	Southern Wetland	18-Nov	30-40																		
13-10619	Discharge Location	18-Nov	0-10						2.9	<1.0	<1.0	2.9									
13-10620/21**	Discharge Location	18-Nov	40-50						3.2	**5.1**	<1.0	8.3									
13-10622	Western Wetland	18-Nov	10-15																		
13-10623	Western Wetland	18-Nov	0-10																		
13-10624	Western Wetland	18-Nov	30-40																		
13-10626	Western Wetland	18-Nov	45-60																		
13-10627	Western Wetland	18-Nov	50-60																		
13-10628	Small Settling Cell	19-Nov	0-35	<2.0	<10*	<2.0	<50*	<2.0	***37***	***15***	**2.0**	54	<5.0*	<1.0	<1.0	<2.0	<2.0	<5.0	<1.0	<2.0	<2.0
13-10629	Small Settling Cell	19-Nov	0-60																		
13-10630/31	Large Storage Cell	19-Nov	0-45																		
13-10632	Large Storage Cell	19-Nov	0-45																		
13-10633	Large Storage Cell	19-Nov	0-45	<2.0	<10*	<2.0	<2.0	<50*	***94***	***18***	**2.0**	110	<5.0*	<1.0	<1.0	<2.0	<2.0	<5.0	<1.0	<2.0	<2.0

NG - Non Given

* Detection limits increased due to interferences - (GC/MC results reported)

** Only one sample from the field duplicate analyzed. Result is not averaged.

Table B-13: Surface Water Sample Inorganic Element Analytical Results

Sample #	Location	Date	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Sulfur	Thalium	Tin	Titanium	Uranium	Vanadium	Zinc	pH	Hardness
			[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	[ng/mL]	-	mg/L
CCME Water Quality Guidelines for the Protection of Freshwater Aquatic Life*			**100[a]**	**NG**	**5**	**NG**	**NG**	**1500**	**0.3 - 0.37[b]**	**NG**	**1.0**	**NG**	**1000**	**NG**	**7[c]**	**NG**	**NG**	**0.026**	**73**	**150[d]**	**NG**	**NG**	**1.0**	**0.10**	**NG**	**NG**	**NG**	**0.80**	**NG**	**NG**	**15**	**NG**	**30**	-	-
CCME Water Quality Guidelines for the Protection of Agriculture - Livestock			5000	NG	25	NG	100	5000	80	1000000	NG	1000	1000	NG	100	NG	NG	3.0	500	1000	NG	NG	50	NG	NG	NG	NG	NG	NG	NG	200	100	50000	-	-
Alberta Tier I Surface Water Quality Guidelines (Livestock)			5000	NG	25	NG	NG	5000	80	NG	NG	NG	500	NG	100	NG	NG	3.0	NG	1000	NG	NG	50	50		NG		NG	NG	NG	200	NG	50000	-	-
13-10600/01	Recreation Lagoon	28-Oct	<100	<0.20	1.7	44	<0.020	<1000	<0.017	51000	<1.0	<3.0	<3.0	240	<5.0	18000	240	<0.025	<1.0	<5.0	1600	17000	<0.50	<0.050	25000	310	6600	0.062	<0.50	<10	0.35	<1.0	<5.0	8.5	250
13-10602	Recreation Lagoon	28-Oct	**6600**	2.2	4.7	230	0.28	<1000	0.27	79000	**10**	3.9	52	9400	**9.4**	20000	570	**0.043**	1.4	13	3800	20000	<0.50	**0.22**	30000	360	7800	0.10	1.5	100	0.77	14	**277**	8.1	370
13-10603	Admin Southern Wetland	28-Oct	**870**	<0.20	**5.6**	210	0.047	<1000	0.15	280000	**1.5**	4.4	11	12000	<5.0	97000	3900	**0.60**	<1.0	9.3	3300	6300	<0.50	<0.050	110000	1200	79000	<0.050	<0.50	15	5.5	2.5	**55**	7.1	1400
13-10604	Admin Discharge Location	28-Oct	<100	0.22	**9.4**	46	<0.020	<1000	<0.017	100000	<1.0	<3.0	7.9	650	<5.0	25000	220	<0.025	<1.0	<5.0	1600	10000	<0.50	<0.050	26000	640	27000	<0.050	<0.50	<10	2.1	1.1	<5.0	7.6	350
13-10605	Admin Western Wetland	28-Oct	**6600**	0.31	**20**	210	0.38	<1000	0.22	120000	**12**	6.6	26	13000	5.9	35000	1200	**0.027**	2.0	20	6900	19000	0.76	0.068	32000	710	33000	0.12	<0.50	94	4.0	18	**100**	7.2	440
13-10606	Admin Lagoon - Small Settling Cell	28-Oct	**130**	<0.20	1.4	43	<0.020	<1000	<0.017	68000	<1.0	<3.0	8.5	500	<5.0	17000	330	<0.025	<1.0	<5.0	1500	6700	<0.50	<0.050	15000	480	25000	<0.050	<0.50	<10	1.6	<1.0	13	7.4	240
13-10607	Admin Lagoon - Large Storage Cell	28-Oct	<100	0.28	4.3	55	<0.020	<1000	<0.017	51000	<1.0	<3.0	5.8	740	<5.0	23000	280	<0.025	1.9	<5.0	<1000	11000	<0.50	<0.050	24000	350	20000	<0.050	<0.50	<10	1.8	1.6	<5.0	8.6	220

NG - Not Given

* Long Term

a - Al criterion is 100 ng/mL when pH >6.5

b - Cd criterion is 0.3 ng/mL for hardness of 220 mg/L to a maximum of 0.37 ng/mL for hardness values >280 mg/L.

c - Pb criterion is 7 ng/mL for hardness values >180 mg/L.

d - Ni criterion is 150 ng/mL for hardness values >180 mg/L.

Table B-14: Surface Water Sample Hydrocarbon Analytical Results

Sample #	Location	Date	Benzene	Toluene	Ethyl-benzene	o-Xylene	m+p-Xylene	Xylenes (Total)	PHC				Oil & Grease
									F1 (C6-C10)	F2 (C10-C16)	F3 (C16-C34)	F4 (C34- C50)	
			[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
CCME Water Quality Guidelines or the Protection of Freshwater Aquatic Life			**0.37**	**0.0020**	**0.090**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**
CCME Water Quality Guidelines or the Protection of Agriculture			NG	0.024	0.0024	NG	NG	NG	NG	NG	NG	NG	NG
Alberta Tier 1 Surface Water Quality Guidelines (Livestock)			0.088	4.91	3.2	NG	NG	13.1	53.6	49.2	79.7	42	NG
13-10600/01	Recreation Lagoon	28-Oct	<0.0020	<0.00050	<0.0020	<0.0020	<0.0020	<0.0020	<0.050	<0.50	<1.0	<1.0	4.1*
13-10602	Recreation Lagoon	28-Oct	<0.0020	<0.00050	<0.0020	<0.0020	<0.0020	<0.0020	<0.050	<0.50	<1.0	<1.0	3.8
13-10603	Admin Southern Wetland	28-Oct	<0.0020	<0.00050	<0.0020	<0.0020	<0.0020	<0.0020	<0.050	<0.50	<1.0	<1.0	8.5
13-10604	Admin Discharge Location	28-Oct	<0.0020	<0.00050	<0.0020	<0.0020	<0.0020	<0.0020	<0.050	<0.50	<1.0	<1.0	<2.0
13-10605	Admin Western Wetland	28-Oct	<0.0020	<0.00050	<0.0020	<0.0020	<0.0020	<0.0020	<0.050	<0.50	<1.0	<1.0	3.7
13-10606	Admin Lagoon - Small Settling Cell	28-Oct	<0.0020	<0.00050	<0.0020	<0.0020	<0.0020	<0.0020	<0.050	<0.50	<1.0	<1.0	<2.0
13-10607	Admin Lagoon - Large Storage Cell	28-Oct	<0.0020	<0.00050	<0.0020	<0.0020	<0.0020	<0.0020	<0.050	<0.50	<1.0	<1.0	<2.0

NG - Non Given

*Only one sample from the field duplicate analyzed for oil and grease. Result is not averaged.

Table B-15: Surface Water Sample Polycyclic Aromatic Hydrocarbons (PAH) Analytical Results

Sample #	Location	Date	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(1,2,3-cd)pyrene	Dibenz(a,h)anthracene	Benzo(ghi)perylene
			[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]
CCME Water Quality Guidelines for the Protection of Freshwater Aquatic Life			**1.1**	**NG**	**5.8**	**3.0**	**0.40**	**0.012**	**0.040**	**0.025**	**0.018**	**NG**	**NG**	**NG**	**0.015**	**NG**	**NG**	**NG**
CCME Water Quality Guidelines for the Protection of Agriculture			NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Alberta Tier 1 Surface Water Quality Guidelines (Livestock)			NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
13-10600/01	Recreation Lagoon	28-Oct	0.020	0.019	0.015	0.015	0.020	**0.016**	<0.010	<0.010	**0.031**	0.0030	0.027	0.025	**0.026**	0.033	0.037	0.041
13-10602	Recreation Lagoon	28-Oct	0.030	<0.010	0.011	<0.010	0.011	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.0064	0.019	0.024	0.024
13-10603	Admin Southern Wetland	28-Oct	0.033	0.031	<0.010	<0.010	0.013	0.0077	<0.010	<0.010	**0.018**	<0.010	<0.010	<0.010	0.0072	0.028	0.031	0.029
13-10604	Admin Discharge Location	28-Oct	0.039	0.012	<0.010	<0.010	0.014	0.0076	<0.010	<0.010	**0.028**	<0.010	<0.010	<0.010	0.0040	0.022	0.026	0.025
13-10605	Admin Western Wetland	28-Oct	0.051	<0.010	<0.010	<0.010	<0.010	0.0071	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.00087	0.015	0.018	0.017
13-10606	Admin Lagoon - Small Settling Cell	28-Oct	0.18	0.20	<0.010	0.016	0.054	0.0093	0.015	<0.010	0.016	<0.010	<0.010	<0.010	<0.0010	0.016	0.017	0.016
13-10607	Admin Lagoon - Large Storage Cell	28-Oct	0.13	0.15	<0.010	0.020	0.048	0.0060	<0.010	<0.010	0.014	<0.010	<0.010	<0.010	0.0011	0.010	0.013	0.012

NG - Non Given

Table B-16: Surface Water Sample VOC Analytical Results

Sample #	Location	Date	Dichlorodifluoromethane	Chloromethane	Vinyl chloride	Bromomethane	Chloroethane	Trichlorofluoromethane	1,1-Dichloroethene	Methylene chloride	trans-1,2-Dichloroethene	Methyl tert-butyl ether	1,1-Dichloroethane	2,2-Dichloropropane	cis-1,2-Dichloroethene	Bromochloromethane	Chloroform	1,1,1-Trichloroethane	Carbon Tetrachloride	1,1-Dichloropropene	Benzene	1,2-Dichloroethane	Trichloroethene	1,2-Dichloropropane	Bromodichloromethane	Dibromomethane	cis-1,3-Dichloropropene	Toluene	trans-1,3-Dichloropropene	1,1,2-Trichloroethane	Tetrachloroethylene	1,3-Dichloropropane	Dibromochloromethane	1,2-Dibromoethane
			[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]
CCME Water Quality Guidelines for the Protection of Freshwater Aquatic Life			**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**10000**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**370**	**100**	**NG**	**NG**	**NG**	**NG**	**NG**	**2.0**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**
CCME Water Quality Guidelines for the Protection of Agriculture - Livestock			NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	5.0	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Alberta Tier 1 Surface Water Quality Guidelines (Livestock)			NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
13-10600/01	Recreation Lagoon	28-Oct	<10	<10	<10	<10	<10	<10	<10	<10	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<0.7	<2.0	<2.0	<2.0	<2.0	<2.0	<0.5	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
13-10602	Recreation Lagoon	28-Oct	<10	<10	<10	<10	<10	<10	<10	<10	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<0.7	<2.0	<2.0	<2.0	<2.0	<2.0	<0.5	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
13-10603	Admin Southern Wetland	28-Oct	<10	<10	<10	<10	<10	<10	<10	<10	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<0.7	<2.0	<2.0	<2.0	<2.0	<2.0	<0.5	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
13-10604	Admin Discharge Location	28-Oct	<10	<10	<10	<10	<10	<10	<10	<10	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<0.7	<2.0	<2.0	<2.0	<2.0	<2.0	<0.5	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
13-10605	Admin Western Wetland	28-Oct	<10	<10	<10	<10	<10	<10	<10	<10	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<0.7	<2.0	<2.0	<2.0	<2.0	<2.0	<0.5	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
13-10606	Admin Lagoon - Small Settling Cell	28-Oct	<10	<10	<10	<10	<10	<10	<10	<10	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<0.7	<2.0	<2.0	<2.0	<2.0	<2.0	<0.5	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
13-10607	Admin Lagoon - Large Storage Cell	28-Oct	<10	<10	<10	<10	<10	<10	<10	<10	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<0.7	<2.0	<2.0	<2.0	<2.0	<2.0	<0.5	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0

NG - Non Given

Table B-16: Surface Water Sample VOC Analytica

Sample #	Location	Date	Chlorobenzene	1,1,1,2-Tetrachloroethane	Ethylbenzene	m+p-Xylene	o-Xylene	Styrene	Bromoform	Isopropylbenzene	Bromobenzene	1,2,3-Trichloropropane	1,1,2,2-Tetrachloroethane	n-Propylbenzene	2-Chlorotoluene	4-Chlorotoluene	1,3,5-Trimethylbenzene	tert-Butylbenzene	1,2,4-Trimethylbenzene	sec-ButylBenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	p-Isopropyltoluene	1,2-Dichlorobenzene	n-butylbenzene	1,2-Dibromo-3-chloropropane	1,2,4-Trichlorobenzene	1,2,3-Trichlorobenzene	Naphthalene	Hexachlorobutadiene
			[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]	[ug/L]
CCME Water Quality Guidelines for the Protection of Freshwater Aquatic Life			**NG**	**NG**	**90**	**NG**	**NG**	**72**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**150**	**26**	**NG**	**0.70**	**NG**	**NG**	**NG**	**8.0**	**1.1**	**1.3**
CCME Water Quality Guidelines for the Protection of Agriculture - Livestock			NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Alberta Tier 1 Surface Water Quality Guidelines (Livestock)			NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
13-10600/01	Recreation Lagoon	28-Oct	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<1.1	<1.3
13-10602	Recreation Lagoon	28-Oct	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<1.1	<1.3
13-10603	Admin Southern Wetland	28-Oct	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<1.1	<1.3
13-10604	Admin Discharge Location	28-Oct	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<1.1	<1.3
13-10605	Admin Western Wetland	28-Oct	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<1.1	<1.3
13-10606	Admin Lagoon - Small Settling Cell	28-Oct	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<1.1	<1.3
13-10607	Admin Lagoon - Large Storage Cell	28-Oct	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<1.1	<1.3

NG - Non Given

Table B-17: Surface Water Sample Bacterial, Nutrients, and Other Parameters Analytical Results

Sample #	Location	Date	TSS	BOD	Total Coliforms	E. coli	Fecal Coliforms	Conductivity	Chloride	Nitrate	Nitrite	Sulphate	Ammonia	TKN	Total Phosphorus	Fluoride	TDS	Alkalinity
			[mg/L]	[mg/L]	[CFU/ 100 mL]	[CFU/ 100 mL]	[CFU/ 100 mL]	[µS/cm]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
CCME Water Quality Guidelines for the Protection of Freshwater Aquatic Life*			**NG[a]**	**NG**	**NG**	**NG**	**NG**	**NG**	**120[b]**	**13[b]**	**NG**	**NG**	**0.19**	**NG**	**NG**	**12[c]**	**NG[a]**	**NG**
CCME Water Quality Guidelines for the Protection of Agriculture - Livestock			NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Alberta Tier I Surface Water Quality Guidelines (Livestock)			NG	NG	NG	NG	NG	NG	NG	NG[d]	10	1000	NG	NG	NG	1 - 2	3000	NG
13-10600/01	Recreation Lagoon	28-Oct	38	28	150	50	0	690	35	<0.25	<0.25	17	**5.9**	12	1.4	0.49	440	300
13-10602	Recreation Lagoon	28-Oct	510	40	5400	3600	3600	730	46	<0.25	<0.25	18	**6.0**	12	2.3	0.38	460	310
13-10603	Admin Southern Wetland	28-Oct	13000	310	8000	1100	2000	2000	95	<0.50	1.6	300	**1.8**	8.0	2.9	2.8	1500	930
13-10604	Admin Discharge Location	28-Oct	72	13	1600	0	0	740	29	<0.25	<0.25	58	**1.9**	5.2	1.2	0.60	390	280
13-10605	Admin Western Wetland	28-Oct	510	110	14000	0	100	1000	33	<1.0	<1.0	44	**4.1**	14	3.8	<1.0	690	410
13-10606	Admin Lagoon - Small Settling Cell	28-Oct	43	40	6500	20000	31000	650	17	<0.25	<0.25	67	**15**	16	1.5	0.52	380	240
13-10607	Admin Lagoon - Large Storage Cell	28-Oct	60	38	3000	100	0	590	24	<0.25	<0.25	65	**3.6**	8.2	0.61	0.67	410	190

NG - Not Given

* Long Term

[a] Guideline value compares background levels to measured levels. Background levels are unknown for the areas sampled.

[b] Long-term exposure

[c] Interim guideline

[d] Guideline for nitrate + nitrite is 100 mg/L.

APPENDIX C: QUALITY ASSURANCE AND QUALITY CONTROL

APPENDIX C: QUALITY ASSURANCE/QUALITY CONTROL

I. INTRODUCTION

ESG follows an internal quality assurance/quality control (QA/QC) program that was implemented to allow data quality to be monitored on an ongoing basis. This program is described in full in the Quality Assurance Project Plan (QAPP) (ESG 2013). The points relevant to the discussion of QA/QC sample collection and analysis for the confirmatory sampling program at Elk Island in 2013 are summarized here.

All samples are given sequential numerical codes before submission to the analytical firms; these codes mask any information concerning the sample site location, type and possible concentration.

Accuracy is measured and controlled by instrument calibration, the use of control standards and control spikes and the collection and analysis of blanks (equipment rinsate blanks ("scoop" blanks) and analytical blanks).

Control standards and control spikes are reference materials with known concentrations. After analysis of a control standard or spike, the instrument's calibration is evaluated by comparing the results of the analysis with the known concentration.

Organic analyses include surrogate spikes. All samples are spiked with compounds not found in environmental samples but representative of the analytes to be determined ("surrogates"). The surrogates are spiked into the samples early in the sample preparation and are measured at the end of the analytical process. Recoveries are reported as a percentage of the original spike concentration, and acceptable results are ± 40 percent.

The effectiveness of equipment decontamination procedures between samples is monitored by the collection and analysis of equipment rinsate blanks, or scoop blanks. ESG uses a soil sampling protocol in which reusable stainless steel scoops are used to collect soil samples rather than disposable plastic scoops. The primary reason for this is to reduce waste. A "scoop blank" is collected from a known clean soil (e.g., local clean soil or standard Ottawa sand) using a cleaned scoop.

Analytical blanks are processed through the typical sample extraction/digestion and analysis procedures. These blanks give a measure of the quantity of any contaminant or analyte that may be added to the overall result during the analysis.

Precision is measured and controlled by analysis of field and analytical duplicates. Field duplicates are samples of the same material that are collected in the field and submitted blind as

separate samples for analysis. Analytical duplicates are replicate preparations and analyses of the same sample. Comparison of the average relative percent difference (RPD) — which is calculated as the absolute difference divided by the average of the two values, expressed as a percentage — is used to evaluate laboratory precision. Acceptable RPD limits are generally considered to be less than 30 percent, with 20 percent or less considered good agreement.

The results of the QA/QC program for the 2013 sampling program at Elk Island, Alberta, are discussed below. The laboratory associated with each analysis type is listed.

A. Inorganic Elements in Soil and Water Samples — Analytical Services Unit (ASU), Queen's University

Sediment samples were analyzed for 30 inorganic elements by inductively coupled plasma (ICP) optical emission spectrometry (OES) or ICP mass spectrometry (MS). QA/QC results are listed in Tables C-1 to C-8.

1. Accuracy

Accuracy of inorganic analyses for soil was monitored internally by ASU with the analysis of Standard Reference Materials, specifically NRC Canada Marine Sediment Reference MESS-3 and contaminated soil reference material SS-2 for inorganic elements (Tables C-1 and C-2). The results of analysis of the reference materials were within controls limits established by ASU. The limits were created by compiling data from each MESS-3 and SS-2 sample over the past several years and checking for trends such as moving averages. Differences between the control limits and certified values indicate metals that are extractable using the *aqua regia* digestion method and hence biologically available. Results for all inorganic elements in the MESS-3 and SS-2 reference samples for this project were within control limits (Tables C-1 and C-2).

Inorganic analyses for water were monitored for accuracy using control spikes and NIST Certified Reference Material (CRM) 1643e for trace elements in water. Control spike recoveries ranged from 93 percent to 112 percent (Table C-6). Recovery results for CRM 1643e ranged from 85 percent to 114 percent (Table C-6). Notes from the lab indicate that scandium, indium and bismuth were also used as internal standards during analysis and were within acceptable limits.

Two soil and three water analytical blank samples were run with the soil and water batches, and results were below detection for inorganic elements (Tables C-3 and C-7). One soil scoop blank was analyzed, and, while some elements were detectable, on review of results it was

determined that they did not affect classification or concentration of elements of interest in the soil samples (Table C-3).

2. Precision/Repeatability

Precision was monitored externally by ESG with the submission of three soil sample field duplicates, which were homogenized in the field and submitted blind as separate samples to ASU for analysis. The resulting average RPDs ranged from 3.9 percent to 47 percent, with most reported below 10 percent (Table C-4). Only one average RPD (for Ti) exceeded the acceptable level of 30 percent because of variation seen in one sample pair (13-10630/31). All other elements averaged well for the pair and, as other QA/QC parameters in the batch were acceptable, results were accepted and further analysis was not required. One water field duplicate reported RPDs of 20 percent or less for all detectable elements (Table C-8).

One water and four soil analytical duplicates were reported, and average RSDs were below 15 percent for all, showing good precision for the method (Tables C-5 and C-8).

B. Mercury in Soil and Water Samples — Analytical Sciences Group (ASG), Royal Military College of Canada (RMC)

1. Accuracy

The soil sample control spike yielded a recovery of 109 percent (Table C-9), while the water sample spike recovery was 108 percent (Table C-10). Mercury results for the soil and water blank samples were below detection (Tables C-9 and C-10).

2. Precision

Two soil field duplicates reported detectable concentrations of mercury in one sample, just over the detection limit (Table C-9). Results for the soil analytical duplicate and the water field and analytical duplicates were below detection for mercury in all (Tables C-9 and C-10).

C. Polychlorinated Biphenyls (PCBs) in Sediment Samples — ASG, RMC

The QA/QC protocol for PCBs calls for analyses to be carried out in batches of no more than 30 samples. Each batch must include one analytical duplicate, a procedural blank and a spiked control sample. Duplicates, blanks, the spiked control sample, decachlorobiphenyl (DCBP) recovery and the calibration check were all required to be within predetermined control limits. Each batch is treated as a separate unit: samples within the same batch must be worked up and analyzed continuously, and the QA/QC data must be considered with respect to each batch.

1. Accuracy and Precision

Internally, all samples were spiked with an aliquot of the surrogate standard DCBP prior to analysis by gas chromatography (GC) with electron capture detection (ECD), in order to measure recovery of PCBs. Sample results were corrected for this recovery. The method was calibrated using known standards of Aroclor 1260. A calibration check standard was run with each batch to verify the calibration. Recoveries and checks were within laboratory control limits.

The control spike recovery was calculated to be 108 percent. All results were below detection limits for PCBs in the sediment analytical blank and analytical duplicate (Table C-11). The field duplicate reported detectable levels of Aroclor 1254, with a calculated RPD of 102 percent. Results were acceptable as concentrations were well below CCME guidelines for protection of human health and the environment.

D. Pesticides in Soil Samples — ASG, RMC

1. Accuracy and Precision

Soil samples were analyzed, along with one control spike, for 17 pesticide compounds and one for DDT and derivatives DDE and DDD. Recoveries ranged from 92 percent to 130 percent (Table C-12). Pesticide results were below detection in the analytical blanks. Reported results were also below detection in the analytical duplicate and one of the field replicates. One analytical duplicate showed detectable levels of DDD, with an RPD of 22 percent (Table C-13). The second field duplicate reported detectable levels of DDE, DDD and DDT with RPDs ranging from 2.6 percent to 119 percent. Most of the detectable compounds reported RPDs within acceptable limits, duplicating well, with only 4,4 DDT reporting the elevated value of 119 percent. Results for this duplicate were close to detection limit for one sample, and both results were well below CCME guidelines for protection of human health and the environment so further analysis was not required.

E. Polycyclic Aromatic Hydrocarbons in Soil and Water Samples — ASG, RMC

Selected soil and water samples were analyzed for PAHs; QA/QC results are listed in Tables C-14 to C-18. Surrogate spikes were added to samples prior to analysis, and sample results were corrected according to surrogate recovery. Overall soil sample surrogate recoveries averaged 89 percent for Naphthalene-d8, 81 percent for Phenanthrene-d10, 72 percent for Anthracene-d10 and 62 percent for Benzo(a)anthracene-d12, all well within the acceptable recovery limits of 50 to 140 percent. Water surrogate recovery averages were 103 percent, 121 percent, 126 percent and 120 percent respectively.

1. Accuracy

Two soil sample control spikes were analyzed, and average recovery for total PAHs was 102 percent. Average recoveries for individual PAHs ranged from 76 percent to 119 percent, all within acceptable limits of 30 percent (Table C-14). Surrogate recoveries for the control spikes ranged from 80 percent to 96 percent. The water sample control spike reported recoveries ranging from 70 percent to 155 percent, with surrogate recoveries ranging from 97 percent to 140 percent (Table C-17). Variations in recoveries for five of the PAH compounds in the water control spike were higher than the usual accepted 30 percent limit. Notes from the lab indicate that, because of the nature of PAHs in water, variations in recovery that exceed the control limits do occur for some compounds. Data are reviewed and, if all other QA/QC parameters in the batch are acceptable and data results are not close to criteria limits, the control results are accepted.

PAH results were below detection in the soil and water analytical blanks and in the soil scoop blank (Tables C-15 and C-17).

2. Precision

Most PAH compounds in the soil analytical replicates were below detection. For sample 13-10612, those with detectable concentrations were reported as just over the detection limit (Table C-15). Sample 13-10631 was analyzed in duplicate as part of a reanalysis batch, and four compounds reported low but detectable concentrations in it. Some variability was seen in the duplicate analysis, as is often seen when levels approach the detection limit. For one field duplicate pair (13-10631/31), detectable levels were reported in one sample but not in the replicate. To clarify, this sample pair was reanalyzed for PAHs. Results showed more variability in the pair with elevated RPDs, confirming that this was a heterogeneous sample (Table C-16).

One water analytical replicate reported RPDs ranging from zero to 33 percent for detectable levels of PAHs. RPDs for the water field duplicate showed higher variability, ranging from 5.9 percent to 112 percent. PAH values in water were reported at very low concentrations; the low levels along with the volatile nature of PAHs could result in artificially elevated RPDs in field duplicates (Table C-18).

Surrogate recoveries for the all soil and water blanks and duplicates were within acceptable limits, with the exception of one soil field duplicate (sample 13-10630) with surrogate recoveries below 50 percent (Tables C-15, C-16 and C-18). Reanalysis of this sample showed low surrogate recovery again, suggesting interferences from something in the sample matrix (Table C-16).

F. CCME Method of Petroleum Hydrocarbons in Soil and Water Samples — ASG, RMC

Soil analyses were performed as prescribed in the CCME Reference Method for the Canada-wide Standard for Petroleum Hydrocarbons in Soil, 2001/2002. Results were reported for the F1–F4 fractions of petroleum hydrocarbons.

1. Accuracy

One soil sample control spike was analyzed, and recoveries reported were 83 percent for the F1 hydrocarbon fraction, 96 percent for the F2–F4 fraction control spike and 88 percent for the F2–F4 fraction control standard (Table C-19).

Results for the soil and water analytical blanks and the scoop blank were below detection for hydrocarbons (Tables C-20 and C-22).

2. Precision

Precision was monitored externally by ESG using three pairs of soil sample field duplicates. These were homogenized in the field and submitted blind as separate samples to ASU for analysis. RPDs were calculated as 86 percent for the F3 hydrocarbon fraction and 33 percent for the F4 fraction (Table C-20). RPDs for the soil analytical duplicates were calculated as 8 percent and 21 percent for the F3 and F4 hydrocarbon fractions respectively. Variability seen in the field replicates may have been due to insufficient homogenization of the soil samples in the field. Results were well below the CCME SQGs for protection of human health and the environment so further analysis was not required (Table C-20).

Results for water sample field and analytical replicates were below detection for the F1–F4 hydrocarbon fractions (Table C-22).

G. Volatile Organic Compound in Soil and Water Samples — ASG, RMC

1. Accuracy

Soil and water samples were analyzed for VOCs, and QA/QC results are listed in Tables C-23 to C-26. The average control spike recoveries ranged from 86 percent to 138 percent for the soil sample (Table C-23) and from 83 percent to 140 percent for the water sample (Table C-26). One soil and one water analytical blank and one soil scoop blank were analyzed for VOCs; results were below detection for all (Tables C-23 and C-25). Surrogate recoveries were determined and sample results were corrected for the recovery results. The soil sample control spike, analytical blank and scoop blank reported average surrogate recoveries ranging from 82

percent to 111 percent (Table C-23). Surrogate recoveries for both the water sample control spike and the analytical blank were reported as 127 percent.

2. Precision

One soil analytical replicate reported only one detectable VOC, with an RPD of 22 percent (Table C-24). Three soil field replicates reported detectable 1,1,2-trichloroethane, with RPDs of less than 20 percent for all three. One field replicate (13-10630/31) also reported detectable toluene and 1,4-dichlorobenzene, with RPDs of 183 percent and 53 percent respectively. This sample pair was reanalyzed for BTEX (benzene, toluene, ethylbenzene and xylenes) to clarify differences, and the same variability was seen in toluene results, suggesting that differences between the samples were the cause for the variability and that laboratory precision is acceptable (Table C-24).

One water field duplicate and one analytical duplicate reported no detectable VOCs (Table C-26). Surrogate recoveries for soil and water replicates were within acceptable levels.

H. Bacteria in Water Samples — ASG, RMC

1. Accuracy

Water samples were analyzed for total coliforms, *E. coli* and fecal coliforms. Control spikes showed average recoveries ranging from 100 percent to 111 percent (Table C-27). Analytical blank samples showed no growth (Table C-27).

2. Precision

One analytical duplicate was processed, and resulting RPDs were 15 percent or less (Table C-27). One field duplicate was also run, and variations were seen in the total coliform and *E. coli* growth, resulting in RPDs of 67 percent and 200 percent respectively (Table C-27). This difference in the field duplicate suggests that contamination of one of the samples may have occurred in the field or in the lab. Fecal coliforms showed no growth in the field duplicate (Table C-27).

I. Biological Oxygen Demand and Conductivity in Water — ASG, RMC

1. Accuracy and Precision

Recoveries for control spikes were 115 percent for BOD and 93 percent for conductivity, while analytical blank sample results were below detection for BOD (Table C-28). Analytical duplicates were run for both BOD and conductivity, resulting in RPDs of zero percent and 3.5 percent respectively (Table C-28). One field duplicate was analyzed, and RPDs were calculated

as 43 percent for BOD and 6.4 percent for conductivity. The field duplicate samples were composites of water from four different locations; this may have resulted in some variability in the replicate results.

J. Total Dissolved Solids and Total Suspended Solids in Water Samples — ASU, Queen's University

1. Accuracy and Precision

Water samples and one control spiked sample were analyzed for total dissolved solids (TDS) and total suspended solids (TSS), resulting in recoveries of 105 percent and 90 percent respectively (Table C-29). One analytical blank showed no detectable TDS or TSS. One analytical replicate resulted in RPDs of less than three percent for both TDS and TSS (Table C-29).

K. Oil and Grease in Water Samples — ASU, Queen's University

1. Accuracy and Precision

Water samples and one control spiked sample were analyzed for oil and grease, resulting in a recovery of 97 percent (Table C-30). Oil and grease results were below detection in the analytical blank (Table C-30).

L. Fluoride, Chloride, Nitrite, Nitrate and Sulfate in Water Samples — ASU, Queen's University

1. Accuracy

QA/QC results are listed in Table C-31. Control spike recoveries ranged from 98 percent to 101 percent. Analytical blank samples were below detection for all (Table C-31).

2. Precision

One field duplicate and one analytical duplicate resulted in RPDs of 20 percent or less, indicating good agreement between replicates (Table C-31).

M. Alkalinity, Total Phosphorus, Total Kjeldahl Nitrogen and Total Ammonia in Water Samples — Caduceon Environmental Laboratories, Kingston

1. Accuracy and Precision

Control spike recoveries ranged from 83 percent to 103 percent (Table C-32). Results were below detection in the analytical blank (Table C-32).

II. REFERENCES

Environmental Sciences Group (ESG 2013). Quality Assurance Project Plan. Royal Military College, Kingston, ON.

Table C-1: Inorganic Element Results for Control Standard MESS-3 Analyzed by Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) or ICP Mass Sprectrometry (ICP-MS), ASU

Sample	MESS-3 Certified	MESS-3 Determined Average (n=2)	ASU Control Limits
	[ppm]	[ppm]	[ppm]
Ag	0.18 ± 0.02	<2.0	-
Al	85900 ± 2300	20650 ± 920	11600-32300
As	21.2 ± 1.1	17 ± 0.2	14.8-20.0
B	-	-	-
Ba	-	360 ± 1.4	261-454
Be	2.3 ± 0.12	<4.0	-
Ca		12900 ± 283	11300-15300
Cd	0.24 ± 0.01	0.25 ± 0.01	-
Co	14.4 ± 2.0	12 ± 0.1	9.8-14.3
Cr	105 ± 4.0	35 ± 1.7	24.6-57.5
Cu	33.9 ± 1.6	33 ± 1.3	26.4-35.2
Fe	-	32600 ± 707	30400-39200
K	-	4595 ± 233	3100-7890
Mg	-	13000 ± 140	11500-14800
Mn	324 ± 12	293 ± 0	258-353
Mo	2.78 ± 0.07	2.0 ± 0	<2.0-3.4
Na	-	11650 ± 354	9540-12400
Ni	46.9 ± 2.2	38 ± 3.1	32.5-44.1
P	-	966 ± 13	818-1220
Pb	21.1 ± 0.7	19 ± 0.5	15.6-20.6
S	-	1610 ± 42	1400-1940
Sb	1.02 ± 0.09	<10	-
Se	0.72 ± 0.05	1.15 ± 0.1	-
Sn	2.5 ± 0.52	<2.0	-
Sr	129 ± 11	64 ± 1.4	52.9-78.1
Ti	4400 ± 600	-	-
Tl	0.9 ± 0.06	0.25 ± 0.01	-
U	4.0*	<10	-
V	243 ± 10	87 ± 4.0	50.5-127
Zn	159 ± 8.0	128 ± 0.7	116-154

* information only, not certified

Table C-2: Inorganic Element Results for Contaminated Soil Reference Material SS-2 Analyzed by ICP-OES or ICP-MS, ASU

Sample	SS-2 Certified	SS-2 Determined	ASU Control Limits
	[ppm]	[ppm]	[ppm]
Ag	1.3*	<2.0	
Al	13265 ± 1194	17800	13300-21600
As	75 ± 9.75	82.9	53.2-98.5
B	12*	-	-
Ba	215 ± 13	248	187-295
Be	0.7*	<4.0	-
Ca	112861 ± 4514	109000	81700-160000
Cd	2.0*	2.1	1.2-2.5
Co	12 ± 1.0	14.8	11.0-17.0
Cr	34 ± 4.08	41.5	32.9-53.2
Cu	191 ± 9.6	204	150-230
Fe	21046 ± 1473	25100	22200-31400
K	3418 ± 342	4140	3740-5860
Mg	11065 ± 553	12600	10600-14800
Mn	457 ± 23	535	445-645
Mo	4.0*	2.7	<2.0-4.0
Na	558 ± 100	945	463-1019
Ni	54 ± 3.8	55.1	44.5-62.5
P	752 ± 15	725	451-989
Pb	126 ± 10	95.7	93.7-138
S	2193*	2150	1730-2590
Sb	0.8*	<10	-
Se	0.8*	0.91	-
Sn	-	3.2	<2.0-5.0
Sr	214 ± 13	210	182-252
Ti	850 ± 111	1430	616-2060
Tl	0.3*	0.37	-
U	1.3*	<10	-
V	34 ± 3.1	49.2	35.1-60.8
Zn	467 ± 23	444	373-534

* information only - not certified

Table C-3: Inorganic Element Results for Analytical Blanks and Scoop Blank Analyzed by Inductively Coupled Plasma Atomic Emission Spectroscopy, ASU

Sample	Blank	Blank		13-10625
	[ppm]	[ppm]		[ppm]
	Analytical Blanks			*Scoop Blank*
Ag	<2.0	<2.0		<2.0
Al	<50	<50		59
As	<1.0	<1.0		<1.0
B	<5.0	<5.0		<5.0
Ba	<5.0	<5.0		<5.0
Be	<4.0	<4.0		<4.0
Ca	<100	<100		373
Cd	<0.05	<0.05		<0.05
Co	<5.0	<5.0		<5.0
Cr	<20	<20		<20
Cu	<5.0	<5.0		<5.0
Fe	<50	<50		77
K	<20	<20		33
Mg	<20	<20		22
Mn	<1.0	<1.0		23
Mo	<2.0	<2.0		<2.0
Na	<75	<75		<75
Ni	<5.0	<5.0		<5.0
P	<20	<20		147
Pb	<10	<10		<10
S	<25	<25		<25
Sb	<10	<10		<10
Se	<0.25	<0.25		<0.25
Sn	<2.0	<2.0		<2.0
Sr	<5.0	<5.0		<5.0
Ti	<10	<10		<10
Tl	<0.025	<0.025		<0.025
U	<10	<10		<10
V	<10	<10		<10
Zn	<15	<15		<15

* information only - not certified

Table C-4: Inorganic Element Results for Soil Sample Field Duplicates Analyzed by ICP-OES and ICP-MS, ASU

Sample	13-10620	13-10621	RPD	13-10630	13-10631	RPD
	[ppm]	[ppm]	(%)	[ppm]	[ppm]	(%)
	Field Duplicates			*Field Duplicates*		
Ag	<2.0	<2.0		<2.0	<2.0	
Al	12700	14200	11	18000	19500	8.0
As	7.5	5.7	27	5.2	4.9	5.9
B	12.9	13.3	3.1	21.7	34.3	45
Ba	140	149	6.2	220	222	0.9
Be	<4.0	<4.0		<4.0	<4.0	
Ca	5280	5120	3.1	18000	19400	7.5
Cd	0.21	0.21	0	0.32	0.34	6.1
Co	5.8	5.8	0	10.6	11	3.7
Cr	21.5	21.7	0.93	28.3	29.6	4.5
Cu	18.4	17.6	4.4	31.3	31.8	1.6
Fe	16000	15500	3.2	23400	23900	2.1
K	1480	1500	1.3	2370	2410	1.7
Mg	3300	3250	1.5	6450	6400	0.78
Mn	82.1	81.6	0.61	332	336	1.2
Mo	<2.0	<2.0		<2.0	<2.0	
Na	198	200	1	323	338	4.5
Ni	16.4	16.7	1.8	28.2	27.4	2.9
P	582	476	20	865	860	0.6
Pb	<10	<10		13	12.6	3.1
S	1470	1230	18	7050	7610	7.6
Sb	<10	<10		<10	<10	
Se	0.64	0.77	18	0.97	1.1	13
Sn	<2.0	<2.0		<2.0	<2.0	
Sr	42.8	43	0.5	84.5	89.7	6.0
Ti	151	182	19	59.6	172	97
Tl	0.18	0.16	12	0.25	0.24	4.1
U	<10	<10		<10	<10	
V	36.4	39.5	8.2	50.3	54.5	8.0
Zn	58.8	57	3.1	80.8	85.2	5.3

Sample	13-10640	13-10641	RPD	Average RPD	Std Dev
	[ppm]	[ppm]	(%)	(%)	
	Field Duplicates				
Ag	<2.0	<2.0			
Al	13700	15800	14	**11**	**± 3.1**
As	3.5	3.4	3	**12**	**± 13**
B	13.6	18	28	**25**	**± 21**
Ba	152	181	17	**8.2**	**± 8.4**
Be	<4.0	<4.0			
Ca	3940	4460	12	**7.6**	**± 4.7**
Cd	0.13	0.15	14	**6.8**	**± 7.2**
Co	7.1	7.9	11	**4.8**	**± 5.4**
Cr	20.5	22.9	11	**5.5**	**± 5.1**
Cu	13.3	16.5	21	**9.2**	**± 11**
Fe	15700	17500	11	**5.4**	**± 4.8**
K	1690	1980	16	**6.3**	**± 8.3**
Mg	3210	3640	13.0	**5.0**	**± 6.6**
Mn	209	231	10	**3.9**	**± 5.3**
Mo	<2.0	<2.0			
Na	213	266	22	**9.2**	**± 11**
Ni	16.2	17.9	10	**4.9**	**± 4.4**
P	798	1030	25	**15**	**± 13**
Pb	<10	10.1			
S	474	589	22	**16**	**± 7.2**
Sb	<10	<10			
Se	0.55	0.58	5.3	**12**	**± 6.6**
Sn	<2.0	<2.0			
Sr	31.3	34.8	11	**5.7**	**± 5.1**
Ti	283	367	26	**47**	**± 43**
Tl	0.2	0.18	11	**8.8**	**± 4.1**
U	<10	<10			
V	34.3	38.4	11	**9.2**	**± 1.8**
Zn	55.9	62.3	11	**6.4**	**± 4.0**

Table C-5: Inorganic Element Results for Soil Sample Analytical Duplicates Analyzed by ICP-OES and ICP-MS, ASU

Sample	13-10608	Duplicate	RPD	13-10623	Duplicate	RPD
	[ppm]	[ppm]	(%)	[ppm]	[ppm]	(%)
	Analytical Duplicates					
Ag	<2.0	<2.0		<2.0	<2.0	
Al	3280	2840	14	2370	2240	5.6
As	3.1	3.1	0.0	<1.0	<1.0	
B	73.4	72.8	0.8	25.4	23.6	7.3
Ba	76	70.8	7.1	53.6	50.5	6.0
Be	<4.0	<4.0		<4.0	<4.0	
Ca	34900	32700	6.5	20000	18600	7.3
Cd	0.63	0.62	1.6	0.58	0.57	1.7
Co	<5.0	<5.0		<5.0	<5.0	
Cr	<20	<20		<20	<20	
Cu	12.6	11.5	9.1	12.4	11.8	5.0
Fe	8300	8060	2.9	3240	3010	7.4
K	540	505	6.7	455	440	3.4
Mg	4660	4480	3.9	3000	2820	6.2
Mn	279	263	5.9	259	244	6.0
Mo	<2.0	<2.0		<2.0	<2.0	
Na	739	793	7.0	265	254	4.2
Ni	14.8	13.7	7.7	9.9	9.4	5.2
P	1190	1160	2.6	973	928	4.7
Pb	<10	<10		<10	<10	
S	10300	10500	1.9	10700	10200	4.8
Sb	<10	<10		<10	<10	
Se	0.69	0.77	11	0.7	0.61	14
Sn	<2.0	<2.0		<2.0	<2.0	
Sr	144	135	6.5	86	80.3	6.9
Ti	54	52.7	2.4	45.2	42.2	6.9
Tl	0.078	0.068	14	0.065	0.069	6.0
U	<10	<10		<10	<10	
V	11.2	<10		<10	<10	
Zn	114	111	2.7	106	100	5.8

Sample	13-10628	Duplicate	RPD	13-10637	Duplicate	RPD	Average RPD	Std Dev
	[ppm]	[ppm]	(%)	[ppm]	[ppm]	(%)	(%)	
	Analytical Duplicates							
Ag	<2.0	<2.0		<2.0	<2.0			
Al	25300	25900	2.3	10400	8810	17	**9.7**	**± 6.8**
As	7.2	7.7	6.7	1.9	1.8	5.4	**4.0**	**± 3.6**
B	103	140	30	18	14.9	19	**14**	**± 13**
Ba	373	388	3.9	114	99.6	14	**7.6**	**± 4.1**
Be	<4.0	<4.0		<4.0	<4.0			
Ca	20600	22600	9.3	6740	5870	14	**9.2**	**± 3.3**
Cd	1.9	1.8	5.4	0.13	0.1	26	**8.7**	**± 12**
Co	9.8	9.2	6.3	5.4	<5.0		**6.3**	
Cr	32.8	32.7	0.31	25.2	26	3.1	**1.7**	**± 2.0**
Cu	175	183	4.5	53.4	141	90	**27**	**± 42**
Fe	24400	24300	0.41	19700	16400	18	**7.2**	**± 7.9**
K	2230	2210	0.9	1550	1380	12	**5.6**	**± 4.6**
Mg	5510	5580	1.3	3750	3550	5.5	**4.2**	**± 2.2**
Mn	408	450	9.8	229	207	10	**7.9**	**± 2.3**
Mo	3.4	3.5	2.9	<2.0	<2.0		**2.9**	**± 0**
Na	513	538	4.8	172	151	13	**7.3**	**± 4.0**
Ni	28	28.1	0.36	18.4	17.2	6.7	**5.0**	**± 3.3**
P	6090	7640	23	823	740	11	**10**	**± 9.0**
Pb	23.4	23.8	1.7	15.2	13.8	9.7	**5.7**	**± 5.6**
S	10200	11600	13	720	594	19	**9.7**	**± 7.8**
Sb	<10	<10		<10	<10			
Se	2.8	2.7	3.6	0.43	0.38	12	**10**	**± 4.5**
Sn	8.6	9.4	8.9	2.2	2.2	0	**4.4**	**± 6.3**
Sr	169	183	8.0	35.4	32	10	**7.8**	**± 1.6**
Ti	53.9	53.7	0.37	197	168	16	**6.4**	**± 6.9**
Tl	0.22	0.21	4.7	0.14	0.13	7.4	**7.9**	**± 4.0**
U	<10	<10		<10	<10			
V	49.1	47.9	2.5	31.3	27.6	13	**7.5**	**± 7.1**
Zn	336	360	6.9	140	122	14	**7.3**	**± 4.7**

Table C-6: Inorganic Element Results for Water Control Spikes Analyzed by ICP-MS and ICP-OES, ASU

Sample	Control 1	Control 1 Target	Recovery	Control 2	Control 2 Target	Recovery	1643e CRM	1643e Target	Recovery
	[ppb]	[ppb]	(%)	[ppb]	[ppb]	(%)	[ppb]	[ppb]	(%)
Aluminium	27	25	108	-	-		160	140	114
Antimony	-	-		25	25	100	57	58	98
Arsenic	26	25	104	-	-		58	60	97
Barium	25	25	100	-	-		560	540	104
Beryllium	26	25	104	-	-		14	14	100
Boron*	2000	2000	100	-	-		-	-	
Cadmium	25	25	100	-	-		6.6	6.6	100
Calcium	-	-		-	-		32000	32000	100
Chromium	24	25	96	-	-		19	20	95
Cobalt	24	25	96	-	-		25	26	96
Copper	24	25	96	-	-		21	22	95
Iron	26	25	104	-	-		<100	96	
Lead	25	25	100	-	-		18	20	90
Magnesium	28	25	112	-	-		7700	7800	99
Manganese	24	25	96	-	-		36	38	95
Molybdenum	-	-		26	25	104	120	120	100
Nickel	24	25	96	-	-		56	61	92
Phosphorus*	29000	30000	97		-		-	-	
Potassium	-	-		-	-		2000	2000	100
Selenium	25	25	100	-	-		12	12	100
Silver	25	25	100	-	-		0.94	1.1	85
Sodium	-	-		-	-		20000	20000	100
Strontium	25	25	100	-	-		340	320	106
Sulfur*	28000	30000	93	-	-		-	-	
Thallium	25	25	100	-	-		6.4	7.4	86
Tin	-	-		24	25	96	-	-	
Titanium	-	-		25	25	100	-	-	
Uranium	25	25	100	-	-		-	-	
Vanadium	25	25	100	-	-		36	37	97
Zinc	24	25	96	-	-		70	76	92

* B, P and S by ICP-OES. CCME reporing limits for total metals used.

Table C-7: Inorganic Element Results for Water Analytical Blanks

Sample	Blank	Blank	Blank
	[ppb]	[ppb]	[ppb]
Aluminium	<100	<100	<100
Antimony	<0.2	<0.2	<0.2
Arsenic	<1.0	<1.0	<1.0
Barium	<1.0	<1.0	<1.0
Beryllium	<0.02	<0.02	<0.02
Boron*	<1000	<1000	<1000
Cadmium	<0.017	<0.017	<0.017
Calcium	<100	<100	<100
Chromium	<1.0	<1.0	<1.0
Cobalt	<3.0	<3.0	<3.0
Copper	<3.0	<3.0	<3.0
Iron	<100	<100	<100
Lead	<5.0	<5.0	<5.0
Magnesium	<100	<100	<100
Manganese	<5.0	<5.0	<5.0
Molybdenum	<1.0	<1.0	<1.0
Nickel	<5.0	<5.0	<5.0
Phosphorus*	<1000	<1000	<1000
Potassium	<50	<50	<50
Selenium	<0.5	<0.5	<0.5
Silver	<0.05	<0.05	<0.05
Sodium	<100	<100	<100
Strontium	<0.5	<0.5	<0.5
Sulfur*	<1000	<1000	<1000
Thallium	<0.05	<0.05	<0.05
Tin	<0.5	<0.5	<0.5
Titanium	<10	<10	<10
Uranium	<0.05	<0.05	<0.05
Vanadium	<1.0	<1.0	<1.0
Zinc	<5.0	<5.0	<5.0

Table C-8: Inorganic Element Results for Water Field and Analytical Blanks

Sample	13-10600	13-10601	RPD	13-10607	Duplicate	RPD
	[ppb]	[ppb]	(%)	[ppb]	[ppb]	(%)
	Field Duplicate			*Analytical Duplicate*		
Aluminium	<100	<100		<100	<100	
Antimony	<0.2	<0.2		0.27	0.29	7.1
Arsenic	1.6	1.7	6.1	4	4.6	14
Barium	44	44	0	53	57	7.3
Beryllium	<0.02	<0.02		<0.02	<0.02	
Boron*	<1000	<1000		<1000	<1000	
Cadmium	<0.017	<0.017		<0.017	<0.017	
Calcium	50000	51000	2.0	50000	52000	3.9
Chromium	<1.0	<1.0		<1.0	<1.0	
Cobalt	<3.0	<3.0		<3.0	<3.0	
Copper	<3.0	<3.0		5.4	6.2	14
Hardness (mg/L)	250	250	0			
Iron	220	250	13	700	780	11
Lead	<5.0	<5.0		<5.0	<5.0	
Magnesium	17000	18000	5.7	22000	23000	4.4
Manganese	232	253	8.7	270	290	7.1
Molybdenum	1.2	<1.0		1.8	2	11
Nickel	<5.0	<5.0		<5.0	<5.0	
Phosphorus*	1500	1700	13	<1000	<1000	
Potassium	16000	17000	6.1	10000	11000	9.5
Selenium	<0.5	<0.5		<0.5	<0.5	
Silver	<0.05	<0.05		<0.05	<0.05	
Sodium	24000	25000	4.1	23000	24000	4.3
Strontium	273	337	21	350	350	0
Sulfur*	5900	7200	20	20000	20000	0
Thallium	0.098	<0.05		<0.05	<0.05	
Tin	<0.5	<0.5		<0.5	<0.5	
Titanium	<10	<10		<10	<10	
Uranium	0.34	0.36	5.7	1.8	1.9	5.4
Vanadium	<1.0	<1.0		1.6	1.7	6.1
Zinc	<5.0	<5.0		<5.0	<5.0	

Table C-9: Mercury Analysis of Soil QA/QC Samples

Sample	Hg [ppm]
Control Spikes	
Control Sample	0.48
Control Target	0.44
Recovery (%)	109
Analytical Blank	
Blank	< 0.09
Field Duplicates	
13-10610	< 0.09
13-10611	0.097
13-10640	< 0.09
13-10641	< 0.09
Analytical Duplicate	
13-10648	<0.09
Duplicate	<0.09

Table C-10: Mercury Analysis of Water QA/QC Samples

Sample	Hg [ppm]
Control Spikes	
Control Sample	0.0043
Control Target	0.004
Recovery (%)	108
Analytical Blank	
Blank	<0.000025
Field Duplicate	
13-10600	<0.000025
13-10601	<0.000025
Analytical Duplicate	
13-10607	<0.000025
Duplicate	<0.000025

Table C-11: Aroclor Polychlorinated Biphenyl (PCB) Results for Soil QA/QC Samples

Sample	Aroclor 1254	Aroclor 1260
	[ppb]	[ppb]
Control Spike		
Control	<0.003	0.054
Control Target	<0.003	0.05
Recovery (%)		108
Analytical Blank		
Blank	<0.003	<0.003
Field Duplicate		
13-10610	9.8	<0.003
13-10611	3.2	<0.003
Average	6.5	
Std Dev	4.7	
RPD (%)	102	
Analytical Duplicate		
13-10628	<0.003	<0.003
Duplicate	<0.003	<0.003

Table C-12: Pesticide Results for Soil Control Spikes and Blanks

Sample	Control	Control Target	Recovery	Control	Control Target	Recovery	Blank	Blank
	[ppb]	[ppb]	(%)	[ppb]	[ppb]	(%)	[ppb]	[ppb]
Control Spike								
alpha-BHC*	26	20	129					<10
beta-BHC	23	20	115					<2.0
gamma-BHC	25	20	125					<2.0
delta-BHC	24	20	121					<2.0
heptachlor	24	20	121					<1.0
aldrin	25	20	124					<2.0
heptachlor epox iso B	24	20	119					<2.0
endosulfan I	23	20	117					<1.0
dieldrin*	25	20	123					<5.0
endrin	22	20	112					<2.0
Endosulfan II	25	20	127					<1.0
endrin aldehyde	24	20	118					<5.0
endosulfan sulfate	26	20	128					<2.0
methoxychlor	26	20	130					<2.0
2,4-DDE	-	-					<1.0	<1.0
4,4-DDE	24	20	121	22	20	112	<1.0	<1.0
2,4-DDD	-	-					<1.0	<1.0
4,4-DDD	23	20	117	23	20	115	<1.0	<1.0
2,4-DDT	-	-					<1.0	<1.0
4,4-DDT	18	20	92	23	20	115	<1.0	<1.0

* Detection limit increased due to interferences - (GC/MS results reported)

Table C-13: Pesticide Results for Soil Analytical and Field Duplicates

Sample	13-10637	Duplicate	RPD	13-10641	Duplicate	13-10610	13-10611	RPD	13-10640	13-10641
	[ppb]	[ppb]	(%)	[ppb]	[ppb]	[ppb]	[ppb]	(%)	[ppb]	[ppb]
				Analytical Duplicate		*Field Duplicates*				
alpha-BHC*				<10	<10	<10	<10		<10	<10
beta-BHC				<2.0	<2.0	<2.0	<2.0		<2.0	<2.0
gamma-BHC				<50*	<50*	<2.0	<2.0		<50*	<50*
delta-BHC				<2.0	<2.0	<50*	<50*		<2.0	<2.0
heptachlor				<1.0	<1.0	<1.0	<1.0		<1.0	<1.0
aldrin				<2.0	<2.0	<2.0	<2.0		<2.0	<2.0
heptachlor epox iso B				<2.0	<2.0	<2.0	<2.0		<2.0	<2.0
endosulfan I				<1.0	<1.0	<50*	<50*		<1.0	<1.0
dieldrin*				<5.0	<5.0	<5.0	<5.0		<5.0	<5.0
endrin				<2.0	<2.0	<2.0	<2.0		<2.0	<2.0
Endosulfan II				<1.0	<1.0	<1.0	<1.0		<1.0	<1.0
endrin aldehyde				<5.0	<5.0	<5.0	<5.0		<5.0	<5.0
endosulfan sulfate				<2.0	<2.0	<2.0	<2.0		<2.0	<2.0
methoxychlor				<2.0	<2.0	<2.0	<2.0		<2.0	<2.0
2,4-DDE	<1.0	<1.0		<1.0	<1.0	11	8.4	22	<1.0	<1.0
4,4-DDE	<1.0	<1.0		<1.0	<1.0	37	38	2.6	<1.0	<1.0
2,4-DDD	<1.0	<1.0		<1.0	<1.0	5.4	7.6	33	<1.0	<1.0
4,4-DDD	1.7	2.1	22	<1.0	<1.0	13	13	4.6	<1.0	<1.0
2,4-DDT	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0		<1.0	<1.0
4,4-DDT	<1.0	<1.0		<1.0	<1.0	2.1	8.4	119	<1.0	<1.0

* Detection limit increased due to interferences - (GC/MS results reported)

Table C-14: Polycyclic Aromatic Hydrocarbon Results for Soil Control Spikes

Sample	Control Sample [ppm]	Control Target [ppm]	Recovery (%)	Control Sample [ppm]	Control Target [ppm]	Recovery (%)	Control Sample [ppm]	Control Target [ppm]	Recovery (%)	Average Recovery (%)	Std Dev
Naphthalene	0.18	0.23	78	0.20	0.27	74	0.10	0.11	74	**75**	**± 2.3**
Acenaphthylene	0.30	0.28	107	0.34	0.32	106	0.11	0.13	106	**106**	**± 0.5**
Acenaphthene	0.25	0.21	119	0.92	0.77	119	0.31	0.31	119	**119**	**± 0.3**
Fluorene	0.31	0.27	115	0.54	0.47	115	0.19	0.19	115	**115**	**± 0.1**
Phenanthrene	0.19	0.21	90	0.20	0.18	111	0.12	0.07	111	**104**	**± 12**
Anthracene	0.2	0.24	83	0.22	0.17	129	0.12	0.07	129	**114**	**± 27**
Fluoranthene	0.19	0.22	86	0.20	0.23	87	0.11	0.09	87	**87**	**± 0.6**
Pyrene	0.28	0.23	122	0.48	0.49	98	0.18	0.19	98	**106**	**± 14**
Benzo(a)anthracene	0.23	0.2	115	0.21	0.23	91	0.1	0.09	91	**99**	**± 14**
Chrysene	0.24	0.22	109	0.26	0.24	108	0.13	0.1	108	**108**	**± 0.5**
Benzo(b)fluoranthene	0.24	0.2	120	0.29	0.29	100	0.12	0.12	100	**107**	**± 12**
Benzo(k)fluoranthene	0.23	0.21	110	0.28	0.23	122	0.11	0.09	122	**118**	**± 6.9**
Benzo(a)pyrene	0.27	0.23	117	0.30	0.4	75	0.12	0.16	75	**89**	**± 24**
Indeno(1,2,3-cd)pyrene	0.20	0.21	95	0.19	0.2	95	< 0.1	0.08	95	**95**	**± 0**
Dibenz(a,h)anthracene	0.19	0.24	79	0.17	0.19	89	0.06	0.08	89	**86**	**± 5.9**
Benzo(ghi)perylene	0.21	0.22	95	0.25	0.3	83	0.1	0.12	83	**87**	**± 6.8**
Total	3.7	3.62	102	5.1	5.0	102	2	2.0	102	**102**	**± 0**
Surrogate Recovery	**(%)**			**(%)**			**(%)**			**(%)**	
Naphthalene-d8	99			92			92			**94**	**± 4.0**
Phenanthrene-d10	94			87			100			**94**	**± 6.5**
Anthracene-d10	89			81			95			**88**	**± 7.0**
Benzo(a)anthracene-d12	87			72			71			**77**	**± 9.0**

Table C-15: Polycyclic Aromatic Hydrocarbon Results for Soil Blanks and Analytical Duplicate

Sample	Blank	Blank	Blank	13-10625	13-10612	Duplicate	RPD	13-10631	Duplicate	RPD
	[ppm]	[ppm]	[ppm]	[ppm]	[ppm]	[ppm]	(%)	[ppm]	[ppm]	(%)
	Analytical Blanks			*Scoop blank*	*Analytical Duplicate*			*Analytical Duplicate*		
Naphthalene	< 0.011	< 0.011	< 0.01	< 0.011	< 0.011	< 0.011		0.03	0.06	67
Acenaphthylene	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005		< 0.005	< 0.005	
Acenaphthene	< 0.005	< 0.005	< 0.006	< 0.005	< 0.005	< 0.005		0.01	0.01	0
Fluorene	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02		< 0.02	< 0.02	
Phenanthrene	< 0.04	< 0.04	< 0.04	< 0.04	0.05	0.05	0	0.05	0.07	33
Anthracene	< 0.04	< 0.04	< 0.004	< 0.04	< 0.04	< 0.04		< 0.004	< 0.004	
Fluoranthene	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05		0.06	0.07	15
Pyrene	< 0.029	< 0.029	< 0.05	< 0.029	< 0.029	< 0.029		< 0.05	< 0.05	
Benzo(a)anthracene	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03		< 0.03	< 0.03	
Chrysene	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05		< 0.05	< 0.05	
Benzo(b)fluoranthene	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05		< 0.05	< 0.05	
Benzo(k)fluoranthene	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05		< 0.05	< 0.05	
Benzo(a)pyrene	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03		< 0.03	< 0.03	
Indeno(1,2,3-cd)pyrene	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1	< 0.1	
Dibenz(a,h)anthracene	< 0.005	< 0.005	< 0.006	< 0.005	< 0.005	< 0.005		< 0.006	< 0.006	
Benzo(ghi)perylene	< 0.03	< 0.03	< 0.03	< 0.03	<0.03	<0.03		< 0.03	< 0.03	
Total	< 0.25	< 0.250	< 0.250	< 0.25	< 0.25	< 0.25		0.26	0.27	3.8
Surrogate Recovery	**(%)**			**(%)**	**(%)**			**(%)**		
Naphthalene-d8	104	75		114	94	83		86	77	
Phenanthrene-d10	93	62		113	84	83		81	71	
Anthracene-d10	88	58		97	79	78		80	69	
Benzo(a)anthracene-d12	86	48		88	65	69		52	42	

Table C-16: Polycyclic Aromatic Hydrocarbon Results for Soil Field Duplicates

Sample	13-10620	13-10621	13-10630	13-10631	13-10630	13-10631	RPD	13-10640	13-10641
	[ppm]	[ppm]	[ppm]	[ppm]	[ppm]	[ppm]	(%)	[ppm]	[ppm]
					Repeats				
Naphthalene	< 0.011	< 0.011	< 0.011	0.02	0.06	0.05	18	< 0.011	< 0.011
Acenaphthylene	< 0.005	< 0.005	< 0.005	< 0.005	0.01	< 0.005		< 0.005	< 0.005
Acenaphthene	0.01	< 0.005	0.02	< 0.005	0.01	0.01	0	< 0.005	< 0.005
Fluorene	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02		< 0.02	< 0.02
Phenanthrene	< 0.04	< 0.04	< 0.04	< 0.04	0.12	0.06	67	< 0.04	< 0.04
Anthracene	< 0.04	< 0.04	< 0.04	< 0.04	< 0.004	< 0.004		< 0.04	< 0.04
Fluoranthene	< 0.05	< 0.05	< 0.05	< 0.05	0.13	0.07	60	< 0.05	< 0.05
Pyrene	< 0.029	< 0.029	< 0.029	< 0.029	< 0.05	< 0.05		< 0.029	< 0.029
Benzo(a)anthracene	< 0.03	< 0.03	< 0.03	0.07	0.03	< 0.03		< 0.03	< 0.03
Chrysene	< 0.05	< 0.05	< 0.05	0.09	< 0.05	< 0.05		< 0.05	< 0.05
Benzo(b)fluoranthene	< 0.05	< 0.05	< 0.05	0.08	0.05	< 0.05		< 0.05	< 0.05
Benzo(k)fluoranthene	< 0.05	< 0.05	< 0.05	0.07	< 0.05	< 0.05		< 0.05	< 0.05
Benzo(a)pyrene	< 0.03	< 0.03	< 0.03	0.07	< 0.03	< 0.03		< 0.03	< 0.03
Indeno(1,2,3-cd)pyrene	< 0.1	< 0.1	< 0.1	0.09	< 0.1	< 0.1		< 0.1	< 0.1
Dibenz(a,h)anthracene	< 0.005	< 0.005	< 0.005	0.13	< 0.006	< 0.006		< 0.005	< 0.005
Benzo(ghi)perylene	< 0.03	< 0.03	< 0.03	0.1	< 0.03	< 0.03		< 0.03	< 0.03
Total	< 0.25	< 0.25	< 0.25	0.8	0.41	0.19	73	< 0.25	< 0.25
Surrogate Recovery	(%)		(%)		(%)			(%)	
Naphthalene-d8	78	93	53	60	53	82		103	110
Phenanthrene-d10	71	84	47	68	50	76		80	100
Anthracene-d10	66	65	40	65	50	75		77	95
Benzo(a)anthracene-d12	61	67	35	62	26	47		58	76

Table C-17: Polycyclic Aromatic Hydrocarbon Results for Water Control Spikes and Blank

Sample	Control Sample	Control Target	Recovery	Blank
	[ppb]	[ppb]	(%)	[ppb]
	Control Spike			*Analytical Blank*
Naphthalene	0.09	0.08	111	< 0.01
Acenaphthylene	0.09	0.13	70	< 0.01
Acenaphthene	0.22	0.29	75	< 0.01
Fluorene	0.18	0.15	123	< 0.01
Phenanthrene	0.08	0.08	100	< 0.01
Anthracene	0.07	0.08	97	< 0.006
Fluoranthene	0.08	0.06	123	< 0.01
Pyrene	0.18	0.14	129	< 0.01
Benzo(a)anthracene	0.12	0.08	154	< 0.01
Chrysene	0.1	0.07	155	< 0.01
Benzo(b)fluoranthene	0.12	0.09	139	< 0.01
Benzo(k)fluoranthene	0.11	0.1	105	< 0.01
Benzo(a)pyrene	0.13	0.14	94	< 0.007
Indeno(1,2,3-cd)pyrene	0.08	0.06	150	< 0.01
Dibenz(a,h)anthracene	0.1	0.07	148	< 0.01
Benzo(ghi)perylene	0.12	0.1	127	< 0.01
Total	1.9	1.7	110	< 0.01
Surrogate Recovery	**%**			**%**
Naphthalene-d8	109			97
Phenanthrene-d10	122			122
Anthracene-d10	127			140
Benzo(a)anthracene-d12	113			135

Table C-18: Polycyclic Aromatic Hydrocarbon Results for Water Analytical and Field Duplicates

Sample	13-10607	Duplicate	RPD	13-10600	13-10601	RPD
	[ppb]	[ppb]	(%)	[ppb]	[ppb]	(%)
	Analytical Duplicate			*Field Duplicate*		
Naphthalene	0.14	0.12	15	0.02	0.02	5.9
Acenaphthylene	0.15	0.15	0	0.03	0.01	79
Acenaphthene	<0.01	<0.01		0.02	< 0.01	
Fluorene	0.02	0.02	0	0.03	< 0.01	
Phenanthrene	0.05	0.05	0	0.03	0.01	59
Anthracene	0.007	0.005	33	0.02	0.01	60
Fluoranthene	<0.01	<0.01		0.01	< 0.01	
Pyrene	<0.01	<0.01		0.01	< 0.01	
Benzo(a)anthracene	0.01	0.01	0	0.03	0.04	36
Chrysene	<0.01	<0.01		0.005	0.001	112
Benzo(b)fluoranthene	<0.01	<0.01		0.04	0.02	63
Benzo(k)fluoranthene	<0.01	<0.01		0.04	0.01	85
Benzo(a)pyrene	0.001	<0.001		0.04	0.01	88
Indeno(1,2,3-cd)pyrene	0.01	0.01	0	0.04	0.03	32
Dibenz(a,h)anthracene	0.01	0.01	0	0.04	0.03	41
Benzo(ghi)perylene	0.01	0.01	0	0.05	0.03	44
Total	0.41	0.36	13	0.43	0.23	62
Surrogate Recovery	**%**	**%**		**%**	**%**	
Naphthalene-d8	103	106		98	97	
Phenanthrene-d10	124	123		123	128	
Anthracene-d10	125	122		126	132	
Benzo(a)anthracene-d12	122	122		122	126	

Table C-19: Canadian Council of Ministers of the Environment (CCME) Hydrocarbon for Control Spikes in Soil Samples, ASG

Sample	F1 (C6-C10) [ppm]
Control Sample F1	
Control F1	24
Control Target	29
Recovery (%)	83

Sample	Total Hydrocarbons (C10-C50) [ppm]
Diesel Spike	48
Diesel Spike Target	50
Recovery (%)	96

Sample	Total Hydrocarbons (C10-C50) [mg/L]
Control Standard	2200
Control Standard Target	2500
Recovery (%)	88

Table C-20: CCME Hydrocarbon Analysis of Soil Blanks and Duplicates

Sample	F1 (C6-C10) [ppm]	F2 (C10-C16) [ppm]	F3 (C16-C34) [ppm]	F4 (C34-C50) [ppm]
Analytical Blank				
Blank	<10	<4.0	<9.0	<8.0
Scoop Blank				
13-10625	<10	<4.0	<9.0	<8.0
Soil Field Duplicates				
13-10620	< 10	< 4.0	< 9.0	11
13-10621	< 10	< 4.0	< 9.0	12
Average				11.5
Std Dev				0.7
RPD (%)				8.7
13-10630	19	< 4.0	90	34
13-10631	< 10	5.1	150	42
Average			120	38
Std Dev			42	5.7
RPD (%)			50	21
13-10640	< 10	5.9	49	39
13-10641	< 10	< 4.0	12	19
Average			31	29
Std Dev			26	14
RPD (%)			121	69
Average RPD (%)			**86**	**33**
Std Dev			**± 50**	**± 32**
Soil Analytical Duplicate				
13-10608	<10			
Duplicate	<10			
13-10641		<4.0	12	17
Duplicate		<4.0	13	21
Average			12.5	19
Std Dev			0.7	2.8
RPD (%)			8.0	21

Table C-21: Canadian Council of Ministers of the Environment (CCME) Hydrocarbon for Control Spikes in Water Samples, ASG

Sample	F1 (C6-C10) [mg/L]
Control Sample F1	
Control F1	0.12
Control Target	0.16
Recovery (%)	75

Sample	Total Hydrocarbons (C10-C50) [mg/L]
Diesel Spike	7.2
Diesel Spike Target	10
Recovery (%)	72

Sample	Total Hydrocarbons (C10-C50) [mg/L]
Control Standard	2800
Control Standard Target	2500
Recovery (%)	112

Table C-22: CCME Hydrocarbon Analysis of Water QA/QC Samples

Sample	F1 (C6-C10) [ppm]	F2 (C10-C16) [ppm]	F3 (C16-C34) [ppm]	F4 (C34-C50) [ppm]
Analytical Blank				
Blank	<0.05	< 0.5	< 1.0	< 1.0
Analytical Duplicates				
13-10600	<0.05			
Duplicate	<0.05			
13-10607		<0.5	<1.0	<1.0
Duplicate		<0.5	<1.0	<1.0
Field Duplicate				
13-10600	< 0.05	< 0.5	< 1.0	< 1.0
13-10601	< 0.05	< 0.5	< 1.0	< 1.0

Table C-23: Volatile Organic Carbon (VOC) Analysis of Soil Control and Blank Samples, ASG

PAH	Control Sample	Control Target	Recovery	Control Sample	Control Target	Recovery	Average Recovery	Std Dev	Blank	Blank	13-10625
	[ppm]	[ppm]	(%)	[ppm]	[ppm]	(%)	(%)		[ppm]	[ppm]	[ppm]
	Control Spike			*Control Spike*					*Analytical Blank*	*Analytical Blank*	*Scoop Blank*
Dichlorodifluoromethane	0.09	0.08	116				**116**	-	< 0.10		< 0.10
Chloromethane	0.09	0.08	118				**118**	-	< 0.10		< 0.10
Vinyl chloride	0.1	0.08	125				**125**	-	< 0.009		< 0.009
Bromomethane	0.1	0.08	125				**125**	-	< 0.10		< 0.10
Chloroethane	0.1	0.08	121				**121**	-	< 0.10		< 0.10
Trichlorofluoromethane	0.09	0.08	108				**108**	-	< 0.10		< 0.10
1,1-Dichloroethene	0.09	0.08	106				**106**	-	< 0.080		< 0.080
Methylene chloride	0.08	0.08	99				**99**	-	< 0.080		< 0.080
trans-1,2-Dichloroethene	0.09	0.08	106				**106**	-	< 0.020		< 0.020
Methyl tert-butyl ether	0.08	0.08	103				**103**	-	< 0.020		< 0.020
1,1-Dichloroethane	0.08	0.08	101				**101**	-	< 0.020		< 0.020
2,2-Dichloropropane	0.07	0.08	89				**89**	-	< 0.020		< 0.020
cis-1,2-Dichloroethene	0.08	0.08	101				**101**	-	< 0.020		< 0.020
Bromochloromethane	0.08	0.08	94				**94**	-	< 0.020		< 0.020
Chloroform	0.08	0.08	103				**103**	-	< 0.0019		< 0.0019
1,1,1-Trichloroethane	0.08	0.08	98				**98**	-	< 0.020		< 0.020
Carbon Tetrachloride	0.08	0.08	95				**95**	-	< 0.020		< 0.020
1,1-Dichloropropene	0.1	0.1	109				**109**	-	< 0.020		< 0.020
Benzene	0.1	0.1	110	0.078	0.08	98	**104**	**± 8.8**	< 0.005	< 0.005	< 0.005
1,2-Dichloroethane	0.1	0.1	91				**91**	-	< 0.010		< 0.010
Trichloroethene	0.1	0.1	106				**106**	-	< 0.020		< 0.020
1,2-Dichloropropane	0.1	0.1	99				**99**	-	< 0.020		< 0.020
Bromodichloromethane	0.1	0.1	94				**94**	-	< 0.020		< 0.020
Dibromomethane	0.1	0.1	91				**91**	-	< 0.020		< 0.020
cis-1,3-Dichloropropene	0.1	0.1	95				**95**	-	< 0.020		< 0.020
Toluene	0.1	0.1	105	0.072	0.08	90	**98**	**± 11**	< 0.020	< 0.020	< 0.020
trans-1,3-Dichloropropene	0.1	0.1	91				**91**	-	< 0.020		< 0.020
1,1,2-Trichloroethane	0.1	0.1	94				**94**	-	< 0.020		< 0.020
Tetrachloroethene	0.1	0.1	100				**100**	-	< 0.020		< 0.020
1,3-Dichloropropane	0.1	0.1	94				**94**	-	< 0.020		< 0.020
Dibromochloromethane	0.1	0.1	91				**91**	-	< 0.020		< 0.020
1,2-Dibromoethane	0.1	0.1	90				**90**	-	< 0.020		< 0.020
Chlorobenzene	0.1	0.1	109				**109**	-	< 0.020		< 0.020
1,1,1,2-Tetrachloroethane	0.1	0.1	93				**93**	-	< 0.020		< 0.020
Ethylbenzene	0.1	0.1	125	0.097	0.08	122	**123**	**± 2.7**	< 0.011	< 0.011	< 0.011
m+p-Xylene	0.2	0.2	125	0.18	0.16	113	**119**	**± 8.8**	< 0.020	< 0.020	< 0.020
o-Xylene	0.1	0.1	124	0.1	0.08	125	**125**	**± 0.7**	< 0.020	< 0.020	< 0.020
Styrene	0.1	0.1	138				**138**	-	< 0.020		< 0.020
Bromoform	0.1	0.1	89				**89**	-	< 0.020		< 0.020
Isopropylbenzene	0.1	0.1	125				**125**	-	< 0.020		< 0.020
Bromobenzene	0.1	0.1	109				**109**	-	< 0.020		< 0.020
1,2,3-Trichloropropane	0.1	0.1	91				**91**	-	< 0.020		< 0.020
1,1,2,2-Tetrachloroethane	0.1	0.1	90				**90**	-	< 0.020		< 0.020
n-Propylbenzene	0.1	0.1	138				**138**	-	< 0.020		< 0.020
2-Chlorotoluene	0.1	0.1	111				**111**	-	< 0.020		< 0.020
4-Chlorotoluene	0.1	0.1	114				**114**	-	< 0.020		< 0.020
1,3,5-Trimethylbenzene	0.1	0.1	124				**124**	-	< 0.020		< 0.020
tert-Butylbenzene	0.1	0.1	118				**118**	-	< 0.020		< 0.020
1,2,4-Trimethylbenzene	0.1	0.1	138				**138**	-	< 0.020		< 0.020
sec-ButylBenzene	0.1	0.1	125				**125**	-	< 0.020		< 0.020
1,3-Dichlorobenzene	0.1	0.1	108				**108**	-	< 0.020		< 0.020
1,4-Dichlorobenzene	0.1	0.1	114				**114**	-	< 0.020		< 0.020
p-Isopropyltoluene	0.1	0.1	125				**125**	-	< 0.020		< 0.020
1,2-Dichlorobenzene	0.1	0.1	106				**106**	-	< 0.020		< 0.020
n-butylbenzene	0.1	0.1	138				**138**	-	< 0.020		< 0.020
1,2-Dibromo-3-chloropropane	0.1	0.1	93				**93**	-	< 0.10		< 0.10
1,2,4-Trichlorobenzene	0.1	0.1	119				**119**	-	< 0.020		< 0.020
1,2,3-Trichlorobenzene	0.1	0.1	119				**119**	-	< 0.030		< 0.030
Naphthalene	0.1	0.1	114				**114**	-	< 0.0099		< 0.0099
Hexachlorobutadiene	0.1	0.1	113				**113**	-	< 0.10		< 0.10
Surrogate Recovery	**(%)**			**(%)**					**(%)**	**(%)**	**(%)**
Recovery	111			98					82	72	91

Table C-24: Volatile Organic Carbon (VOC) Analysis of Soil Analytical and Field Duplicates, ASG

PAH	13-10608	Duplicate	RPD	13-10620	13-10621	RPD	13-10630	13-10631	RPD	13-10630	13-10631	RPD	13-10640	13-10641	RPD
	[ppm]	[ppm]	(%)	[ppm]	[ppm]	(%)	[ppm]	[ppm]	(%)	[ppm]	[ppm]	(%)	[ppm]	[ppm]	(%)
	Analytical Duplicate			*Field Duplicate*			*Field Duplicate*			*Field Duplicate (repeat)*			*Field Duplicate*		
Dichlorodifluoromethane	<0.10	<0.10		< 0.10	< 0.10		< 0.10	< 0.10					< 0.10	< 0.10	
Chloromethane	<0.10	<0.10		< 0.10	< 0.10		< 0.10	< 0.10					< 0.10	< 0.10	
Vinyl chloride	<0.009	<0.009		< 0.009	< 0.009		< 0.009	< 0.009					< 0.009	< 0.009	
Bromomethane	<0.10	<0.10		< 0.10	< 0.10		< 0.10	< 0.10					< 0.10	< 0.10	
Chloroethane	<0.10	<0.10		< 0.10	< 0.10		< 0.10	< 0.10					< 0.10	< 0.10	
Trichlorofluoromethane	<0.10	<0.10		< 0.10	< 0.10		< 0.10	< 0.10					< 0.10	< 0.10	
1,1-Dichloroethene	<0.080	<0.080		< 0.080	< 0.080		< 0.080	< 0.080					< 0.080	< 0.080	
Methylene chloride	<0.080	<0.080		< 0.080	< 0.080		< 0.080	< 0.080					< 0.080	< 0.080	
trans-1,2-Dichloroethene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
Methyl tert-butyl ether	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
1,1-Dichloroethane	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
2,2-Dichloropropane	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
cis-1,2-Dichloroethene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
Bromochloromethane	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
Chloroform	<0.0019	<0.0019		< 0.0019	< 0.0019		< 0.0019	< 0.0019					< 0.0019	< 0.0019	
1,1,1-Trichloroethane	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
Carbon Tetrachloride	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
1,1-Dichloropropene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
Benzene	<0.005	<0.005		< 0.005	< 0.005		< 0.005	< 0.005		< 0.005	< 0.005		< 0.005	< 0.005	
1,2-Dichloroethane	<0.010	<0.010		< 0.010	< 0.010		< 0.010	< 0.010					< 0.010	< 0.010	
Trichloroethene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
1,2-Dichloropropane	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
Bromodichloromethane	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
Dibromomethane	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
cis-1,3-Dichloropropene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
Toluene	1.6	2.0	22	< 0.020	< 0.020		0.18	4.0	183	< 0.020	3.9		< 0.020	< 0.020	
trans-1,3-Dichloropropene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
1,1,2-Trichloroethane	<0.020	<0.020		0.025	0.03	18	0.041	0.043	4.8				0.025	0.022	13
Tetrachloroethene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
1,3-Dichloropropane	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
Dibromochloromethane	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
1,2-Dibromoethane	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
Chlorobenzene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
1,1,1,2-Tetrachloroethane	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
Ethylbenzene	<0.011	<0.011		< 0.011	< 0.011		< 0.011	< 0.011		< 0.011	< 0.011		< 0.011	< 0.011	
m+p-Xylene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020		< 0.020	< 0.020		< 0.020	< 0.020	
o-Xylene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020		< 0.020	< 0.020		< 0.020	< 0.020	
Styrene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
Bromoform	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
Isopropylbenzene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
Bromobenzene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
1,2,3-Trichloropropane	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
1,1,2,2-Tetrachloroethane	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
n-Propylbenzene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	0.033					< 0.020	< 0.020	
2-Chlorotoluene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
4-Chlorotoluene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
1,3,5-Trimethylbenzene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
tert-Butylbenzene	<0.020	<0.020		< 0.020	< 0.020		0.036	< 0.020					< 0.020	< 0.020	
1,2,4-Trimethylbenzene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
sec-ButylBenzene	<0.020	<0.020		< 0.020	< 0.020		0.11	< 0.020					< 0.020	< 0.020	
1,3-Dichlorobenzene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
1,4-Dichlorobenzene	<0.020	<0.020		< 0.020	< 0.020		0.055	0.032	53				< 0.020	< 0.020	
p-Isopropyltoluene	<0.020	<0.020		< 0.020	< 0.020		0.11	< 0.020					< 0.020	< 0.020	
1,2-Dichlorobenzene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
n-butylbenzene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
1,2-Dibromo-3-chloropropane	<0.10	<0.10		< 0.10	< 0.10		< 0.10	< 0.10					< 0.10	< 0.10	
1,2,4-Trichlorobenzene	<0.020	<0.020		< 0.020	< 0.020		< 0.020	< 0.020					< 0.020	< 0.020	
1,2,3-Trichlorobenzene	<0.030	<0.030		< 0.030	< 0.030		< 0.030	< 0.030					< 0.030	< 0.030	
Naphthalene	<0.0099	<0.0099		< 0.0099	< 0.0099		< 0.0099	< 0.0099					< 0.0099	< 0.0099	
Hexachlorobutadiene	<0.10	<0.10		< 0.10	< 0.10		< 0.10	< 0.10					< 0.10	< 0.10	
Surrogate Recovery	**(%)**			**(%)**	**(%)**		**(%)**	**(%)**		**(%)**	**(%)**		**(%)**	**(%)**	
Recovery	123	96		92	103		84	73		74	71		74	83	

Table C-25: Volatile Organic Carbon (VOC) Analysis of Water Control and Blank Samples, ASG

PAH	Control Sample	Control Target	Recovery	Blank
	[ppb]	[ppb]	(%)	[ppb]
	Control Spike			*Analytical Blank*
Dichlorodifluoromethane	9.8	10	98	< 10
Chloromethane	11	10	110	< 10
Vinyl chloride	11	10	110	< 10
Bromomethane	11	10	110	< 10
Chloroethane	9.8	10	98	< 10
Trichlorofluoromethane	10	10	100	< 10
1,1-Dichloroethene	11	10	110	< 10
Methylene chloride	10	10	100	< 10
trans-1,2-Dichloroethene	11	10	110	< 2.0
Methyl tert-butyl ether	11	10	110	< 2.0
1,1-Dichloroethane	10	10	100	< 2.0
2,2-Dichloropropane	8.6	10	86	< 2.0
cis-1,2-Dichloroethene	10	10	100	< 2.0
Bromochloromethane	10	10	100	< 2.0
Chloroform	10	10	100	< 2.0
1,1,1-Trichloroethane	10	10	100	< 2.0
Carbon Tetrachloride	10	10	100	< 2.0
1,1-Dichloropropene	10	10	100	< 2.0
Benzene	10	10	100	< 2.0
1,2-Dichloroethane	9.6	10	96	< 0.7
Trichloroethene	10	10	100	< 2.0
1,2-Dichloropropane	10	10	100	< 2.0
Bromodichloromethane	10	10	100	< 2.0
Dibromomethane	9.9	10	99	< 2.0
cis-1,3-Dichloropropene	11	10	110	< 2.0
Toluene	10	10	100	< 0.5
trans-1,3-Dichloropropene	11	10	110	< 2.0
1,1,2-Trichloroethane	9.7	10	97	< 2.0
Tetrachloroethene	9.7	10	97	< 2.0
1,3-Dichloropropane	10	10	100	< 2.0
Dibromochloromethane	11	10	110	< 2.0
1,2-Dibromoethane	10	10	100	< 2.0
Chlorobenzene	10	10	100	< 2.0
1,1,1,2-Tetrachloroethane	11	10	110	< 2.0
Ethylbenzene	14	10	140	< 2.0
m+p-Xylene	24	20	120	< 2.0
o-Xylene	13	10	130	< 2.0
Styrene	13	10	130	< 2.0
Bromoform	12	10	120	< 2.0
Isopropylbenzene	14	10	140	< 2.0
Bromobenzene	10	10	100	< 2.0
1,2,3-Trichloropropane	11	10	110	< 2.0
1,1,2,2-Tetrachloroethane	11	10	110	< 2.0
n-Propylbenzene	13	10	130	< 2.0
2-Chlorotoluene	12	10	120	< 2.0
4-Chlorotoluene	14	10	140	< 2.0
1,3,5-Trimethylbenzene	12	10	120	< 2.0
tert-Butylbenzene	12	10	120	< 2.0
1,2,4-Trimethylbenzene	12	10	120	< 2.0
sec-ButylBenzene	14	10	140	< 2.0
1,3-Dichlorobenzene	11	10	110	< 2.0
1,4-Dichlorobenzene	11	10	110	< 2.0
p-Isopropyltoluene	14	10	140	< 2.0
1,2-Dichlorobenzene	10	10	100	< 2.0
n-butylbenzene	13	10	130	< 2.0
1,2-Dibromo-3-chloropropane	11	10	110	< 2.0
1,2,4-Trichlorobenzene	11	10	110	< 2.0
1,2,3-Trichlorobenzene	12	10	120	< 2.0
Naphthalene	11	10	110	< 1.1
Hexachlorobutadiene	9.6	10	96	< 1.3
Surrogate Recovery	**(%)**			**(%)**
Recovery	127			127

Table C-26: Volatile Organic Carbon (VOC) Analysis of Water Field and Analytical Duplicate Samples, ASG

PAH	13-10600	Duplicate	13-10600	13-10601
	[ppb]	[ppb]	[ppb]	[ppb]
	Analytical Duplicate		*Field Duplicate*	
Dichlorodifluoromethane	< 10	< 10	< 10	< 10
Chloromethane	< 10	< 10	< 10	< 10
Vinyl chloride	< 10	< 10	< 10	< 10
Bromomethane	< 10	< 10	< 10	< 10
Chloroethane	< 10	< 10	< 10	< 10
Trichlorofluoromethane	< 10	< 10	< 10	< 10
1,1-Dichloroethene	< 10	< 10	< 10	< 10
Methylene chloride	< 10	< 10	< 10	< 10
trans-1,2-Dichloroethene	< 2.0	< 2.0	< 2.0	< 2.0
Methyl tert-butyl ether	< 2.0	< 2.0	< 2.0	< 2.0
1,1-Dichloroethane	< 2.0	< 2.0	< 2.0	< 2.0
2,2-Dichloropropane	< 2.0	< 2.0	< 2.0	< 2.0
cis-1,2-Dichloroethene	< 2.0	< 2.0	< 2.0	< 2.0
Bromochloromethane	< 2.0	< 2.0	< 2.0	< 2.0
Chloroform	< 2.0	< 2.0	< 2.0	< 2.0
1,1,1-Trichloroethane	< 2.0	< 2.0	< 2.0	< 2.0
Carbon Tetrachloride	< 2.0	< 2.0	< 2.0	< 2.0
1,1-Dichloropropene	< 2.0	< 2.0	< 2.0	< 2.0
Benzene	< 2.0	< 2.0	< 2.0	< 2.0
1,2-Dichloroethane	< 0.7	< 0.7	< 0.7	< 0.7
Trichloroethene	< 2.0	< 2.0	< 2.0	< 2.0
1,2-Dichloropropane	< 2.0	< 2.0	< 2.0	< 2.0
Bromodichloromethane	< 2.0	< 2.0	< 2.0	< 2.0
Dibromomethane	< 2.0	< 2.0	< 2.0	< 2.0
cis-1,3-Dichloropropene	< 2.0	< 2.0	< 2.0	< 2.0
Toluene	< 0.5	< 0.5	< 0.5	< 0.5
trans-1,3-Dichloropropene	< 2.0	< 2.0	< 2.0	< 2.0
1,1,2-Trichloroethane	< 2.0	< 2.0	< 2.0	< 2.0
Tetrachloroethene	< 2.0	< 2.0	< 2.0	< 2.0
1,3-Dichloropropane	< 2.0	< 2.0	< 2.0	< 2.0
Dibromochloromethane	< 2.0	< 2.0	< 2.0	< 2.0
1,2-Dibromoethane	< 2.0	< 2.0	< 2.0	< 2.0
Chlorobenzene	< 2.0	< 2.0	< 2.0	< 2.0
1,1,1,2-Tetrachloroethane	< 2.0	< 2.0	< 2.0	< 2.0
Ethylbenzene	< 2.0	< 2.0	< 2.0	< 2.0
m+p-Xylene	< 2.0	< 2.0	< 2.0	< 2.0
o-Xylene	< 2.0	< 2.0	< 2.0	< 2.0
Styrene	< 2.0	< 2.0	< 2.0	< 2.0
Bromoform	< 2.0	< 2.0	< 2.0	< 2.0
Isopropylbenzene	< 2.0	< 2.0	< 2.0	< 2.0
Bromobenzene	< 2.0	< 2.0	< 2.0	< 2.0
1,2,3-Trichloropropane	< 2.0	< 2.0	< 2.0	< 2.0
1,1,2,2-Tetrachloroethane	< 2.0	< 2.0	< 2.0	< 2.0
n-Propylbenzene	< 2.0	< 2.0	< 2.0	< 2.0
2-Chlorotoluene	< 2.0	< 2.0	< 2.0	< 2.0
4-Chlorotoluene	< 2.0	< 2.0	< 2.0	< 2.0
1,3,5-Trimethylbenzene	< 2.0	< 2.0	< 2.0	< 2.0
tert-Butylbenzene	< 2.0	< 2.0	< 2.0	< 2.0
1,2,4-Trimethylbenzene	< 2.0	< 2.0	< 2.0	< 2.0
sec-ButylBenzene	< 2.0	< 2.0	< 2.0	< 2.0
1,3-Dichlorobenzene	< 2.0	< 2.0	< 2.0	< 2.0
1,4-Dichlorobenzene	< 2.0	< 2.0	< 2.0	< 2.0
p-Isopropyltoluene	< 2.0	< 2.0	< 2.0	< 2.0
1,2-Dichlorobenzene	< 2.0	< 2.0	< 2.0	< 2.0
n-butylbenzene	< 2.0	< 2.0	< 2.0	< 2.0
1,2-Dibromo-3-chloropropane	< 2.0	< 2.0	< 2.0	< 2.0
1,2,4-Trichlorobenzene	< 2.0	< 2.0	< 2.0	< 2.0
1,2,3-Trichlorobenzene	< 2.0	< 2.0	< 2.0	< 2.0
Naphthalene	< 1.0	< 1.0	< 1.1	< 1.1
Hexachlorobutadiene	< 1.0	< 1.0	< 1.3	< 1.3
Surrogate Recovery	**(%)**	**(%)**	**(%)**	**(%)**
Recovery	96	49	73	58

Table C-27: PolyAromatic Hydrocarbon Analysis of Water QA/QC Samples, ASG

Sample ID	Total Coliforms (CFU/100 mL)	E. coli (CFU/100 mL)	Fecal Coliforms (CFU/100 mL)
Control Spike			
Control Sample	28	28	31
Control Target	28	28	28
Recovery (%)	100	100	111
Analytical Blank			
Blank	0	0	0
Analytical Duplicate			
13-10606	6000	20000	29200
Duplicate	7000	20000	32000
Average	6500	20000	30600
Std Dev	707	0	1980
RPD (%)	15	0	9.2
Field Duplicate			
13-10600	100	100	0
13-10601	200	0	0
Average	150	50	
Std Dev	71	71	
RPD (%)	67	200	

Table C-28: Biological Oxygen Demand (BOD) and Conductivity A of Water QA/QC Samples Analyzed at ASG

Sample	BOD [mg/L]	Conductivity (µS/cm)
Control Spikes		
Control	190	93
Control Target	165	100
Recovery (%)	115	93
Analytical Blanks		
Blank	< 3	
Analytical Duplicate		
13-10607	38	
Duplicate	38	
Average	38	
Std Dev	0	
RPD (%)	0	
13-10606		642
Duplicate		665
Average		654
Std Dev		16
RPD (%)		3.5
Field Duplicate		
13-10600	22	662
13-10601	34	706
Average	28	684
Std Dev	8.5	31
RPD (%)	43	6.4

Table C-29: Total Suspended Solid (TSS) Results for Water QA/QC Samples

Sample	Total Dissolved Solids [mg/L]	Total Suspended Solids [mg/L]
Control Spikes		
Control	79	180
Control Target	75	200
Recovery (%)	105	90
Analytical Blanks		
Blank	< 5	< 1.0
Field Duplicates		
13-10600	440	37
13-10601	430	38
Average	435	38
Std Dev	7.1	0.7
RSD (%)	1.6	2.7

Table C-30: Oil and Grease Analysis of Water QA/QC Samples

Sample	Oil and Grease [mg/L]
Control Spikes	
Control	15.4
Control Target	15.9
Recovery (%)	97
Analytical Blank	
Blank	<2.0

Table C-31: Fluoride, Chloride, Nitrite, Nitrate and Sulfate Analysis of Water QA/QC Samples

Sample	Fluoride [mg/L]	Chloride [mg/L]	Nitrite [mg/L]	Nitrate [mg/L]	Sulfate [mg/L]
Control Spikes					
Control	2.48	5.1	2.4	2.46	5.3
Control Target	2.5	5.0	2.5	2.5	5.0
Recovery (%)	99	101	98	99	107
Analytical Blank					
Blank	<0.05	<0.05	<0.05	<0.05	<0.10
Analytical Duplicate					
13-10607	0.6	23.7	<0.25	<0.25	65.5
Duplicate	0.73	23.9	<0.25	<0.25	65.1
Average	0.67	23.8			65.3
Std Dev	0.09	0.1			0.3
RPD (%)	20	0.6			0.6
Field Duplicate					
13-10600	0.47	35	<0.25	<0.25	16
13-10601	0.5	34	<0.25	<0.25	19
Average	0.48	34			17
Std Dev	0.02	0.8			1.9
RPD (%)	6.0	3.2			15

Table C-32: Alkalinity, Total Phosphorus, TKN and Total Ammonia Analysis in Water Samples, Caduceon

Sample ID	Alkalinity	Total Phosphorus	TKN	Total Ammonia
	% Recovery	% Recovery	% Recovery	% Recovery
Control	100	103	102	83
	mg/L	mg/L	mg/L	mg/L
Blank	<3.0	0.0	<0.1	<0.005

APPENDIX D: NATIONAL CLASSIFICATION SYSTEM FOR CONTAMINATED SITES SCORING FOR THE ELK ISLAND SEWAGE LAGOONS

Recreational Area Sewage Lagoon

CCME National Classification System for Contaminated Sites (2008, 2010 v 1.2)
Pre-Screening Checklist

Question	Response (yes / no)	Comment
1. Are **Radioactive material**, **Bacterial contamination** or **Biological hazards** likely to be present at the site?	No	If yes, do not proceed through the NCSCS. Contact applicable regulatory agency immediately.
2. Are there **no contamination exceedances** (known or suspected)? Determination of exceedances may be based on: 1) CCME environmental quality guidelines; 2) equivalent provincial guidelines/standards if no CCME guideline exists for a specific chemical in a relevant medium; or 3) toxicity benchmarks derived from the literature for chemicals not covered by CCME or provincial guidelines/standards.	No	If yes (i.e., there are no exceedances), do not proceed through the NCSCS.
3. Have **partial/incompleted or no environmental site investigations** been conducted for the Site?	No	If yes, do not proceed through the NCSCS.
4. Is there direct and signficant evidence of **impacts to humans** at the site, or off-site due to migration of contaminants from the site?	No	If yes, automatically rate the site as Class 1, a priority for remediation or risk management, regardless of the total score obtained should one be calculated (e.g., for comparison with other Class 1 sites).
5. Is there direct and significant evidence of **impacts to ecological receptors** at the site, or off-site due to migration of contaminants from the site?	No	Some low levels of impact to ecological receptors are considered acceptable, particularly on commercial and industrial land uses. However, if ecological effects are considered to be severe, the site may be categorized as Class 1, regardless of the numerical total NCSCS score. For the purpose of application of the NCSCS, effects that would be considered severe include observed effects on survival, growth or reproduction which could threaten the viability of a population of ecological receptors at the site. Other evidence that qualifies as severe adverse effects may be determined based on professional judgement and in consultation with the relevant jurisdiction.
6. Are there indicators of significant **adverse effects in the exposure zone** (i.e., the zone in which receptors may come into contact with contaminants)? Some examples are as follows: -Hydrocarbon sheen or NAPL in the exposure zone -Severely stressed biota or devoid of biota; -Presence of material at ground surface or sediment with suspected high concentration of contaminants such as ore tailings, sandblasting grit, slag, and coal tar.	No	If yes, automatically rate the site as Class 1, a priority for remediation or risk management, regardless of the total score obtained should one be calculated (e.g., for comparison with other Class 1 sites).
7. Do measured concentrations of volatiles or unexploded ordnances represent an **explosion hazard**?	No	If yes, automatically rate the site as Class 1, a priority for remediation or risk management, and do not continue until the safety risks have been addressed. Consult your jurisdiction's occupational health and safety guidance or legislation on exposive hazards and measurement of lower explosive limits.

If none of the above applies, proceed with the NCSCS scoring.

CCME National Classification System for Contaminated Sites (2008, 2010 v 1.2)
Summary of Site Conditions

Subject Site:	**Astotin Lake Recreational Area Sewage Lagoon Elk Island National Park**	
Civic Address: *(or other description of location)*	Elk Island National Park, Fort Saskatchewan, AB T8G 2N7	
Site Common Name : *(if applicable)*	Astotin Lade Recreational Area Sewage Lagoon	
Site Owner or Custodian: *(Organization and Contact Person)*	Parks Canada Agency	
Legal description *or* metes and bounds:	Elk Island National Park	
Approximate Site area:	250 m x 150 m	
PID(s) : *(or Parcel Identification Numbers [PIN] if untitled Crown land)*		
Centre of site: *(provide latitude/longitude or UTM coordinates)*	Latitude:	_____ degrees _____ min _____ secs
	Longitude:	_____ degrees _____ min _____ secs
	UTM Coordinate:	Northing 5949592 Easting 379856
Site Land Use:	Current:	National Park - Agricultural
	Proposed:	Agricultural
Site Plan	**To delineate the bounds of the Site a site plan MUST be attached. The plan must be drawn to scale indicating the boundaries in relation to well-defined reference points and/or legal descriptions. Delineation of the contamination should also be indicated on the site plan.**	
Provide a brief description of the Site:	The recreational area sewage lagoon (Rec Lagoon) was constructed in 1964 and has not been upgraded or modified. The lagoon is a single cell design that can hold up to 22,000 m3 of contents. Dumping practices into the Rec Lagoon prior to 1995 are not fully known. Currently all of the washrooms and showers in the campground area are gravity fed to the nearby lift station and then pumped into the Rec Lagoon through the inlet pipe in the southwestern side of the lagoon. The Rec Lagoon also receives contents from the outhouses that are deposited by a vacuum truck into the north side of the lagoon. The outlet structure located on the east side of the lagoon consists of a system of three valves at various levels to control the discharge. However, the control structure is in poor repair and the middle valve is stuck in the open position. As a result, the lagoon discharges whenever the level in the lagoon is above the middle valve. The outlet of the discharge structure is located to the east of the lagoon and the discharge flows through the outlet, to a wetland located approximately 10 m away. PCA has requested a Phase II assessment of the environmental concerns with the lagoon and associated wetlands. The work in 2013 will build and expand upon the limited Phase II conducted in 2000/2001 (O'Connor, 2001).	

CCME National Classification System for Contaminated Sites (2008, 2010 v 1.2)
Summary of Site Conditions

Affected media and Contaminants of Potential Concern (COPC):	Affected media includes sediment in the lagoon and wetland, and surface water iin the lagoon and wetlands. Groundwater is potentially affected and will be assessed in the spring of 2014. COPC include inorganic elements (aluminum, arsenic, cadmium, chromium, lead, mercury, zinc), DDD, DDE, DDT, and PAHs.

Please fill in the "letter" that best describes the level of information available for the site being assessed

Site Letter Grade **D**

If letter grade is F, do not continue, you must have a minimum of a Phase I Environmental Site Assessment or equivalent.

Scoring Completed By:	Shari Reed
Date Scoring Completed:	7-Feb-14

CCME National Classification System (2008, 2010 v 1.2)

(I) Contaminant Characteristics

Astotin Lake Recreational Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method of Evaluation	Notes
1. Residency Media (replaces physical state)				
Which of the following residency media are known (or strongly suspected) to have one or more exceedances of the applicable CCME guidelines? **yes** = has an exceedance or strongly suspected to have an exceedance **no** = does not have an exceedance or strongly suspected not to have an exceedance		All samples collected form the bottom of the lagoon and the wetlands are scored as sediment samples. Sediment exceedances include inorganic elements and pesticides (DDD, DDE, DDT). CCME guidelines were used where possible. However, if there was no CCME criterion for a parameter in sediment, the soil criterion was used instead. Soil was not sampled. Possible for some soil contamination outside the lagoon in the soil based on historic practices. Groundwater will be sampled in the spring. Surface water samples exceedances include Inorganic Elements & PAHs (x3).	The overall score is calculated by adding the individual scores from each residency media (having one or more exceedance of the most conservative media specific and land-use appropriate CCME guideline). Summary tables of the Canadian Environmental Quality Guidelines for soil, water (aquatic life, non-potable groundwater environments, and agricultural water uses) and sediment are available on the CCME website at http://www.ccme.ca/publications/cegg_rcqe.html?category_id=124 . For potable groundwater environments, guidelines for Canadian Drinking Water Quality (for comparison with groundwater monitoring data) are available on the Health Canada website at http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/doc_sup-appui/sum_guide-res_recom/index_e.html.	An increasing number of residency media containing chemical exceedances often equates to a greater potential risk due to an increase in the number of potential exposure pathways.
A. Soil	Do Not Know			
Yes				
No				
Do Not Know				
B. Groundwater	Do Not Know			
Yes				
No				
Do Not Know				
C. Surface water	Yes			
Yes				
No				
Do Not Know				
D. Sediment	Yes			
Yes				
No				
Do Not Know				
"Known" -score	4			
"Potential" - score	2			
2. Chemical Hazard				
What is the relative degree of chemical hazard of the contaminant in the list of hazard rankings proposed by the Federal Contaminated Sites Action Plan (FCSAP)?	High	Multiple contaminants are in the High category in sediment and surface water: Arsenic, Cadmium, DDD, DDE, DDT, Mercury, Benzo(a)anthracene, and Benzo(a)pyrene.	The relative degree of chemical hazard should be selected based on the most hazardous contaminant known or suspected to be present at the site. The degree of hazard has been defined by the Federal Contaminated Sites Action Plan (FCSAP) and a list of substances with their associated hazard (Low, Medium and High) has been provided as a separate sheet in this file. *See Attached Reference Material for Contaminant Hazard Rankings.*	Hazard as defined in the revised NCS pertains to the physical properties of a chemical which can cause harm. Properties can include toxic potency, propensity to biomagnify, persistence in the environment, etc. Although there is some overlap between hazard and contaminant exceedance factor below, it will not be possible to derive contaminant exceedance factors for many substances which have a designated chemical hazard designation, but don't have a CCME guideline. The purpose of this category is to avoid missing a measure of toxic potential.
High				
Medium				
Low				
Do Not Know				
"Known" -score	8			
"Potential" - score	---			
3. Contaminant Exceedence Factor				
What is the ratio between the measured contaminant concentration and the applicable CCME guidelines (or other "standards")?	dium (10x to 10	DDD is 13x above ISQG	Ranking of contaminant "exceedance" is determined by comparing contaminant concentrations with the *most conservative media-specific and land-use appropriate CCME* environmental quality guidelines. **Ranking should be based on contaminant with greatest exceedance of CCME guidelines.** Ranking of contaminant hazard as high, medium and low is as follows: High = One or more measured contaminant concentration is greater than 100 X appropriate CCME guidelines Medium = One or more measured contaminant concentration is 10 - 99.99 X appropriate CCME guidelines Low = One or more measured contaminant concentration is 1 - 9.99 X appropriate CCME guidelines Mobile NAPL = Contaminant is a non-aqueous phase liquid (i.e., due to its low solubility, it does not dissolve in water, but remains as a separate liquid) and is present at a sufficiently high saturation (i.e., greater than residual NAPL saturation) such that there is significant potential for mobility either downwards or laterally. Other standards may include local background concentration or published toxicity benchmarks. Results of toxicity testing with site samples can be used as an alternative. This approach is only relevant for contaminants that do not biomagnify in the food web, since toxicity tests would not indicate potential effects at higher trophic levels. High = lethality observed. Medium = no lethality, but sub lethal effects observed. Low = neither lethal nor sub lethal effects observed.	In the event that elevated levels of a material with no associated CCME guidelines are present, check provincial and USEPA environmental criteria. Hazard Quotients (sometimes referred to as a screening quotient in risk assessments) refer to the ratio of measured concentration to the concentration believed to be the threshold for toxicity. A similar calculation is used here to determine the contaminant exceedance factor (CEF). Concentrations greater than one times the applicable CCME guideline (i.e., CEF=>1) indicate that risks are possible. Mobile NAPL has the highest associated score (8) because of its highly concentrated nature and potential for increase in the size of the impacted zone.
Mobile NAPL				
High (>100x)				
Medium (10x to 100x)				
Low (1x to 10x)				
Do Not Know				
"Known" -score	4			
"Potential" - score	---			

CCME National Classification System (2008, 2010 v 1.2)

(I) Contaminant Characteristics

Astotin Lake Recreational Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method of Evaluation	Notes
4. Contaminant Quantity (known or strongly suspected)				
What is the known or strongly suspected quantity of all contaminants? >10 hectare (ha) or 5000 m^3 2 to 10 ha or 1000 to 5000 m^3 <2 ha or 1000 m^3 Do Not Know	>10 hectare (ha) or 5000 m3	Minimum area if entire lagoon plus wetland is contaminated is: lagoon 125mx105m = 13,125 m2 east wetland 30mx10m +10x7 + 12x1 = 382m2 Minimum depth of 0.5 = 6754 m3 But boundaries are not defined so the area could be larger. As the minimum area is over 5000 m3, the area is scored in the highest category.	Measure or estimate the area or quantity of total contamination (i.e, all contaminants known or strongly suspected to be present on the site). The "Area of Contamination" is defined as the area or volume of contaminated media (soil, sediment, groundwater, surface water) exceeding appropriate environmental criteria.	A larger quantity of a potentially toxic substance can result in a larger frequency of exposure as well as a greater probability of migration, therefore, larger quantities of these substances earn a higher score.
"Known" -score	9			
"Potential" - score	---			
5. Modifying Factors				
Does the chemical fall in the class of persistent chemicals based on its behavior in the environment? Yes No Do Not Know	Yes	DDE and DDT are persistent chemicals.	Persistent chemicals, e.g., PCBs, chlorinated pesticides etc. either do not degrade or take longer to degrade, and therefore may be available to cause effects for a longer period of time. Canadian Environmental Protection Act (CEPA) classifies a chemical as persistent when it has at least one of the following characteristics: (a) in air, (i) its half-life is equal to or greater than 2 days, or (ii) it is subject to atmospheric transport from its source to a remote area; (b) in water, its half-life is equal to or greater than 182 days; (c) in sediments, its half-life is equal to or greater than 365 days; or (d) in soil, its half-life is equal to or greater than 182 days. This list does not include metals or metalloids, which in their elemental form do not degrade. However metals and metalloids form chemical species in the environment, many of which are not readily bioavailable.	*Examples of Persistent Substances are provided in attached Reference Materials*
Are there contaminants present that could cause damage to utilities and infrastructure, either now or in the future, given their location? Yes No Do Not Know	No	Underground sewage main is constructed of asbestos cement which is resistant to the contamination present in the lagoon.		Some contaminants may react or absorb into underground utilities and infrastructure. For example, organic solvents may degrade some plastics, and salts could cause corrosion of metal.
How many different contaminant classes have representative CCME guideline exceedances? one two to four five or more Do Not Know	two to four	3 classes: Inorganics, PAHs, Pesticides	For the purposes of the revised NCS ranking system, the following chemicals represent distinct chemical "classes": inorganic substances (including metals), volatile petroleum hydrocarbons, light extractable petroleum hydrocarbons, heavy extractable petroleum hydrocarbons, PAHs, phenolic substances, chlorinated hydrocarbons, halogenated methanes, phthalate esters, pesticides.	*Refer to the Reference Material sheet for a list of example substances that fall under the various chemical classes.*
"Known" - Score	4			
"Potential" - Score	---			

Contaminant Characteristic Total

Raw Total Scores- "Known"	29
Raw Total Scores- "Potential"	2
Raw Combined Total Scores	31
Total Score (Raw Combined / 40 * 33)	**25.6**

(II) Migration Potential (Evaluation of contaminant migration pathways)

Astotin Lake Recreational Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
1. Groundwater Movement				
A. Known COPC exceedances and an operable groundwater pathway within and/or beyond the property boundary.				
i) For **potable groundwater environments**, 1) groundwater concentrations exceed background concentrations and 1X the Guideline for Canadian Drinking Water Quality (GCDWQ) or 2) there is known contact of contaminants with groundwater, based on physica evidence of groundwater contamination. For **non-potable environments** (typically urban environments with municipal services), 1) groundwater concentrations exceed 1X the applicable non potable guidelines or modified generic guidelines (which exclude ingestion of drinking water pathway) or 2) there is known contact of contaminants with groundwater, based on physical evidence of groundwater impacts.	12	Groundwater has not been sampled yet. Sampling will occur in spring 2014. Potential section is scored instead.	Review chemical data and evaluate groundwater quality. The evaluation method concentrates on 1) a potable or non-potable groundwater environment; 2) the groundwater flow system and its potential to be an exposure pathway to known or potential receptors An aquifer is defined as a geologic unit that yields groundwater in usable quantities and drinking water quality. The aquifer can currently be used as a potable water supply or could have the potential for use in the future. Non-potable groundwater environments are defined as areas that are serviced with a reliable alternative water supply (most commonly provided in urban areas). The evaluation of a non-potable environment will be based on a site specific basis. Physical evidence includes significant sheens, liquid phase contamination, or contaminant saturated soils. Seeps and springs are considered part of the groundwater pathway. In Arctic environments, the potability and evaluation of the seasonal active layer (above the permafrost) as a groundwater exposure pathway will be considered on a site-specific basis.	The 1992 NCS rationale evaluated the off-site migration as a regulatory issue. The exposure assessment and classification of hazards should be evaluated regardless of the property boundaries. Someone experienced must provide a thorough description of the sources researched to determine the presence/absence of a groundwater supply source in the vicinity of the contaminated site. This information must be documented in the NCS Site Classification Worksheet including contact names, phone numbers, e-mail correspondence and/or reference maps/reports and other resources such as internet links. Note that for potable groundwater that also daylights into a nearby surface water body, the more stringent guidelines for both drinking water and protection of aquatic life should be considered. **Selected References** Potable Environments Guidelines for Canadian Drinking Water Quality: www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/doc_sup-appui/sum_guide-res_recom/index_e.html Non-Potable Environments Canadian Water Quality Guidelines for Protection of Aquatic Life. CCME. 1999 www.ccme.ca Compilation and Review of Canadian Remediation Guidelines, Standards and Regulations. Science Applications International Corporation (SAIC Canada), report to Environment Canada, January 4, 2002.
ii) Same as (i) except the information is not known but strongly suspected based on indirect observations.	9			
iii) Meets GCDWQ for **potable environments**; meets non-potable criteria or modified generic criteria (excludes ingestion of drinking water pathway) for **non-potable environments** **or** Absence of groundwater exposure pathway (i.e., there is no aquifer (see definition at right) at the site or there is an adequate isolating layer between the aquifer and the contamination, and within 5 km of the site there are no aquatic receiving environments and the groundwater does not daylight).	0			
	Go to Potential			
Score	---			
NOTE: If a score is assigned here for Known COPC Exceedances, then you can skip Part B (Potential for groundwater pathway) and go to Section 2 (Surface Water Pathway)				
B. Potential for groundwater pathway.				
a. Relative Mobility High Moderate Low Insignificant Do Not Know		Anthracene has the highest log Koc of 4.47 which is low.	Organics Koc (L/kg) / Metals with higher mobility at acidic conditions / Metals with higher mobility at alkaline conditions Koc < 500 (i.e., log Koc < 2.7) — pH < 5 — pH > 8.5 Koc = 500 to 5000 (i.e., log Koc = 2.7 to 3.7) — pH = 5 to 6 — pH = 7.5 to 8.5 Koc = 5,000 to 100,000 (i.e., log Koc = 3.7 to 5) — pH > 6 — pH < 7.5 Koc > 100,000 (i.e., log Koc > 5)	Reference: US EPA Soil Screening Guidance (Part 5 - Table 39) If a score of zero is assigned for relative mobility, it is still recommended that the following sections on potential for groundwater pathway be evaluated and scored. Although the Koc of an individual contaminant may suggest that it will be relatively immobile, it is possible that, with complex mixtures, there could be enhanced mobility due to co-solvent effects. Therefore, the Koc cannot be relied on solely as a measure of mobility. An evaluation of other factors such as containment, thickness of confining layer, hydraulic conductivities and precipitation infiltration rate are still useful in predicting potential for groundwater migration, even if a contaminant is expected to have insignificant mobility based on its chemistry alone.
	Low			
Score	1			
b. Presence of engineered sub-surface containment? No containment Partial containment Full containment Do Not Know		A clay liner is present at the base of the lagoon, and berms are present around the lagoon. However, the outlet structure is not functioning properly and effluent outlets to the wetland when the level reaches a certain height. Because the retention time is not controlled the lagoon was scored as partial containment.	Review the existing engineered systems or natural attenuation processes for the site and determine full or partial containment is achieved. Full containment is defined as an engineered system or natural attenuation processes, monitored as being effective, which provide for full capture and/or treatment of contaminants. All chemicals of concern must be contained for "Full Containment" scoring. Natural attenuation must have sufficient data, and reports cited with monitoring data to support steady state conditions and the attenuation processes. If there is no containment or insufficient natural attenuation process, this category is evaluated as high. If there is less than full containment or if uncertain, then evaluate as medium. In Arctic environments, permafrost will be evaluated, as appropriate, based on detailed evaluations, effectiveness and reliability to contain/control contaminant migration.	Someone experienced must provide a thorough description of the sources researched to determine the containment of the source at the contaminated site. This information must be documented in the NCS Site Classification Worksheet including contact names, phone numbers, e-mail correspondence and/or reference maps, geotechnical reports or natural attenuation studies and other resources such as internet links. **Selected Resources:** United States Environmental Protection Agency (USEPA) 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater. EPA/600/R-98/128. Environment Canada – Ontario Region – Natural Attenuation Technical Assistance Bulletins (TABS) Number 19 –21.
	Partial containmer			
Score	1.5			
c. Thickness of confining layer over aquifer of concern or groundwater exposure pathway 3 m or less including no confining layer or discontinuous confining layer 3 to 10 m > 10 m Do Not Know		There is a clay layer present below the ground surface, however the depth is uncertain, approximately 10m below surface. Thickness of the clay layer above the aquifer is also uncertain, approximately 10+m think. Scored as "do not know".	The term "confining layer" refers to geologic material with little or no permeability or hydraulic conductivity (such as unfractured clay); water does not pass through this layer or the rate of movement is extremely slow. Measure the thickness and extent of materials that will impede the migration of contaminants to the groundwater exposure pathway. The evaluation of this category is based on: 1) The presence and thickness of saturated subsurface materials that impede the vertical migration of contaminants to lower aquifer units which can or are used as drinking water sources or 2) The presence and thickness of unsaturated subsurface materials that impede the vertical migration of contaminants from the source location to the saturated zone (e.g., water table aquifer, first hydrostratigraphic unit or other groundwater pathway).	
	Do Not Know			
Score	0.5			
d. Hydraulic conductivity of confining layer >10^{-4} cm/s or no confining layer 10^{-4} to 10^{-5} cm/s <10^{-6} cm/s Do Not Know		Insufficient information is available about the confining layer over the aquifer. Scored as Do Not Know.	Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure in the Reference Material sheet). Unfractured clays should be scored low. Silts should be scored medium. Sand, gravel should be scored high. The evaluation of this category is based on: 1) The presence and hydraulic conductivity ("K") of saturated subsurface materials that impede the vertical migration of contaminants to lower aquifer units which can or are used as a drinking water source, groundwater exposure pathway or 2) The presence and permeability ("k") of unsaturated subsurface materials that impede the vertical migration of contaminants from the source location to the saturated water table aquifer, first hydrostratigraphic unit or other groundwater pathway.	
	Do Not Know			
Score	0.5			

(II) Migration Potential (Evaluation of contaminant migration pathways)

Astotin Lake Recreational Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
B. Potential for groundwater pathway.				
e. Precipitation infiltration rate (Annual precipitation factor x surface soil relative permeability factor) High Moderate Low Very Low None Do Not Know	Low	Annual precipitaiton for Edmoton, AB ranged between 243 to 525 mm. Permeability is 0 b/c the bottom is lined with clay. Results in a score of "None" For the wetland area, soil would be loam (0.3). Using the highest precipitation value of 0.5, the rate would be 0.15. It is assumed that 0.15 corresponds ot a "low" score.	Precipitation Refer to Environment Canada precipitation records for relevant areas. Divide annual precipitation by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score). Permeability For surface soil relative permeability (i.e., infiltration) assume: gravel (1), sand (0.6), loam (0.3) and pavement or clay (0). Multiply the surface soil relative permeability factor with precipitation factor to obtain the score for precipitation infiltration rate.	
Score	0.4			
f. Hydraulic conductivity of aquifer $>10^{-2}$ cm/s 10^{-2} to 10^{-4} cm/s $<10^{-4}$ cm/s Do Not Know	Do Not Know	Hydraulic Conductivity of the aquifer is unknown.	Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" in the Reference Material sheet).	
Score	1			
Potential groundwater pathway total	4.9			
Allowed Potential score	4.9	Note: If a "known" score is provided, the "potential" score is disallowed.		
Groundwater pathway total	**4.9**			
2. Surface Water Movement				
A. Demonstrated migration of COPC in surface water above background conditions				
Known concentrations of surface water: i) Concentrations exceed background concentrations and exceed CCME CWQG for protection of aquatic life, irrigation, livestock water, and/or recreation (whichever uses are applicable at the site) by >1 X; or There is known contact of contaminants with surface water based on site observations. or In the absence of CWQG, chemicals have been proven to be toxic based on site specific testing (e.g. toxicity testing; or other indicator testing of exposure).	12	SW exceedances of the CCME CWQG for FAL for Inorganic Elements, and Athracene, Benzo(a)anthracene, Benzo(a)pyrene.	Collect all available information on quality of surface water near to site. Evaluate available data against Canadian Water Quality Guidelines (select appropriate guidelines based on local water use, e.g., recreation, irrigation, aquatic life, livestock watering, etc.). The evaluation method concentrates on the surface water flow system and its potential to be an exposure pathway. Contamination is present on the surface (above ground) and has the potential to impact surface water bodies. Surface water is defined as a water body that supports one of the following uses: recreation, irrigation, livestock watering, aquatic life.	General Notes: Someone experienced must provide a thorough description of the sources researched to classify the surface water body in the vicinity of the contaminated site. This information must be documented in the NCS Site Classification Worksheet including contact names, phone numbers, e-mail correspondence and/or reference maps/reports and other resource such as internet links. Selected References: CCME. 1999. Canadian Water Quality Guidelines for the Protection of Aquatic Life www.ccme.ca CCME. 1999. Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses (Irrigation and Livestock Water) www.ccme.ca Health and Welfare Canada. 1992. Guidelines for Canadian Recreational Water Quality.
ii) Same as (i) except the information is not known but strongly suspected based on indirect observations.	8			
iii) Meets CWQG or absence of surface water exposure pathway (i.e., Distance to nearest surface water is > 5 km.)	0			
	12			
Score	12			
NOTE: If a score is assigned here for Demonstrated Migration in Surface Water, then you can skip Part B (Potential for migration of COPCs in surface water) and go to Section 3 (Surface Soils)				
B. Potential for migration of COPCs in surface water				
a. Presence of containment No containment Partial containment Full containment Do Not Know	Do Not Know	Known is scored	Review the existing engineered systems and relate these structures to site conditions and proximity to surface water and determine if full containment is achieved: score low if there is full containment such as capping, berms, dikes; score medium if there is partial containment such as natural barriers, trees, ditches, sedimentation ponds; score high if there are no intervening barriers between the site and nearby surface water. Full containment must include containment of all chemicals.	
Score	3			
b. Distance to Surface Water 0 to <100 m 100 - 300 m >300 m Do Not Know	Do Not Know	Known is scored	Review available mapping and survey data to determine distance to nearest surface water bodies.	
Score	2			

(II) Migration Potential (Evaluation of contaminant migration pathways)

Astotin Lake Recreational Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
c. Topography Contaminants above ground level and slope is steep Contaminants at or below ground level and slope is steep Contaminants above ground level and slope is intermediate Contaminants at or below ground level and slope is intermediate Contaminants above ground level and slope is flat Contaminants at or below ground level and slope is flat Do Not Know	Do Not Know	Known is scored	Review engineering documents on the topography of the site and the slope of surrounding terrain. Steep slope = >50% Intermediate slope = between 5 and 50% Flat slope = < 5% Note: Type of fill placement (e.g., trench, above ground, etc.).	
Score	1			
d. Run-off potential High (rainfall run-off score > 0.6) Moderate (0.4 < rainfall run-off score <0.6) Low (0.2 < rainfall run-off score <0.4) Very Low (0 < rainfall run-off score < 0.2) None (rainfall run-off score = 0) Do Not Know	Do Not Know	Known is scored	Rainfall Refer to Environment Canada precipitation records for relevant areas. Divide rainfall by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score). The former definition of "annual rainfall" did not include the precipitation as snow. This minor adjustment has been made. The second modification was the inclusion of permeability of surface materials as an evaluation factor. Permeability For infiltration assume: gravel (0), sand (0.3), loam (0.6) and pavement or clay (1). Multiply the infiltration factor with precipitation factor to obtain rainfall run off score.	Selected Sources: Environment Canada web page link:www.msc.ec.gc.ca Snow to rainfall conversion apply ratio of 15 (snow):1(water)
Score	0.4			
e. Flood potentia 1 in 2 years 1 in 10 years 1 in 50 years Not in floodplain Do Not Know	Do Not Know	Known is scored	Review published data such as flood plain mapping or flood potential (e.g., spring or mountain run-off) and Conservation Authority records to evaluate flood potential of nearby water courses both up and down gradient. Rate zero if site not in flood plain.	
Score	0.5			
Potential surface water pathway total	6.9			
Allowed Potential score	---	Note: If a "known" score is provided, the "potential" score is disallowed.		
Surface water pathway total	**12**			
3. Surface Soils (potential for dust, dermal and ingestion exposure)				
A. Demonstrated concentrations of COPC in surface soils (top 1.5 m)				
COPCs measured in surface soils exceed the CCME soil quality guideline	12	Sediment exceedances are within the top 0.5 m	Collect all available information on quality of surface soils (i.e., top 1.5 metres) at the site. Evaluate available data against Canadian Soil Quality Guidelines. Select appropriate guidelines based on current (or proposed future) land use (i.e, agricultural, residential/parkland, commercial, or industrial), and soil texture if applicable (i.e., coarse or fine).	Selected References: CCME. 1999. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health www.ccme.ca
Strongly suspected that soils exceed guidelines	9			
COPCs in surface soils does not exceed the CCME soil quality guideline or is not present (i.e., bedrock).	0			
	12			
Score	12			
NOTE: If a score is assigned here for Demonstrated Concentrations in Surface Soils, then you can skip Part B (Potential for a surface soils migration pathway) and go to Section 4 (Vapour)				
B. Potential for a surface soils (top 1.5 m) migration pathway				
a. Are the soils in question covered? Exposed Vegetated Landscaped Paved Do Not Know	Do Not Know	Known is scored	Consult engineering or risk assessment reports for the site. Alternatively, review photographs or perform a site visit. Landscaped surface soils must include a minimum of 0.5 m of topsoil.	The possibility of contaminants in blowing snow have not been included in the revised NCS as it is difficult to assess what constitutes an unacceptable concentration and secondly, spills to snow or ice are most efficiently mitigated while freezing conditions remain.
Score	4			
b. For what proportion of the year does the site remain covered by snow? 0 to 10% of the year 10 to 30% of the year More than 30% of the year Do Not Know	Do Not Know	Known is scored	Consult climatic information for the site. The increments represent the full span from soils which are always wet or covered with snow (and therefore less likely to generate dust) to those soils which are predominantly dry and not covered by snow (and therefore are more likely to generate dust).	
Score	3			
Potential surface soil pathway total	7			
Allowed Potential score	---	**Note: If a "known" score is provided, the "potential" score is disallowed.**		
Soil pathway total	**12**			

(II) Migration Potential (Evaluation of contaminant migration pathways)

Astotin Lake Recreational Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
4. Vapour				
A. Demonstrated COPCs in vapour.				
Vapour has been measured (indoor or outdoor) in concentrations exceeding risk based concentrations.	12	unknown, potential is scored.	Consult previous investigations, including human health risk assessments, for reports of vapours detected.	
Strongly suspected (based on observations and/or modelling)	9			
Vapour has not been measured and volatile hydrocarbons have not been found in site soils or groundwater.	0			
	Go to Potential			
Score	---			
NOTE: If a score is assigned here for Demonstrated COPCs in Vapour, then you can skip Part B (Potential for COPCs in vapour) and go to Section 5 (Sediment)				
B. Potential for COPCs in vapour				
a. Relative Volatility based on Henry's Law Constant, H' (dimensionless) High (H' > 1.0E-1) Moderate (H' = 1.0E-1 to 1.0E-3) Low (H' < 1.0E-3) Not Volatile Do Not Know		Anthracene has the greatest volatility based on a H' of 2.67e-3, which is moderate.	Reference: US EPA Soil Screening Guidance (Part 5 - Table 36) *Provided in Attached Reference Materials*	If the Henry's Law Constant for a substance indicates that it is not volatile, and a score of zero is assigned here for relative volatility, then the other three questions in this section on Potential for COPCs will be automatically assigned scores of zero and you can skip to section 5.
	Moderate			
Score	2.5			
b. What is the soil grain size? Fine Coarse Do Not Know		Grain size is not known.	Review soil permeability data in engineering reports. The greater the permeability of soils, the greater the possible movement of vapours. Fine-grained soils are defined as those which contain greater than 50% by mass particles less than 75 µm mean diameter (D50 < 75 µm). Coarse-grained soils are defined as those which contain greater than 50% by mass particles greater than 75 µm mean diameter (D50 > 75 µm).	
	Do Not Know			
Score	3			
c. Is the depth to the source less than 10m? Yes No Do Not Know		Source is in the surface.	Review groundwater depths below grade for the site.	
	Yes			
Score	2			
d. Are there any preferential pathways? Yes No Do Not Know		Underground sewage piping could be a preferrential pathway.	Visit the site during dry summer conditions and/or review available photographs. Where bedrock is present, fractures would likely act as preferential pathyways.	Preferential pathways refer to areas where vapour migration is more likely to occur because there is lower resistance to flow than in the surrounding materials. For example, underground conduits such as sewer and utility lines, drains, or septic systems may serve as preferential pathways. Features of the building itself that may also be preferential pathways include earthen floors, expansion joints, wall cracks, or foundation perforations for subsurface features such as utility pipes, sumps, and drains.
	Yes			
Score	2			
Potential vapour pathway total	9.5			
Allowed Potential score	9.5	Note: If a "known" score is provided, the "potential" score is disallowed.		
Vapour pathway total	**9.5**			
5. Sediment Movement				
A. Demonstrated migration of sediments containing COPCs				
There is evidence to suggest that sediments originally deposited to the site (exceeding the CCME sediment quality guidelines) have migrated.	12	unknown, potential is scored.	Review sediment assessment reports. Evidence of migration of contaminants in sediments must be reported by someone experienced in this area.	Usually not considered a significant concern in lakes/marine environments, but could be very important in rivers where transport downstream could be significant.
Strongly suspected (based on observations and/or modelling)	9			
Sediments have been contained and there is no indication that sediments will migrate in future. **or** Absence of sediment exposure pathway (i.e., within 5 km of the site there are no aquatic receiving environments, and therefore no sediments).	0			
	Go to Potential			
Score	---			
NOTE: If a score is assigned here for Demonstrated Migration of Sediments, then you can skip Part B (Potential for Sediment Migration) and go to Section 6 (Modifying Factors)				

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(II) Migration Potential (Evaluation of contaminant migration pathways)

Astotin Lake Recreational Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
B. Potential for sediment migration		Sediments are in a wetland, not a river or water body.		
a. Are the sediments having COPC exceedances capped with sediments having no exceedances ("clean sediments")?	No	Sediments are not capped.	Review existing sediment assessments. If sediment coring has been completed, it may indicate that historically contaminated sediments have been covered over by newer "clean" sediments. This assessment will require that cores collected demonstrate a low concentration near the top and higher concentration with sediment depth.	
Yes				
No				
Do Not Know	4			
b. For lakes and marine habitats, are the contaminated sediments in shallow water and therefore likely to be affected by tidal action, wave action or propeller wash?	No	No tidal action.	Review existing sediment assessments. If the sediments present at the site are in a river, select "no for this question.	
Yes				
No				
Do Not Know	0			
c. For rivers, are the contaminated sediments in an area prone to sediment scouring?	Yes	Sediment scouring is possible in the drainage channel from the outlet to the wetland. However, once the sediment reaches the wetland movement would be limited.	Review existing sediment assessments. It is important that the assessment is made under worst case flows (high yearly flows). Under high yearly flows, areas which are commonly depositional may	
Yes				
No				
Do Not Know	4			
Potential sediment pathway total	8			
Allowed Potential score	8	Note: If a "known" score is provided, the "potential" score is disallowed.		
Sediment pathway total	**8**			
6. Modifying Factors				
		none present		
Are there subsurface utility conduits in the area affected by contamination?	No		Consult existing engineering reports. Subsurface utilities can act as conduits for contaminant migration.	
Yes				
No				
Do Not Know				
Known	0			
Potential	0			

Migration Potential Total		
Raw "known" total	24	
Raw "potential" total	22.4	
Raw combined total	46.4	Note: If "Known" and "Potential" scores are provided, the checklist defaults to known. Therefore, the total "Potential" Score may not reflect the sum of the individual "Potential" scores.
Total (max 33)	**23.9**	

(III) Exposure (Demonstrates the presence of an exposure pathway and receptors)

Astotin Lake Recreational Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
1. Human				
A. Known exposure				
Documented adverse impact or high quantified exposure which has or will result in an adverse effect, injury or harm or impairment of the safety to humans as a result of the contaminated site. (Class 1 Site*)	22	No documented human known exposures. Potential is scored.	*Where adverse effects on humans are documented, the site should be automatically designated as a Class 1 site (i.e., action required). There is no need to proceed through the NCS in this case. However, a scoring guideline (22) is provided in case a numerical score for the site is still desired (e.g., for comparison with other Class 1 sites). This category can be based on the outcomes of risk assessments and applies to studies which have reported Hazard Quotients >1 for noncarcinogenic chemicals and incremental cancer risks that exceed acceptable levels defined by the jurisdiction for carcinogenic chemicals (for most jurisdictions this is typically either $>10^{-5}$ or $>10^{-6}$). Known impacts can also be evaluated based on blood testing (e.g. blood lead >10 ug/dL) or other health based testing. This category can be based on the outcomes of risk assessments and applies to studies which have reported Hazard Quotients of less than 0.2 for non-carcinogenic chemicals and incremental lifetime cancer risks for carcinogenic chemicals that are within acceptable levels as defined by the jurisdiction (for most jurisdictions this is less than either 10^{-6} or 10^{-5}).	Known adverse impact includes domestic and traditional food sources. Adverse effects based on food chain transfer to humans and/or animals can be scored in this category. However, the weight of evidence must show a direct link of a contaminated food source/supply and subsequent ingestion/transfer to humans. Any associated adverse effects to the environment are scored separately later in this worksheet. Someone experienced must provide a thorough description of the sources researched to evaluate and determine the quantified exposure/impact (adverse effect) in the vicinity of the contaminated site. **Selected References:** Health Canada – Federal Contaminated Site Risk Assessment in Canada Parts 1 and 2 Guidance on Human Heath Screening Level Risk Assessments (www.hc-sc.gc.ca/ewh-semt/pubs/contamsite/index_e.html) United States Environmental Protection Agency, Integrated Risk Information System (IRIS) http://toxnet.nml.nih.gov
Same as above, but "Strongly Suspected" based on observations or indirect evidence.	10			
No quantified or suspected exposures/impacts in humans.	0			
	Go to Potential			
Score	---			
NOTE: If a score is assigned here for Known Exposure, then you can skip Part B (Potential for Human Exposure) and go to Section 2 (Human Exposure Modifying Factors)				
B. Potential for human exposure				
a) Land use (provides an indication of potential human exposure scenarios) Agricultural Residential / Parkland Commercial Industrial Do Not Know		National Parks fall in the agricultural land use category.	Review zoning and land use maps over the distances indicated. If the proposed future land use is more "sensitive" than the current land use, evaluate this factor assuming the proposed future use is in place. Agricultural land use is defined as uses of land where the activities are related to the productive capability of the land or facility (e.g., greenhouse) and are agricultural in nature, or activities related to the feeding and housing of animals as livestock. Residential/Parkland land uses are defined as uses of land on which dwelling on a permanent, temporary, or seasonal basis is the activity (residential), as well as uses on which the activities are recreational in nature and require the natural or human designed capability of the land to sustain that activity (parkland). Commercial/Industrial land uses are defined as land on which the activities are related to the buying, selling, or trading of merchandise or services (commercial), as well as land uses which are related to the production, manufacture, or storage of materials (industrial).	This is the main "receptor" factor used in site scoring. A higher score implies a greater exposure and/or exposure of more sensitive human receptors (e.g., children).
	Agricultural			
Score	3			
b. Indicate the level of accessibility to the contaminated portion of the site (e.g., the potential for coming in contact with contamination) Limited barriers to prevent site access; contamination not covered Moderate access or no intervening barriers, contaminants are covered. Remote locations in which contaminants not covered. Controlled access or remote location and contaminants are covered Do Not Know		The Recreational lagoon is in an area of limited access, within a locked fence.	Review location and structures and contaminants at the site and determine if there are intervening barriers between the site and humans. A low rating should be assigned to a (covered) site surrounded by a fence or in a remote location, whereas a high score should be assigned to a site th has no cover, fence, natural barriers or buffer.	
	Controlled or remote			
Score	0			
B. Potential for human exposure				
c) Potential for intake of contaminated soil, water, sediment or foods for operable or potentially operable pathways, as identified in Worksheet II (Migration Potential). i) direct contact Is dermal contact with contaminated surface water, groundwater, sediments or soils anticipated? Yes No Do Not Know		Dermal contact is not anticipated due to the remote location.	If soils or potable groundwater are present exceeding their respective CCME guidelines, dermal contact is assumed. Exposure to surface water, non-potable groundwater or sediments exceeding their respective CCME guidelines will depend on the site. Select "Yes" if dermal exposure to surface water, non-potable groundwater or sediments is expected. For instance, dermal contact with sediments would not be expected in an active port. Only soils in the top 1.5 m are defined by CCME (2003) as surface soils. If contaminated soils are only located deeper than 1.5 m, direct contact with soils is not anticipated to be an operable contaminant exposure pathway.	Exposure via the skin is generally believed to be a minor exposure route. However for some organic contaminants, skin exposure can play a very important component of overall exposure. Dermal exposure can occur while swimming in contaminated waters, bathing with contaminated surface water/groundwater and digging in contaminated dirt, etc.
	No			
Score	0			
ii) inhalation (i.e., inhalation of dust, vapour) Vapour - Are there inhabitable buildings on the site within 30 m of soils or groundwater with volatile contamination as determined in Worksheet II (Migration Potential)? Yes No Do Not Know		No buildings within 30 m.	If inhabitable buildings are on the site within 30 m of soils or groundwater exceeding their respective guidelines for volatile chemicals, there is a potential of risk to human health (Health Canada, 2004). Review site investigations for location of soil samples (having exceedances of volatile substances) relative to buildings. Refer to (II) Migration Potential worksheet, 4B.a) *Potential for COPCs in Vapour* for a definition of volatility.	Exposure via the lungs (inhalation) can be a very important exposure pathway. Inhalation can be via both particulates (dust) and gas (vapours). Vapours can be a problem where buildings have been built on former industrial sites or where volatile contaminants have migrated below buildings resulting in the potential for vapour intrusion. Assesses the potential for humans to be exposed to vapours originating from site soils. The closer the receptor is to a source of volatile chemicals in soil, the greater the potential of exposure. Also, coarser-grained soil will convey vapour much more efficiently in the soil than finer grained material such as clays and silts. General Notes; Someone experienced must provide a thorough description of the sources researched to determine the presence/absence of a vapour migration and/or dust generation in the vicinity of the contaminated site. This information must be documented in the NCS Site Classification Worksheet including conta names, phone numbers, e-mail correspondence and/or reference maps/reports and other resource such as internet links.
	No			
Score	0			
Dust - If there is contaminated surface soil (e.g. top 1.5 m) , indicate whether the soil is fine or coarse textured. If it is known that surfac soil is not contaminated, enter a score of zero. Fine Coarse Surface soil is not contaminated or absent (bedrock) Do Not Know Texture		Surface soils are clay in the lagoon and silts in the wetland.	Consult grain size data for the site. If soils (containing exceedances of the CCME soil quality guidelines) predominantly consist of fine material (having a median grain size of 75 microns; as defined by CCME (2006)) then these soils are more likely to generate dusts.	Selected References; Canadian Council of Ministers of the Environment (CCME). 2006. Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. PN 1332www.ccme.ca Golder, 2004. Soil Vapour Intrusion Guidance for Health Canada Screening Level Risk Assessment (SLRA) Submitted to Health Canada, Burnaby, BC
	Fine			
Score	3			
inhalation total	3			

(III) Exposure (Demonstrates the presence of an exposure pathway and receptors)

Astotin Lake Recreational Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
B. Potential for human exposure				
iii) Ingestion (i.e., ingestion of food items, water and soils [for children]), including traditional foods.		Drinking water is not present on the site. Drinking water is provided in neighbouring communities and at the park's camground facilities.	Review available site data to determine if drinking water (groundwater, surface water, private, commercial or municipal supply) is known or suspected to be contaminated above Guidelines for Canadian Drinking Water Quality. If drinking water supply is known to be contaminated, some immediate action (e.g., provision of alternate drinking water supply) should be initiated to reduce or eliminate exposure. The evaluation of significant potential for exceedances of the water supply in the future may be based on the capture zones of the drinking water wells; contaminant travel times; computer modelling of flow and contaminant transport.	**Selected References:** Guidelines for Canadian Drinking Water Qualitywww.hc-sc.gc.ca/hecs-sesc/water/publications/drinking_water_quality_guidelines/toc.htm Drinking water can be an extremely important exposure pathway to humans. If site groundwater or surface water is not used for drinking, then this pathway is considered to be inoperable. Consider both wild foods such as salmon, venison, caribou, as well as agricultural sources of food items if the contaminated site is on or adjacent to agricultural land uses.
Drinking Water: Choose a score based on the proximity to a drinking water supply, to indicate the potential for contamination (present or future).				
0 to 100 m				
100 to 300 m				
300 m to 1 km				
1 to 5 km				
No drinking water present				
Do Not Know				
	No drinking water preser			
Score	0			
Is an alternative water supply readily available?		Alternate water supplies are available in the park		
Yes				
No				
Do Not Know	Yes			
Score	0			
Is human ingestion of contaminated soils possible?		Contamination is in the surface soils so ingestion is possible.	If contaminated soils are located within the top 1.5 m, it is assumed that ingestion of soils is an operable exposure pathway. Exposure to soils deeper than 1.5 m is possible, but less likely, and the duration is shorter. Refer to human health risk assessment reports for the site in question.	
Yes				
No				
Do Not Know	Yes			
Score	3			
Are food items consumed by people, such as plants, domestic animals or wildlife harvested from the contaminated land and its surroundings?		Traditional plants are allowed to be harvested from the park with a permit. Also bison present in the park are sold at auction and the end use is unknown but could include consuption. Deer, elk and ducks can move out of the park where they could be hunted and consumed. Therefore category is scored as "yes".	Use human health risk assessment reports (or others) to determine if there is significant reliance on traditional food sources associated with the site. Is the food item in question going to spend a large proportion of its time at the site (e.g., large mammals may spend a very small amount of time at a small contaminated site)? Human health risk assessment reports for the site in question will also provide information on potential bioaccumulation of the COPC in question.	
Yes				
No				
Do Not Know	No			
Score	0			
Ingestion total	3			
Human Health Total "Potential" Score	9	Note if a "Known" Human Health score is provided, the "Potential" score is disallowed.		
Allowed "Potential" Score	9			
2. Human Exposure Modifying Factors				
a) Strong reliance of local people on natural resources for survival (i.e., food, water, shelter, etc.)	No	No, these resources are available in neighbouring communities. The consumption described above is not a strong reliance.		
Yes				
No				
Do Not Know				
Known	0			
Potential	---			
Raw Human "known" total	0			
Raw Human "potential" total	9			
Raw Human Exposure Total Score	9			
Human Health Total (max 22)	**9.0**			
3. Ecological				
A. Known exposure				
Documented adverse impact or high quantified exposure which has or will result in an adverse effect, injury or harm or impairment of the safety to terrestrial or aquatic organisms as a result of the contaminated site.	18	Potential scored, No documented evidence.	Some low levels of impact to ecological receptors are considered acceptable, particularly on commercial and industrial land uses. However, if ecological effects are deemed to be severe, the s may be categorized as class one (i.e., a priority for remediation or risk management), regardless of the numerical total NCS score. For the purpose of application of the NCS, effects that would be considered severe include observed effects on survival, growth or reproduction which could threaten the viability of a population of ecological receptors at the site. Other evidence that qualifies as severe adverse effects may be determined based on professional judgement and in consultation with the relevant jurisdiction. If ecological effects are determined to be severe and an automatic Class 1 is assigned, there is no need to proceed through the NCS. However, a scoring guideline (18) is provided in case a numerical score for the site is still desired (e.g., for comparison with other Class sites). This category can be based on the outcomes of risk assessments and applies to studies which have reported Hazard Quotients >1. Alternatively, known impacts can also be evaluated based on a weight of evidence assessment involving a combination of site observations, tissue testing, toxicity testing and quantitative community assessments. Scoring of adverse effects on individual rare or endangered species will be completed on a case-by-case basis with full scientific justification. This category can be based on the outcomes of risk assessments and applies to studies which have reported Hazard Quotients of less than 1 and no other observable or measurable sign of impacts. Alternatively, it can be based on a combination of other lines of evidence showing no adverse effects, such as site observations, tissue testing, toxicity testing and quantitative community assessments.	CCME, 1999: Canadian Water Quality Guidelines for the Protection of Aquatic Lifewww.ccme.ca CCME, 1999: Canadian Water Quality Guidelines for the Protection of Agricultural Water Useswww.ccme.ca Sensitive receptors- review: Canadian Council on Ecological Areaswww.ccea.org. Ecological effects should be evaluated at a population or community level, as opposed to at the level of individuals. For example, population-level effects could include reduced reproduction, growth or survival in a species. Community-level effects could include reduced species diversity or relative abundances. Further discussion of ecological assessment endpoints is provided in*A Framework for Ecological Risk Assessment: General Guidance* (CCME 1996). Notes: Someone experienced must provide a thorough description of the sources researched to classify the environmental receptors in the vicinity of the contaminated site. This information must be documented in the NCS Site Classification Worksheet including contact names, phone numbers, e-mail correspondence and/or reference maps/reports and other resource such as internet links.
Same as above, but "Strongly Suspected" based on observations or indirect evidence.	12			
No quantified or suspected exposures/impacts in terrestrial or aquatic organisms	0			
	Go to Potential			
Score	---			
NOTE: If a score is assigned here for Known Exposure, then you can skip Part B (Potential for Ecological Exposure) and go to Section 4 (Ecological Exposure Modifying Factors)				

(III) Exposure (Demonstrates the presence of an exposure pathway and receptors)

Astotin Lake Recreational Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
B. Potential for ecological exposure (for the contaminated portion of the site)				
a) Terrestrial		National park falls in the land use category of agricultural/wild lands	Review zoning and land use maps. If the proposed future land use is more "sensitive" than the current land use, evaluate this factor assuming the proposed future use is in place (indicate in the worksheet that future land use is the consideration).	
i) Land use				
Agricultural (or Wild lands)			Agricultural land use is defined as uses of land where the activities are related to the productive capability of the land or facility (e.g., greenhouse) and are agricultural in nature, or activities related to the feeding and housing of animals as livestock. Wild lands are grouped with agricultural land due to the similarities in receptors that would be expected to occur there (e.g., herbivorous mammals and birds) and the similar need for a high level of protection to ensure ecological functioning. Residential/Parkland land uses are defined as uses of land on which dwelling on a permanent, temporary, or seasonal basis is the activity (residential), as well as uses on which the activities are recreational in nature and require the natural or human designed capability of the land to sustain that activity (parkland). Commercial/Industrial land uses are defined as land on which the activities are related to the buying, selling, or trading of merchandise or services (commercial), as well as land uses which are related to the production, manufacture, or storage of materials (industrial).	
Residential/Parkland				
Commercial				
Industrial				
Do Not Know				
	Agricultural (or Wild lands			
Score	3			
ii) Uptake potential		Exposure through direct contact with contaminated sediments is possible. Muskrat were observed inside the lagoon.	If contaminated soils are located within the top 1.5 m, it is assumed that direct contact of soils with plants and soil invertebrates is an operable exposure pathway. Exposure to soils deeper than 1.5 m possible, but less likely.	
Direct Contact - Are plants and/or soil invertebrates likely exposed to contaminated soils at the site?	Yes			
Yes				
No				
Do Not Know				
Score	1			
iii) Ingestion (i.e., wildlife or domestic animals ingesting contaminated food items, soils or water)		Mammals are present in the lagoon and the likelihood of ingesting contaminated water is high.		
Are terrestrial animals likely to be ingesting contaminated water at the site?			Refer to an Ecological Risk Assessment for the site. If there is contaminated surface water at the site, assume that terrestrial organisms will ingest it.	
Yes				
No				
Do Not Know	Yes			
Score	1			
Are terrestrial animals likely to be ingesting contaminated soils at the site?			Refer to an Ecological Risk Assessment report. Most animals will co-ingest some soil while eating plant matter or soil invertebrates.	
Yes				
No				
Do Not Know	Yes			
Score	1			
Can the contamination identified bioaccumulate?		DDD/DDE have log Kow greater than 4.	Bioaccumulation of contaminants within food items is considered possible if: 1) The Log(Kow) of the contaminant is greater than 4 (as per the chemical characteristics work sheet) and concentrations in soils exceed the most conservative CCME soil quality guideline for the intended land use, or 2) The contaminant in collected tissue samples exceeds the Canadian Tissue Residue Guidelines.	
Yes				
No				
Do Not Know	Yes			
Score	1			
Distance to sensitive terrestrial ecological area		National parks are considered sensitive terreestrial ecologcial areas. Bison are present in the park.	It is considered that within 300 m of a site, there is a concern for contamination. Therefore an environmental receptor located within this area of the site will be subject to further evaluations. It is also considered that any environmental receptor located greater than 5 km will not be a concern for evaluation. Review Conservation Authority mapping and literature including Canadian Council on Ecological Areas link:www.ccea.org.	Environmental receptors include: local, regional or provincial species of interest or significance; arctic environments (on a site specific basis); nature preserves, habitats for species at risk, sensitive forests, natural parks or forests.
0 to 300 m				
300 m to 1 km				
1 to 5 km				
> 5 km				
Do Not Know				
	0 to 300 m			
Score	3			
Raw Terrestrial Total Potential	10	Note if a "Known" Ecological Effects score is provided, the "Potential" score is disallowed.		
Allowed Terrestrial Total Potential	10			
B. Potential for ecological exposure (for the contaminated portion of the site)				
b) Aquatic		There is a Trumpeter Swan reintroduction program in Elk Island NP. Therefore it was rated as a sensitive aquatic environment.	"Sensitive aquatic environments" include those in or adjacent to shellfish or fish harvesting areas, marine parks, ecological reserves and fish migration paths. Also includes those areas deemed to have ecological significance such as for fish food resources, spawning areas or having rare or endangered species.	
i) Classification of aquatic environment				
Sensitive			"Typical aquatic environments" include those in areas other than those listed above.	
Typical				
Not Applicable (no aquatic environment present)				
Do Not Know				
	Sensitive			
Score	3			
ii) Uptake potential		Do not know about groundwater contaimination		
Does groundwater daylighting to an aquatic environment exceed th CCME water quality guidelines for the protection of aquatic life at the point of contact?			Groundwater concentrations of contaminants at the point of contact with an aquatic receiving environment can be estimated in three ways: 1) by comparing collected nearshore groundwater concentrations to the CCME water quality guidelines (this will be a conservative comparison, as contaminant concentrations in groundwater often decrease between nearshore wells and the point of discharge). 2) by conducting groundwater modeling to estimate the concentration of groundwater immediately before discharge. 3) by installing water samplers, "peepers", in the sediments in the area of daylighting groundwater.	
Yes				
No (or Not Applicable)				
Do Not Know	Do Not Know			
Score	0.5			
Distance from the contaminated site to an important surface water resource		Astotin lake is between 780-940 m away. However, there is another smaller lake within 300 m. Because the lakes are inside a NP it is considered to be an important SW resource.		Environmental receptors include: local, regional or provincial species of interest or significance, sensitive wetlands and fens and other aquatic environments
0 to 300 m			It is considered that within 300 m of a site, there is a concern for contamination. Therefore an environmental receptor or important water resource located within this area of the site will be subject to further evaluation. It is also considered that any environmental receptor located greater than 5 km away will not be a concern for evaluation. Review Conservation Authority mapping and literature including Canadian Council on Ecological Areas link:www.ccea.org.	
300 m to 1 km				
1 to 5 km				
> 5 km				
Do Not Know				
	0 to 300 m			
Score	3			
			Bioaccumulation of food items is possible if:	

(III) Exposure (Demonstrates the presence of an exposure pathway and receptors)

Astotin Lake Recreational Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
Are aquatic species (i.e., forage fish, invertebrates or plants) that are consumed by predatory fish or wildlife consumers, such as mammals and birds, likely to accumulate contaminants in their tissues?		DDD/DDE/DDT have log Kow greater than 4.	1) The Log(Kow) of the contaminant is greater than 4 (as per the chemical characteristics work sheet) and concentrations in sediments exceed the CCME ISQGs. 2) The contaminant in collected tissue samples exceeds the CCME tissue quality guidelines.	
Yes				
No				
Do Not Know	Yes			
Score	1			
Raw Aquatic Total Potential	7.5	Note if a "Known" Ecological Effects score is provided, the "Potential" score is disallowed.		
Allowed Aquatic Total Potential	7.5			
4. Ecological Exposure Modifying Factors				
a) Known occurrence of a species at risk.		Plain Bison, Elk and Trumpeter Swan reintroduction and breeding programs occur in the park. Tiger Salamander are also present inside the park.	Consult any ecological risk assessment reports. If information is not present, utilize on-line databas such as Eco Explorer. Regional, Provincial (Environment Ministries), or Federal staff (Fisheries and Oceans or Environment Canada) should be able to provide some guidance.	Species at risk include those that are extirpated, endangered, threatened, or of special concern. For a list of species at risk, consult Schedule 1 of the federal Species at Risk Act (http://www.sararegistry.gc.ca/species/schedules_e.cfm?id=1). Many provincial governments may also provide regionally applicable lists of species at risk. For example, in British Columbia, consult: BCMWLAP. 2005. Endangered Species and Ecosystems in British Columbia. Provincial red and blue lists. Ministry of Sustainable Resource Management and Water, Land and Air Protection http://srmwww.gov.bc.ca/atrisk/red-blue.htm
Is there a potential for a species at risk to be present at the site?				
Yes				
No				
Do Not Know	Yes			
	2			
Score	---			
b) Potential impact of aesthetics (e.g., enrichment of a lake or tainting of food flavor).		Did not investigate		
Is there evidence of aesthetic impact to receiving water bodies?	Do Not Know		Documentation may consist of environmental investigation reports, press articles, petitions or other records.	This Item will require some level of documentation by user, including contact names, addresses, phone numbers, e-m addresses. Evidence of changes must be documented, please attach copy of report containing relevant information.
Yes				
No	---			
Do Not Know	1			
Is there evidence of olfactory impact (i.e., unpleasant smell)?	No	The lagoon has an unplesasnt smell from the sewage but not from the contminants.	Examples of olfactory change can include the smell of a COPC or an increase in the rate of decay in an aquatic habitat.	
Yes				
No	0			
Do Not Know	---			
Is there evidence of increase in plant growth in the lake or water body?	Do Not Know	Did not investigate	A distinct increase of plant growth in an aquatic environment may suggest enrichment. Nutrients e.g., nitrogen or phosphorous releases to an aquatic body can act as a fertilizer.	
Yes				
No	---			
Do Not Know	1			
Is there evidence that fish or meat taken from or adjacent to the site smells or tastes different?	Do Not Know	Did not investigate	Some contaminants can result in a distinctive change in the way food gathered from the site tastes smells.	
Yes	---			
No	1			
Do Not Know				
Ecological Modifying Factors Total - Knowr	**2**			
Ecological Modifying Factors Total - Potentia	**3**			
Raw Ecological Total - Known	2			
Raw Ecological Total - Potential	20.5			
Raw Ecological Total	22.5			
Ecological Total (Max 18	**18.0**			
5. Other Potential Contaminant Receptors				
a) Exposure of permafrost (leading to erosion and structural concerns)		permafrost is not present		Plants and lichens provide a natural insulating layer which will help prevent thawing of the permafrost during the summer. Plants and lichens may also absorb less solar radiation. Solar radiation is turned into heat which can also cause underlying permafrost to melt.
Are there improvements (roads, buildings) at the site dependant upon the permafrost for structural integrity?	No		Consult engineering reports, site plans or air photos of the site. When permafrost melts, the stability of the soil decreases, leading to erosion. Human structures, such as roads and/or buildings are often dependent on the stability that the permafrost provides.	
Yes				
No	0			
Do Not Know	---			
Is there a physical pathway which can transport soils released by damaged permafrost to a nearby aquatic environment?	No	permafrost is not present	Melting permafrost leads to a decreased stability of underlying soils. Wind or surface run-off erosion can carry soils into nearby aquatic habitats. The increased soil loadings into a river can cause an increase in total dissolved solids and a resulting decrease in aquatic habitat quality. In addition, the erosion can bring contaminants from soils to aquatic environments.	
Yes				
No	0			
Do Not Know	---			
Other Potential Receptors Total - Known	**0**			
Other Potential Receptors Total - Potential	**0**			

Exposure Total		
Raw Human Health + Ecological Total - Known	2	
Raw Human Health + Ecological Total - Potential	29.5	Only includes "Allowed potential" - if a "Known" score was supplied under a given category then the "Potential" score was not included.
Raw Total	31.5	
Exposure Total (max 34)	**23.3**	

CCME National Classification System (2008, 2010 v 1.2)
Score Summary

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	4	2
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	4	---
4. Contaminant Quantity	9	---
5. Modifying Factors	4	---
Raw Total Score	29	2
Raw Total Score (Known + Potential)	31	
Adjusted Total Score (Raw Total / 40 *33)	**25.6**	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	---	4.9
2. Surface Water Movement	12	---
3. Soil	12	---
4. Vapour	---	9.5
5. Sediment Movement	---	8
6. Modifying Factors	0	0
Raw Total Score	24	22.4
Raw Total Score (Known + Potential)	46.4	
Adjusted Total Score (Raw Total / 64 * 33)	**23.9**	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	---	
B Potential		
a. Land Use		3
b. Accessibility		0
c. Exposure Route		
i. Direct Contact		0
ii. Inhalation		3
iii. Ingestion		3
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	9
Raw Total Human Score (Known + Potential)	9	
Adjusted Total Human Score	9.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	---	
B. Potential		
a. Terrestrial		10
b. Aquatic		7.5
4. Ecological Receptors Modifying Factors	2	3
Raw Total Ecological Score	2	20.5
Raw Total Ecological Score (Known + Potential)	22.5	
Adjusted Total Ecological Score	18.0	(maximum 18)
5. Other Receptors	0	0
Total Other Receptors Score (Known + Potential)	0	
Total Exposure Score (Human + Ecological + Other)	**27.0**	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	**20.0**	(max 34)

Site Score

Astotin Lake Recreational Area Sewage Lagoon Elk Island National Park

Site Letter Grade	**D**
Certainty Percentage	**69%**
% Responses that are "Do Not Know"	**17%**
Total NCSCS Score for site	**69.5**
Site Classification Category	**INS**

Site Classification Categories*:

Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

Administration Area Sewage Lagoon

CCME National Classification System for Contaminated Sites (2008, 2010 v 1.2)
Pre-Screening Checklist

Question	Response (yes / no)	Comment
1. Are **Radioactive material**, **Bacterial contamination** or **Biological hazards** likely to be present at the site?	No	If yes, do not proceed through the NCSCS. Contact applicable regulatory agency immediately.
2. Are there **no contamination exceedances** (known or suspected)? Determination of exceedances may be based on: 1) CCME environmental quality guidelines; 2) equivalent provincial guidelines/standards if no CCME guideline exists for a specific chemical in a relevant medium; or 3) toxicity benchmarks derived from the literature for chemicals not covered by CCME or provincial guidelines/standards.	No	If yes (i.e., there are no exceedances), do not proceed through the NCSCS.
3. Have **partial/incompleted or no environmental site investigations** been conducted for the Site?	No	If yes, do not proceed through the NCSCS.
4. Is there direct and signficant evidence of **impacts to humans** at the site, or off-site due to migration of contaminants from the site?	No	If yes, automatically rate the site as Class 1, a priority for remediation or risk management, regardless of the total score obtained should one be calculated (e.g., for comparison with other Class 1 sites).
5. Is there direct and significant evidence of **impacts to ecological receptors** at the site, or off-site due to migration of contaminants from the site?	No	Some low levels of impact to ecological receptors are considered acceptable, particularly on commercial and industrial land uses. However, if ecological effects are considered to be severe, the site may be categorized as Class 1, regardless of the numerical total NCSCS score. For the purpose of application of the NCSCS, effects that would be considered severe include observed effects on survival, growth or reproduction which could threaten the viability of a population of ecological receptors at the site. Other evidence that qualifies as severe adverse effects may be determined based on professional judgement and in consultation with the relevant jurisdiction.
6. Are there indicators of significant **adverse effects in the exposure zone** (i.e., the zone in which receptors may come into contact with contaminants)? Some examples are as follows: -Hydrocarbon sheen or NAPL in the exposure zone -Severely stressed biota or devoid of biota; -Presence of material at ground surface or sediment with suspected high concentration of contaminants such as ore tailings, sandblasting grit, slag, and coal tar.	No	If yes, automatically rate the site as Class 1, a priority for remediation or risk management, regardless of the total score obtained should one be calculated (e.g., for comparison with other Class 1 sites).
7. Do measured concentrations of volatiles or unexploded ordnances represent an **explosion hazard**?	No	If yes, automatically rate the site as Class 1, a priority for remediation or risk management, and do not continue until the safety risks have been addressed. Consult your jurisdiction's occupational health and safety guidance or legislation on exposive hazards and measurement of lower explosive limits.

If none of the above applies, proceed with the NCSCS scoring.

CCME National Classification System for Contaminated Sites (2008, 2010 v 1.2)
Summary of Site Conditions

Subject Site:	**Administration Area Sewage Lagoon Elk Island National Park**	
Civic Address: *(or other description of location)*	Elk Island National Park, Fort Saskatchewan, AB T8G 2N7	
Site Common Name : *(if applicable)*	Administration Area Sewage Lagoon	
Site Owner or Custodian: *(Organization and Contact Person)*	Parks Canada Agency	
Legal description *or* metes and bounds:	Elk Island National Park	
Approximate Site area:	150 m x 150 m	
PID(s) : *(or Parcel Identification Numbers [PIN] if untitled Crown land)*		
Centre of site: *(provide latitude/longitude or UTM coordinates)*	Latitude:	_____ degrees _____ min _____ secs
	Longitude:	_____ degrees _____ min _____ secs
	UTM Coordinate:	Northing 5949858 Easting 376280
Site Land Use:	Current:	National Park - Agricultural
	Proposed:	Agricultural
Site Plan	**To delineate the bounds of the Site a site plan MUST be attached. The plan must be drawn to scale indicating the boundaries in relation to well-defined reference points and/or legal descriptions. Delineation of the contamination should also be indicated on the site plan.**	
Provide a brief description of the Site:	The Administration Area Sewage Lagoon was constructed in Elk Island NP in the 1964 to receive inputs from the main park offices, maintenance buildings, and residences in the area around the lagoon. The lagoon was modified in the mid-70s and re-designed in early 80s to a two cell design. Sewage flows through collection mains from the buildings to a pump station, which then pumps the contents through force mains to the lagoon. The Admin lagoon historically received wastewater from the garage which contained inorganic elements, petroleum hydrocarbons, and polycyclic aromatic hydrocarbons, however this practice no longer occurs. The lagoon is currently in poor shape as a result of damage by beavers, and in order to determine the way ahead with the lagoon, PCA has requested a Phase II assessment of the environmental concerns with the lagoon and associated wetlands. The work in 2013 will build and expand upon the limited Phase II conducted in 2000/2001 (O'Connor, 2001).	

CCME National Classification System for Contaminated Sites (2008, 2010 v 1.2)
Summary of Site Conditions

Affected media and Contaminants of Potential Concern (COPC):	Affected media includes surface water in the lagoon and wetlands, and sediment inside the lagoon and in the wetlands. Groundwater has not been sampled at this time, but will be conducted in spring 2014. CoPC include: inorganic elements (aluminum, arsenic, cadmium, copper, chromium, mercury, selenium, tin, zinc), PHC F3, DDD, DDE, DDT, PAHs, and VOCs.

Please fill in the "letter" that best describes the level of information available for the site being assessed

Site Letter Grade **D**

If letter grade is F, do not continue, you must have a minimum of a Phase I Environmental Site Assessment or equivalent.

Scoring Completed By:	Shari Reed
Date Scoring Completed:	7-Feb-14

CCME National Classification System (2008, 2010 v 1.2)

(I) Contaminant Characteristics

Administration Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method of Evaluation	Notes
1. Residency Media (replaces physical state)				
Which of the following residency media are known (or strongly suspected) to have one or more exceedances of the applicable CCME guidelines? **yes** = has an exceedance or strongly suspected to have an exceedance **no** = does not have an exceedance or strongly suspected not to have an exceedance		All samples collected from the bottom of the lagoon and the wetlands are scored as sediment samples. Sediment exceedances include Inorganic Elements, PAHs, Pesticides (DDD, DDE, DDT), Toluene, VOCs, PHC F3. However, if there were no criterion for parameters in sediement, the applicable soil criterion was used instead. Soil was not sampled. Groundwater will be sampled in the spring. Surface water samples exceedances include Inorganic Elements & PAHs.	The overall score is calculated by adding the individual scores from each residency media (having one or more exceedance of the most conservative media specific and land-use appropriate CCME guideline). Summary tables of the Canadian Environmental Quality Guidelines for soil, water (aquatic life, non-potable groundwater environments, and agricultural water uses) and sediment are available on the CCME website at http://www.ccme.ca/publications/cegg_rcqe.html?category_id=124 . For potable groundwater environments, guidelines for Canadian Drinking Water Quality (for comparison with groundwater monitoring data) are available on the Health Canada website at http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/doc_sup-appui/sum_guide-res_recom/index_e.html.	An increasing number of residency media containing chemical exceedances often equates to a greater potential risk due to an increase in the number of potential exposure pathways.
A. Soil	Do Not Know			
Yes				
No				
Do Not Know				
B. Groundwater	Do Not Know			
Yes				
No				
Do Not Know				
C. Surface water	Yes			
Yes				
No				
Do Not Know				
D. Sediment	Yes			
Yes				
No				
Do Not Know				
"Known" -score	4			
"Potential" - score	2			
2. Chemical Hazard				
What is the relative degree of chemical hazard of the contaminant in the list of hazard rankings proposed by the Federal Contaminated Sites Action Plan (FCSAP)?	High	Multiple contaminants are in the High category in sediment and surface water: Arsenic, Cadmium, 1,4-Dicholorobenzene, DDD, DDE, DDT, Mercury, Benzo(a)anthracene, and Dibenzo(a,h)anthracene.	The relative degree of chemical hazard should be selected based on the most hazardous contaminant known or suspected to be present at the site. The degree of hazard has been defined by the Federal Contaminated Sites Action Plan (FCSAP) and a list of substances with their associated hazard (Low, Medium and High) has been provided as a separate sheet in this file. *See Attached Reference Material for Contaminant Hazard Rankings.*	Hazard as defined in the revised NCS pertains to the physical properties of a chemical which can cause harm. Properties can include toxic potency, propensity to biomagnify, persistence in the environment, etc. Although there is some overlap between hazard and contaminant exceedance factor below, it will not be possible to derive contaminant exceedance factors for many substances which have a designated chemical hazard designation, but don't have a CCME guideline. The purpose of this category is to avoid missing a measure of toxic potential.
High				
Medium				
Low				
Do Not Know				
"Known" -score	8			
"Potential" - score	---			
3. Contaminant Exceedence Factor				
What is the ratio between the measured contaminant concentration and the applicable CCME guidelines (or other "standards")?	dium (10x to 10	Toluene is 54 x above CCME SQG. DDE is 32 x above ISQG DDD is 27x above ISQG	Ranking of contaminant "exceedance" is determined by comparing contaminant concentrations with the *most conservative media-specific and land-use appropriate CCME* environmental quality guidelines. **Ranking should be based on contaminant with greatest exceedance of CCME guidelines.** Ranking of contaminant hazard as high, medium and low is as follows: High = One or more measured contaminant concentration is greater than 100 X appropriate CCME guidelines Medium = One or more measured contaminant concentration is 10 - 99.99 X appropriate CCME guidelines Low = One or more measured contaminant concentration is 1 - 9.99 X appropriate CCME guidelines Mobile NAPL = Contaminant is a non-aqueous phase liquid (i.e., due to its low solubility, it does not dissolve in water, but remains as a separate liquid) and is present at a sufficiently high saturation (i.e., greater than residual NAPL saturation) such that there is significant potential for mobility either downwards or laterally. Other standards may include local background concentration or published toxicity benchmarks. Results of toxicity testing with site samples can be used as an alternative. This approach is only relevant for contaminants that do not biomagnify in the food web, since toxicity tests would not indicate potential effects at higher trophic levels. High = lethality observed. Medium = no lethality, but sub lethal effects observed. Low = neither lethal nor sub lethal effects observed.	In the event that elevated levels of a material with no associated CCME guidelines are present, check provincial and USEPA environmental criteria. Hazard Quotients (sometimes referred to as a screening quotient in risk assessments) refer to the ratio of measured concentration to the concentration believed to be the threshold for toxicity. A similar calculation is used here to determine the contaminant exceedance factor (CEF). Concentrations greater than one times the applicable CCME guideline (i.e., CEF=>1) indicate that risks are possible. Mobile NAPL has the highest associated score (8) because of its highly concentrated nature and potential for increase in the size of the impacted zone.
Mobile NAPL				
High (>100x)				
Medium (10x to 100x)				
Low (1x to 10x)				
Do Not Know				
"Known" -score	4			
"Potential" - score	---			

CCME National Classification System (2008, 2010 v 1.2)

(I) Contaminant Characteristics

Administration Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method of Evaluation	Notes
4. Contaminant Quantity (known or strongly suspected)				
What is the known or strongly suspected quantity of all contaminants? >10 hectare (ha) or 5000 m^3 2 to 10 ha or 1000 to 5000 m^3 <2 ha or 1000 m^3 Do Not Know	2 to 10 ha or 1000 to 5000 m3	Minimum area if entire lagoon plus wetlands are contaminated is: lagoon 72mx42m = 3,110 m2 south wetland 30mx20m = 600 m2 west wetland 22mx18m =400 m2 Minimum depth of 0.5 = 2,055 m3 But boundaries are not defined so the area could be larger. Scored as between 1000 - 5000 m3 as the contaminated area is a minimum of 2000 m3	Measure or estimate the area or quantity of total contamination (i.e, all contaminants known or strongly suspected to be present on the site). The "Area of Contamination" is defined as the area or volume of contaminated media (soil, sediment, groundwater, surface water) exceeding appropriate environmental criteria.	A larger quantity of a potentially toxic substance can result in a larger frequency of exposure as well as a greater probability of migration, therefore, larger quantities of these substances earn a higher score.
"Known" -score	6			
"Potential" - score	---			
5. Modifying Factors				
Does the chemical fall in the class of persistent chemicals based on its behavior in the environment? Yes No Do Not Know	Yes	DDE and DDT are persistent chemicals.	Persistent chemicals, e.g., PCBs, chlorinated pesticides etc. either do not degrade or take longer to degrade, and therefore may be available to cause effects for a longer period of time. Canadian Environmental Protection Act (CEPA) classifies a chemical as persistent when it has at least one of the following characteristics: (a) in air, (i) its half-life is equal to or greater than 2 days, or (ii) it is subject to atmospheric transport from its source to a remote area; (b) in water, its half-life is equal to or greater than 182 days; (c) in sediments, its half-life is equal to or greater than 365 days; or (d) in soil, its half-life is equal to or greater than 182 days. This list does not include metals or metalloids, which in their elemental form do not degrade. However metals and metalloids form chemical species in the environment, many of which are not readily bioavailable.	*Examples of Persistent Substances are provided in attached Reference Materials*
Are there contaminants present that could cause damage to utilities and infrastructure, either now or in the future, given their location? Yes No Do Not Know	Yes	Underground pipes to carry the sewage to the lagoon are HDPE which can be degraded by aromatic and halogenated hydrocarbons present in the lagoon.		Some contaminants may react or absorb into underground utilities and infrastructure. For example, organic solvents may degrade some plastics, and salts could cause corrosion of metal.
How many different contaminant classes have representative CCME guideline exceedances? one two to four five or more Do Not Know	five or more	5 classes: Inorganics, VOCs, PHC F3, PAHs, Pesticides	For the purposes of the revised NCS ranking system, the following chemicals represent distinct chemical "classes": inorganic substances (including metals), volatile petroleum hydrocarbons, light extractable petroleum hydrocarbons, heavy extractable petroleum hydrocarbons, PAHs, phenolic substances, chlorinated hydrocarbons, halogenated methanes, phthalate esters, pesticides.	*Refer to the Reference Material sheet for a list of example substances that fall under the various chemical classes.*
"Known" - Score	7			
"Potential" - Score	---			

Contaminant Characteristic Total

Raw Total Scores- "Known"	29
Raw Total Scores- "Potential"	2
Raw Combined Total Scores	31
Total Score (Raw Combined / 40 * 33)	**25.6**

CCME National Classification System (2008, 2010 v 1.2)

(II) Migration Potential (Evaluation of contaminant migration pathways)

Administration Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
1. Groundwater Movement				
A. Known COPC exceedances and an operable groundwater pathway within and/or beyond the property boundary.				
i) For **potable groundwater environments**, 1) groundwater concentrations exceed background concentrations and 1X the Guideline for Canadian Drinking Water Quality (GCDWQ) or 2) there is known contact of contaminants with groundwater, based on physica evidence of groundwater contamination. For **non-potable environments** (typically urban environments with municipal services), 1) groundwater concentrations exceed 1X the applicable non potable guidelines or modified generic guidelines (which exclude ingestion of drinking water pathway) or 2) there is known contact of contaminants with groundwater, based on physical evidence of groundwater impacts.	12	Groundwater has not been sampled yet. Sampling will occur in spring 2014. Potential section is scored instead.	Review chemical data and evaluate groundwater quality. The evaluation method concentrates on 1) a potable or non-potable groundwater environment; 2) the groundwater flow system and its potential to be an exposure pathway to known or potential receptors An aquifer is defined as a geologic unit that yields groundwater in usable quantities and drinking water quality. The aquifer can currently be used as a potable water supply or could have the potential for use in the future. Non-potable groundwater environments are defined as areas that are serviced with a reliable alternative water supply (most commonly provided in urban areas). The evaluation of a non-potable environment will be based on a site specific basis. Physical evidence includes significant sheens, liquid phase contamination, or contaminant saturated soils. Seeps and springs are considered part of the groundwater pathway. In Arctic environments, the potability and evaluation of the seasonal active layer (above the permafrost) as a groundwater exposure pathway will be considered on a site-specific basis.	The 1992 NCS rationale evaluated the off-site migration as a regulatory issue. The exposure assessment and classification of hazards should be evaluated regardless of the property boundaries. Someone experienced must provide a thorough description of the sources researched to determine the presence/absence of a groundwater supply source in the vicinity of the contaminated site. This information must be documented in the NCS Site Classification Worksheet including contact names, phone numbers, e-mail correspondence and/or reference maps/reports and other resources such as internet links. Note that for potable groundwater that also daylights into a nearby surface water body, the more stringent guidelines for both drinking water and protection of aquatic life should be considered. **Selected References** Potable Environments Guidelines for Canadian Drinking Water Quality: www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/doc_sup-appui/sum_guide-res_recom/index_e.html Non-Potable Environments Canadian Water Quality Guidelines for Protection of Aquatic Life. CCME. 1999 www.ccme.ca Compilation and Review of Canadian Remediation Guidelines, Standards and Regulations. Science Applications International Corporation (SAIC Canada), report to Environment Canada, January 4, 2002.
ii) Same as (i) except the information is not known but strongly suspected based on indirect observations.	9			
iii) Meets GCDWQ for **potable environments**; meets non-potable criteria or modified generic criteria (excludes ingestion of drinking water pathway) for **non-potable environments** **or** Absence of groundwater exposure pathway (i.e., there is no aquifer (see definition at right) at the site or there is an adequate isolating layer between the aquifer and the contamination, and within 5 km of the site there are no aquatic receiving environments and the groundwater does not daylight).	0			
	Go to Potential			
Score	---			
NOTE: If a score is assigned here for Known COPC Exceedances, then you can skip Part B (Potential for groundwater pathway) and go to Section 2 (Surface Water Pathway)				
B. Potential for groundwater pathway.				
a. Relative Mobility High Moderate Low Insignificant Do Not Know		1,1,2-Trichloroethane has the highest mobility w a log Koc of 1.7.	Organics Koc (L/kg) / Metals with higher mobility at acidic conditions / Metals with higher mobility at alkaline conditions Koc < 500 (i.e., log Koc < 2.7) — pH < 5 — pH > 8.5 Koc = 500 to 5000 (i.e., log Koc = 2.7 to 3.7) — pH = 5 to 6 — pH = 7.5 to 8.5 Koc = 5,000 to 100,000 (i.e., log Koc = 3.7 to 5) — pH > 6 — pH < 7.5 Koc > 100,000 (i.e., log Koc > 5)	Reference: US EPA Soil Screening Guidance (Part 5 - Table 39) If a score of zero is assigned for relative mobility, it is still recommended that the following sections on potential for groundwater pathway be evaluated and scored. Although the Koc of an individual contaminant may suggest that it will be relatively immobile, it is possible that, with complex mixtures, there could be enhanced mobility due to co-solvent effects. Therefore, the Koc cannot be relied on solely as a measure of mobility. An evaluation of other factors such as containment, thickness of confining layer, hydraulic conductivities and precipitation infiltration rate are still useful in predicting potential for groundwater migration, even if a contaminant is expected to have insignificant mobility based on its chemistry alone.
	High			
Score	4			
b. Presence of engineered sub-surface containment? No containment Partial containment Full containment Do Not Know		A clay liner is present at the base of the lagoon, and berms are present around the lagoon. However, lagoon contents are overtopping the berms. Therefore it is scored as partial containment.	Review the existing engineered systems or natural attenuation processes for the site and determine full or partial containment is achieved. Full containment is defined as an engineered system or natural attenuation processes, monitored as being effective, which provide for full capture and/or treatment of contaminants. All chemicals of concern must be contained for "Full Containment" scoring. Natural attenuation must have sufficient data, and reports cited with monitoring data to support steady state conditions and the attenuation processes. If there is no containment or insufficient natural attenuation process, this category is evaluated as high. If there is less than full containment or if uncertain, then evaluate as medium. In Arctic environments, permafrost will be evaluated, as appropriate, based on detailed evaluations, effectiveness and reliability to contain/control contaminant migration.	Someone experienced must provide a thorough description of the sources researched to determine the containment of the source at the contaminated site. This information must be documented in the NCS Site Classification Worksheet including contact names, phone numbers, e-mail correspondence and/or reference maps, geotechnical reports or natural attenuation studies and other resources such as internet links. **Selected Resources:** United States Environmental Protection Agency (USEPA) 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater. EPA/600/R-98/128. Environment Canada – Ontario Region – Natural Attenuation Technical Assistance Bulletins (TABS) Number 19 –21.
	Partial containmer			
Score	1.5			
c. Thickness of confining layer over aquifer of concern or groundwater exposure pathway 3 m or less including no confining layer or discontinuous confining layer 3 to 10 m > 10 m Do Not Know		There is a clay layer present below the ground surface, however the depth is uncertain, approximately 10m below surface. Thickness of the clay layer above the aquifer is also uncertain, approximately 10+m think. Scored as "do not know".	The term "confining layer" refers to geologic material with little or no permeability or hydraulic conductivity (such as unfractured clay); water does not pass through this layer or the rate of movement is extremely slow. Measure the thickness and extent of materials that will impede the migration of contaminants to the groundwater exposure pathway. The evaluation of this category is based on: 1) The presence and thickness of saturated subsurface materials that impede the vertical migration of contaminants to lower aquifer units which can or are used as drinking water sources or 2) The presence and thickness of unsaturated subsurface materials that impede the vertical migration of contaminants from the source location to the saturated zone (e.g., water table aquifer, first hydrostratigraphic unit or other groundwater pathway).	
	Do Not Know			
Score	0.5			
d. Hydraulic conductivity of confining layer >10^{-4} cm/s or no confining layer 10^{-4} to 10^{-5} cm/s <10^{-6} cm/s Do Not Know		Insufficient information is available about the confining layer over the aquifer. Scored as Do Not Know.	Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure in the Reference Material sheet). Unfractured clays should be scored low. Silts should be scored medium. Sand, gravel should be scored high. The evaluation of this category is based on: 1) The presence and hydraulic conductivity ("K") of saturated subsurface materials that impede the vertical migration of contaminants to lower aquifer units which can or are used as a drinking water source, groundwater exposure pathway or 2) The presence and permeability ("k") of unsaturated subsurface materials that impede the vertical migration of contaminants from the source location to the saturated water table aquifer, first hydrostratigraphic unit or other groundwater pathway.	
	Do Not Know			
Score	0.5			

(II) Migration Potential (Evaluation of contaminant migration pathways)

Administration Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
B. Potential for groundwater pathway.				
e. Precipitation infiltration rate (Annual precipitation factor x surface soil relative permeability factor) High Moderate Low Very Low None Do Not Know	Low	Annual precipitaiton for Edmoton, AB ranged between 243 to 525 mm. Permeability is 0 b/c the bottom is lined with clay. Results in a score of "None" For the wetland area, soil would be loam (0.3). Using the highest precipitation value of 0.5, the rate would be 0.15. It is assumed that 0.15 corresponds to a "low" score.	Precipitation Refer to Environment Canada precipitation records for relevant areas. Divide annual precipitation by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score). Permeability For surface soil relative permeability (i.e., infiltration) assume: gravel (1), sand (0.6), loam (0.3) and pavement or clay (0). Multiply the surface soil relative permeability factor with precipitation factor to obtain the score for precipitation infiltration rate.	
Score	0.4			
f. Hydraulic conductivity of aquifer $>10^{-2}$ cm/s 10^{-2} to 10^{-4} cm/s $<10^{-4}$ cm/s Do Not Know	Do Not Know	Hydraulic Conductivity of the aquifer is unknown.	Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" in the Reference Material sheet).	
Score	1			
Potential groundwater pathway total	7.9			
Allowed Potential score	7.9	Note: If a "known" score is provided, the "potential" score is disallowed.		
Groundwater pathway total	**7.9**			
2. Surface Water Movement				
A. Demonstrated migration of COPC in surface water above background conditions				
Known concentrations of surface water: i) Concentrations exceed background concentrations and exceed CCME CWQG for protection of aquatic life, irrigation, livestock water, and/or recreation (whichever uses are applicable at the site) by >1 X; or There is known contact of contaminants with surface water based on site observations. or In the absence of CWQG, chemicals have been proven to be toxic based on site specific testing (e.g. toxicity testing; or other indicator testing of exposure).	12	For surface water - exceedances of the CCME CWQG for freshwater aquatic life for inorganic elements, and Benzo(a)anthracene.	Collect all available information on quality of surface water near to site. Evaluate available data against Canadian Water Quality Guidelines (select appropriate guidelines based on local water use, e.g., recreation, irrigation, aquatic life, livestock watering, etc.). The evaluation method concentrates on the surface water flow system and its potential to be an exposure pathway. Contamination is present on the surface (above ground) and has the potential to impact surface water bodies. Surface water is defined as a water body that supports one of the following uses: recreation, irrigation, livestock watering, aquatic life.	General Notes: Someone experienced must provide a thorough description of the sources researched to classify the surface water body in the vicinity of the contaminated site. This information must be documented in the NCS Site Classification Worksheet including contact names, phone numbers, e-mail correspondence and/or reference maps/reports and other resource such as internet links. Selected References: CCME. 1999. Canadian Water Quality Guidelines for the Protection of Aquatic Life www.ccme.ca CCME. 1999. Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses (Irrigation and Livestock Water) www.ccme.ca Health and Welfare Canada. 1992. Guidelines for Canadian Recreational Water Quality.
ii) Same as (i) except the information is not known but strongly suspected based on indirect observations.	8			
iii) Meets CWQG or absence of surface water exposure pathway (i.e., Distance to nearest surface water is > 5 km.)	0			
Score	12 12			
NOTE: If a score is assigned here for Demonstrated Migration in Surface Water, then you can skip Part B (Potential for migration of COPCs in surface water) and go to Section 3 (Surface Soils)				
B. Potential for migration of COPCs in surface water				
a. Presence of containment No containment Partial containment Full containment Do Not Know	Do Not Know	Known is scored	Review the existing engineered systems and relate these structures to site conditions and proximity to surface water and determine if full containment is achieved: score low if there is full containment such as capping, berms, dikes; score medium if there is partial containment such as natural barriers, trees, ditches, sedimentation ponds; score high if there are no intervening barriers between the site and nearby surface water. Full containment must include containment of all chemicals.	
Score	3			
b. Distance to Surface Water 0 to <100 m 100 - 300 m >300 m Do Not Know	Do Not Know	Known is scored	Review available mapping and survey data to determine distance to nearest surface water bodies.	
Score	2			

(II) Migration Potential (Evaluation of contaminant migration pathways)

Administration Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
c. Topography Contaminants above ground level and slope is steep Contaminants at or below ground level and slope is steep Contaminants above ground level and slope is intermediate Contaminants at or below ground level and slope is intermediate Contaminants above ground level and slope is flat Contaminants at or below ground level and slope is flat Do Not Know	Do Not Know	Known is scored	Review engineering documents on the topography of the site and the slope of surrounding terrain. Steep slope = >50% Intermediate slope = between 5 and 50% Flat slope = < 5% Note: Type of fill placement (e.g., trench, above ground, etc.).	
Score	1			
d. Run-off potential High (rainfall run-off score > 0.6) Moderate (0.4 < rainfall run-off score <0.6) Low (0.2 < rainfall run-off score <0.4) Very Low (0 < rainfall run-off score < 0.2) None (rainfall run-off score = 0) Do Not Know	Do Not Know	Known is scored	Rainfall Refer to Environment Canada precipitation records for relevant areas. Divide rainfall by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score). The former definition of "annual rainfall" did not include the precipitation as snow. This minor adjustment has been made. The second modification was the inclusion of permeability of surface materials as an evaluation factor. Permeability For infiltration assume: gravel (0), sand (0.3), loam (0.6) and pavement or clay (1). Multiply the infiltration factor with precipitation factor to obtain rainfall run off score.	Selected Sources: Environment Canada web page link:www.msc.ec.gc.ca Snow to rainfall conversion apply ratio of 15 (snow):1(water)
Score	0.4			
e. Flood potentia 1 in 2 years 1 in 10 years 1 in 50 years Not in floodplain Do Not Know	Do Not Know	Known is scored	Review published data such as flood plain mapping or flood potential (e.g., spring or mountain run-off) and Conservation Authority records to evaluate flood potential of nearby water courses both up and down gradient. Rate zero if site not in flood plain.	
Score	0.5			
Potential surface water pathway total	6.9			
Allowed Potential score	---	Note: If a "known" score is provided, the "potential" score is disallowed.		
Surface water pathway total	**12**			
3. Surface Soils (potential for dust, dermal and ingestion exposure)				
A. Demonstrated concentrations of COPC in surface soils (top 1.5 m)				
COPCs measured in surface soils exceed the CCME soil quality guideline	12	Sediment exceedances are within the top 0.5 m	Collect all available information on quality of surface soils (i.e., top 1.5 metres) at the site. Evaluate available data against Canadian Soil Quality Guidelines. Select appropriate guidelines based on current (or proposed future) land use (i.e, agricultural, residential/parkland, commercial, or industrial), and soil texture if applicable (i.e., coarse or fine).	Selected References: CCME. 1999. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health www.ccme.ca
Strongly suspected that soils exceed guidelines	9			
COPCs in surface soils does not exceed the CCME soil quality guideline or is not present (i.e., bedrock).	0			
	12			
Score	12			
NOTE: If a score is assigned here for Demonstrated Concentrations in Surface Soils, then you can skip Part B (Potential for a surface soils migration pathway) and go to Section 4 (Vapour)				
B. Potential for a surface soils (top 1.5 m) migration pathway				
a. Are the soils in question covered? Exposed Vegetated Landscaped Paved Do Not Know	Do Not Know	Known is scored	Consult engineering or risk assessment reports for the site. Alternatively, review photographs or perform a site visit. Landscaped surface soils must include a minimum of 0.5 m of topsoil.	The possibility of contaminants in blowing snow have not been included in the revised NCS as it is difficult to assess what constitutes an unacceptable concentration and secondly, spills to snow or ice are most efficiently mitigated while freezing conditions remain.
Score	4			
b. For what proportion of the year does the site remain covered by snow? 0 to 10% of the year 10 to 30% of the year More than 30% of the year Do Not Know	Do Not Know	Known is scored	Consult climatic information for the site. The increments represent the full span from soils which are always wet or covered with snow (and therefore less likely to generate dust) to those soils which are predominantly dry and not covered by snow (and therefore are more likely to generate dust).	
Score	3			
Potential surface soil pathway total	7			
Allowed Potential score	---	**Note: If a "known" score is provided, the "potential" score is disallowed.**		
Soil pathway total	**12**			

(II) Migration Potential (Evaluation of contaminant migration pathways)

Administration Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
4. Vapour				
A. Demonstrated COPCs in vapour.				
Vapour has been measured (indoor or outdoor) in concentrations exceeding risk based concentrations.	12	No previous investigations included vapours. Potential is scored.	Consult previous investigations, including human health risk assessments, for reports of vapours detected.	
Strongly suspected (based on observations and/or modelling)	9			
Vapour has not been measured and volatile hydrocarbons have not been found in site soils or groundwater.	0			
	Go to Potential			
Score	---			
NOTE: If a score is assigned here for Demonstrated COPCs in Vapour, then you can skip Part B (Potential for COPCs in vapour) and go to Section 5 (Sediment)				
B. Potential for COPCs in vapour				
a. Relative Volatility based on Henry's Law Constant, H' (dimensionless) High (H' > 1.0E-1) Moderate (H' = 1.0E-1 to 1.0E-3) Low (H' < 1.0E-3) Not Volatile Do Not Know		Toluene and Chlorobenzene both have high volatility based on a H'> 1.0e-1.	Reference: US EPA Soil Screening Guidance (Part 5 - Table 36) *Provided in Attached Reference Materials*	If the Henry's Law Constant for a substance indicates that it is not volatile, and a score of zero is assigned here for relative volatility, then the other three questions in this section on Potential for COPCs will be automatically assigned scores of zero and you can skip to section 5.
	High			
Score	4			
b. What is the soil grain size? Fine Coarse Do Not Know		Grain size is not known.	Review soil permeability data in engineering reports. The greater the permeability of soils, the greater the possible movement of vapours. Fine-grained soils are defined as those which contain greater than 50% by mass particles less than 75 µm mean diameter (D50 < 75 µm). Coarse-grained soils are defined as those which contain greater than 50% by mass particles greater than 75 µm mean diameter (D50 > 75 µm).	
	Do Not Know			
Score	3			
c. Is the depth to the source less than 10m? Yes No Do Not Know		Source is in the surface.	Review groundwater depths below grade for the site.	
	Yes			
Score	2			
d. Are there any preferential pathways? Yes No Do Not Know		Underground sewage piping could be a preferrential pathway.	Visit the site during dry summer conditions and/or review available photographs. Where bedrock is present, fractures would likely act as preferential pathyways.	Preferential pathways refer to areas where vapour migration is more likely to occur because there is lower resistance to flow than in the surrounding materials. For example, underground conduits such as sewer and utility lines, drains, or septic systems may serve as preferential pathways. Features of the building itself that may also be preferential pathways include earthen floors, expansion joints, wall cracks, or foundation perforations for subsurface features such as utility pipes, sumps, and drains.
	Yes			
Score	2			
Potential vapour pathway total	11			
Allowed Potential score	11	Note: If a "known" score is provided, the "potential" score is disallowed.		
Vapour pathway total	**11**			
5. Sediment Movement				
A. Demonstrated migration of sediments containing COPCs				
There is evidence to suggest that sediments originally deposited to the site (exceeding the CCME sediment quality guidelines) have migrated.	12	Unknown, potential is scored.	Review sediment assessment reports. Evidence of migration of contaminants in sediments must be reported by someone experienced in this area.	Usually not considered a significant concern in lakes/marine environments, but could be very important in rivers where transport downstream could be significant.
Strongly suspected (based on observations and/or modelling)	9			
Sediments have been contained and there is no indication that sediments will migrate in future. **or** Absence of sediment exposure pathway (i.e., within 5 km of the site there are no aquatic receiving environments, and therefore no sediments).	0			
	Go to Potential			
Score	---			
NOTE: If a score is assigned here for Demonstrated Migration of Sediments, then you can skip Part B (Potential for Sediment Migration) and go to Section 6 (Modifying Factors)				

CCME National Classification System (2008, 2010 v 1.2)

(II) Migration Potential (Evaluation of contaminant migration pathways)

Administration Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
B. Potential for sediment migration		Sediments are in a wetland, not a river or water body.		
a. Are the sediments having COPC exceedances capped with sediments having no exceedances ("clean sediments")?	No	Sediments are not capped.	Review existing sediment assessments. If sediment coring has been completed, it may indicate that historically contaminated sediments have been covered over by newer "clean" sediments. This assessment will require that cores collected demonstrate a low concentration near the top and higher concentration with sediment depth.	
Yes				
No				
Do Not Know	4			
b. For lakes and marine habitats, are the contaminated sediments in shallow water and therefore likely to be affected by tidal action, wave action or propeller wash?	No	No tidal action.	Review existing sediment assessments. If the sediments present at the site are in a river, select "no for this question.	
Yes				
No				
Do Not Know	0			
c. For rivers, are the contaminated sediments in an area prone to sediment scouring?	No	In the wetland flow is overland and no scouring. However downstream there is more of a channel where scouring is possible but samples have not been collected in that area.	Review existing sediment assessments. It is important that the assessment is made under worst case flows (high yearly flows). Under high yearly flows, areas which are commonly depositional may	
Yes				
No				
Do Not Know	0			
Potential sediment pathway total	4			
Allowed Potential score	4	Note: If a "known" score is provided, the "potential" score is disallowed.		
Sediment pathway total	**4**			
6. Modifying Factors				
		Pipes to transport the sewage from the lift station into the lagoon are present in the subsurface. However, it is unknown if they are affected by the contamination.		
Are there subsurface utility conduits in the area affected by contamination?	Do Not Know		Consult existing engineering reports. Subsurface utilities can act as conduits for contaminant migration.	
Yes				
No				
Do Not Know				
Known	---			
Potential	2			

Migration Potential Total		
Raw "known" total	24	
Raw "potential" total	24.9	
Raw combined total	48.9	Note: If "Known" and "Potential" scores are provided, the checklist defaults to known. Therefore, the total "Potential" Score may not reflect the sum of the individual "Potential" scores.
Total (max 33)	**25.2**	

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(III) Exposure (Demonstrates the presence of an exposure pathway and receptors)

Administration Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
1. Human				
A. Known exposure				
Documented adverse impact or high quantified exposure which has or will result in an adverse effect, injury or harm or impairment of the safety to humans as a result of the contaminated site. (Class 1 Site*)	22	No documented human known exposures. Potential is scored.	*Where adverse effects on humans are documented, the site should be automatically designated as a Class 1 site (i.e., action required). There is no need to proceed through the NCS in this case. However, a scoring guideline (22) is provided in case a numerical score for the site is still desired (e.g., for comparison with other Class 1 sites). This category can be based on the outcomes of risk assessments and applies to studies which have reported Hazard Quotients >1 for noncarcinogenic chemicals and incremental cancer risks that exceed acceptable levels defined by the jurisdiction for carcinogenic chemicals (for most jurisdictions this is typically either $>10^{5}$ or $>10^{4}$). Known impacts can also be evaluated based on blood testing (e.g. blood lead >10 ug/dL) or other health based testing. This category can be based on the outcomes of risk assessments and applies to studies which have reported Hazard Quotients of less than 0.2 for non-carcinogenic chemicals and incremental lifetime cancer risks for carcinogenic chemicals that are within acceptable levels as defined by the jurisdiction (for most jurisdictions this is less than either 10^{6} or 10^{5}).	Known adverse impact includes domestic and traditional food sources. Adverse effects based on food chain transfer to humans and/or animals can be scored in this category. However, the weight of evidence must show a direct link of a contaminated food source/supply and subsequent ingestion/transfer to humans. Any associated adverse effects to the environment are scored separately later in this worksheet. Someone experienced must provide a thorough description of the sources researched to evaluate and determine the quantified exposure/impact (adverse effect) in the vicinity of the contaminated site. **Selected References:** Health Canada – Federal Contaminated Site Risk Assessment in Canada Parts 1 and 2 Guidance on Human Heath Screening Level Risk Assessments (www.hc-sc.gc.ca/ewh-semt/pubs/contamsite/index_e.html) United States Environmental Protection Agency, Integrated Risk Information System (IRIS) http://toxnet.nml.nih.gov
Same as above, but "Strongly Suspected" based on observations or indirect evidence.	10			
No quantified or suspected exposures/impacts in humans.	0			
	Go to Potential			
Score	---			
NOTE: If a score is assigned here for Known Exposure, then you can skip Part B (Potential for Human Exposure) and go to Section 2 (Human Exposure Modifying Factors)				
B. Potential for human exposure				
a) Land use (provides an indication of potential human exposure scenarios) Agricultural Residential / Parkland Commercial Industrial Do Not Know	Agricultural	National Parks fall in the agricultural land use.	Review zoning and land use maps over the distances indicated. If the proposed future land use is more "sensitive" than the current land use, evaluate this factor assuming the proposed future use is in place. Agricultural land use is defined as uses of land where the activities are related to the productive capability of the land or facility (e.g., greenhouse) and are agricultural in nature, or activities related to the feeding and housing of animals as livestock. Residential/Parkland land uses are defined as uses of land on which dwelling on a permanent, temporary, or seasonal basis is the activity (residential), as well as uses on which the activities are recreational in nature and require the natural or human designed capability of the land to sustain that activity (parkland). Commercial/Industrial land uses are defined as land on which the activities are related to the buying, selling, or trading of merchandise or services (commercial), as well as land uses which are related to the production, manufacture, or storage of materials (industrial).	This is the main "receptor" factor used in site scoring. A higher score implies a greater exposure and/or exposure of more sensitive human receptors (e.g., children).
Score	3			
b. Indicate the level of accessibility to the contaminated portion of the site (e.g., the potential for coming in contact with contamination) Limited barriers to prevent site access; contamination not covered Moderate access or no intervening barriers, contaminants are covered. Remote locations in which contaminants not covered. Controlled access or remote location and contaminants are covered Do Not Know	Mod. access, covered	Sewage lagoon is in a locked, fenced area. However the wetland areas are not. The Admin lagoon is in an area of low access, typically only the Park Staff are in the area.	Review location and structures and contaminants at the site and determine if there are intervening barriers between the site and humans. A low rating should be assigned to a (covered) site surrounded by a fence or in a remote location, whereas a high score should be assigned to a site th has no cover, fence, natural barriers or buffer.	
Score	1			
B. Potential for human exposure				
c) Potential for intake of contaminated soil, water, sediment or foods for operable or potentially operable pathways, as identified in Worksheet II (Migration Potential). i) direct contact Is dermal contact with contaminated surface water, groundwater, sediments or soils anticipated? Yes No Do Not Know	Yes	Dermal contact is not anticipated. The lagoon is in a locked fenced area. The wetlands are outside the fence but are located in close proximity to the laoogn and off the road by a minimum of 15 m. However water from the wetlands can flow through a culvert under the road and into a stream near where public may go to view beavers in a pond nearby.	If soils or potable groundwater are present exceeding their respective CCME guidelines, dermal contact is assumed. Exposure to surface water, non-potable groundwater or sediments exceeding their respective CCME guidelines will depend on the site. Select "Yes" if dermal exposure to surface water, non-potable groundwater or sediments is expected. For instance, dermal contact with sediments would not be expected in an active port. Only soils in the top 1.5 m are defined by CCME (2003) as surface soils. If contaminated soils are only located deeper than 1.5 m, direct contact with soils is not anticipated to be an operable contaminant exposure pathway.	Exposure via the skin is generally believed to be a minor exposure route. However for some organic contaminants, skin exposure can play a very important component of overall exposure. Dermal exposure can occur while swimming in contaminated waters, bathing with contaminated surface water/groundwater and digging in contaminated dirt, etc.
Score	3			
ii) inhalation (i.e., inhalation of dust, vapour) Vapour - Are there inhabitable buildings on the site within 30 m of soils or groundwater with volatile contamination as determined in Worksheet II (Migration Potential)? Yes No Do Not Know	No	No buildings within 30 m.	If inhabitable buildings are on the site within 30 m of soils or groundwater exceeding their respective guidelines for volatile chemicals, there is a potential of risk to human health (Health Canada, 2004). Review site investigations for location of soil samples (having exceedances of volatile substances) relative to buildings. Refer to (II) Migration Potential worksheet, 4B.a) *Potential for COPCs in Vapour* for a definition of volatility.	Exposure via the lungs (inhalation) can be a very important exposure pathway. Inhalation can be via both particulates (dust) and gas (vapours). Vapours can be a problem where buildings have been built on former industrial sites or where volatile contaminants have migrated below buildings resulting in the potential for vapour intrusion. Assesses the potential for humans to be exposed to vapours originating from site soils. The closer the receptor is to a source of volatile chemicals in soil, the greater the potential of exposure. Also, coarser-grained soil will convey vapour much more efficiently in the soil than finer grained material such as clays and silts. General Notes; Someone experienced must provide a thorough description of the sources researched to determine the presence/absence of a vapour migration and/or dust generation in the vicinity of the contaminated site. This information must be documented in the NCS Site Classification Worksheet including conta names, phone numbers, e-mail correspondence and/or reference maps/reports and other resource such as internet links. Selected References; Canadian Council of Ministers of the Environment (CCME). 2006. Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. PN 1332www.ccme.ca Golder, 2004. Soil Vapour Intrusion Guidance for Health Canada Screening Level Risk Assessment (SLRA) Submitted to Health Canada, Burnaby, BC
Score	0			
Dust - If there is contaminated surface soil (e.g. top 1.5 m) , indicate whether the soil is fine or coarse textured. If it is known that surfac soil is not contaminated, enter a score of zero. Fine Coarse Surface soil is not contaminated or absent (bedrock) Do Not Know Texture		Surface soils are clay in the lagoon and silts in the wetland.	Consult grain size data for the site. If soils (containing exceedances of the CCME soil quality guidelines) predominantly consist of fine material (having a median grain size of 75 microns; as defined by CCME (2006)) then these soils are more likely to generate dusts.	
Score	Fine			
	3			
inhalation total	3			

(III) Exposure (Demonstrates the presence of an exposure pathway and receptors)

Administration Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
B. Potential for human exposure				
iii) Ingestion (i.e., ingestion of food items, water and soils [for children]), including traditional foods.		Drinking water is not present on the site.	Review available site data to determine if drinking water (groundwater, surface water, private, commercial or municipal supply) is known or suspected to be contaminated above Guidelines for Canadian Drinking Water Quality. If drinking water supply is known to be contaminated, some immediate action (e.g., provision of alternate drinking water supply) should be initiated to reduce or eliminate exposure. The evaluation of significant potential for exceedances of the water supply in the future may be based on the capture zones of the drinking water wells; contaminant travel times; computer modelling of flow and contaminant transport.	**Selected References:** Guidelines for Canadian Drinking Water Qualitywww.hc-sc.gc.ca/hecs-sesc/water/publications/drinking_water_quality_guidelines/toc.htm Drinking water can be an extremely important exposure pathway to humans. If site groundwater or surface water is not used for drinking, then this pathway is considered to be inoperable. Consider both wild foods such as salmon, venison, caribou, as well as agricultural sources of food items if the contaminated site is on or adjacent to agricultural land uses.
Drinking Water: Choose a score based on the proximity to a drinking water supply, to indicate the potential for contamination (present or future).				
0 to 100 m				
100 to 300 m				
300 m to 1 km				
1 to 5 km				
No drinking water present				
Do Not Know				
	No drinking water preser			
Score	0			
Is an alternative water supply readily available?		Alternate water supplies are available in the park		
Yes				
No				
Do Not Know	Yes			
Score	0			
Is human ingestion of contaminated soils possible?		Contamination is in the surface soils so ingestion is possible.	If contaminated soils are located within the top 1.5 m, it is assumed that ingestion of soils is an operable exposure pathway. Exposure to soils deeper than 1.5 m is possible, but less likely, and the duration is shorter. Refer to human health risk assessment reports for the site in question.	
Yes				
No				
Do Not Know	Yes			
Score	3			
Are food items consumed by people, such as plants, domestic animals or wildlife harvested from the contaminated land and its surroundings?		Traditional plants are allowed to be harvested from the park with a permit. Also bison present in the park are sold at auction and the end use is unknown but could include consuption. Deer, elk and ducks can move out of the park where they could be hunted and consumed. Therefore category is scored as "yes".	Use human health risk assessment reports (or others) to determine if there is significant reliance on traditional food sources associated with the site. Is the food item in question going to spend a large proportion of its time at the site (e.g., large mammals may spend a very small amount of time at a small contaminated site)? Human health risk assessment reports for the site in question will also provide information on potential bioaccumulation of the COPC in question.	
Yes				
No				
Do Not Know	Yes			
Score	1			
Ingestion total	4			
Human Health Total "Potential" Score	14	Note if a "Known" Human Health score is provided, the "Potential" score is disallowed.		
Allowed "Potential" Score	14			
2. Human Exposure Modifying Factors				
a) Strong reliance of local people on natural resources for survival (i.e., food, water, shelter, etc.)	No	No , there are communities close by that provide these services. The consumption described above is not a strong reliance.		
Yes				
No				
Do Not Know				
Known	0			
Potential	---			
Raw Human "known" total	0			
Raw Human "potential" total	14			
Raw Human Exposure Total Score	14			
Human Health Total (max 22)	**14.0**			
3. Ecological				
A. Known exposure				
Documented adverse impact or high quantified exposure which has or will result in an adverse effect, injury or harm or impairment of the safety to terrestrial or aquatic organisms as a result of the contaminated site.	18	Potential scored, No documented evidence.	Some low levels of impact to ecological receptors are considered acceptable, particularly on commercial and industrial land uses. However, if ecological effects are deemed to be severe, the s may be categorized as class one (i.e., a priority for remediation or risk management), regardless of the numerical total NCS score. For the purpose of application of the NCS, effects that would be considered severe include observed effects on survival, growth or reproduction which could threaten the viability of a population of ecological receptors at the site. Other evidence that qualifies as severe adverse effects may be determined based on professional judgement and in consultation with the relevant jurisdiction. If ecological effects are determined to be severe and an automatic Class 1 is assigned, there is no need to proceed through the NCS. However, a scoring guideline (18) is provided in case a numerical score for the site is still desired (e.g., for comparison with other Class 1 sites). This category can be based on the outcomes of risk assessments and applies to studies which have reported Hazard Quotients >1. Alternatively, known impacts can also be evaluated based on a weight of evidence assessment involving a combination of site observations, tissue testing, toxicity testing and quantitative community assessments. Scoring of adverse effects on individual rare or endangered species will be completed on a case-by-case basis with full scientific justification. This category can be based on the outcomes of risk assessments and applies to studies which have reported Hazard Quotients of less than 1 and no other observable or measurable sign of impacts. Alternatively, it can be based on a combination of other lines of evidence showing no adverse effects, such as site observations, tissue testing, toxicity testing and quantitative community assessments.	CCME, 1999: Canadian Water Quality Guidelines for the Protection of Aquatic Lifewww.ccme.ca CCME, 1999: Canadian Water Quality Guidelines for the Protection of Agricultural Water Useswww.ccme.ca Sensitive receptors- review: Canadian Council on Ecological Areaswww.ccea.org. Ecological effects should be evaluated at a population or community level, as opposed to at the level of individuals. For example, population-level effects could include reduced reproduction, growth or survival in a species. Community-level effects could include reduced species diversity or relative abundances. Further discussion of ecological assessment endpoints is provided in*A Framework for Ecological Risk Assessment: General Guidance* (CCME 1996). Notes: Someone experienced must provide a thorough description of the sources researched to classify the environmental receptors in the vicinity of the contaminated site. This information must be documented in the NCS Site Classification Worksheet including contact names, phone numbers, e-mail correspondence and/or reference maps/reports and other resource such as internet links.
Same as above, but "Strongly Suspected" based on observations or indirect evidence.	12			
No quantified or suspected exposures/impacts in terrestrial or aquatic organisms	0			
	Go to Potential			
Score	---			
NOTE: If a score is assigned here for Known Exposure, then you can skip Part B (Potential for Ecological Exposure) and go to Section 4 (Ecological Exposure Modifying Factors)				

(III) Exposure (Demonstrates the presence of an exposure pathway and receptors)

Administration Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
B. Potential for ecological exposure (for the contaminated portion of the site)				
a) Terrestrial		National park falls in agricultural land use/Wild Lands	Review zoning and land use maps. If the proposed future land use is more "sensitive" than the current land use, evaluate this factor assuming the proposed future use is in place (indicate in the worksheet that future land use is the consideration).	
i) Land use				
Agricultural (or Wild lands)			Agricultural land use is defined as uses of land where the activities are related to the productive capability of the land or facility (e.g., greenhouse) and are agricultural in nature, or activities related to the feeding and housing of animals as livestock. Wild lands are grouped with agricultural land due to the similarities in receptors that would be expected to occur there (e.g., herbivorous mammals and birds) and the similar need for a high level of protection to ensure ecological functioning. Residential/Parkland land uses are defined as uses of land on which dwelling on a permanent, temporary, or seasonal basis is the activity (residential), as well as uses on which the activities are recreational in nature and require the natural or human designed capability of the land to sustain that activity (parkland). Commercial/Industrial land uses are defined as land on which the activities are related to the buying, selling, or trading of merchandise or services (commercial), as well as land uses which are related to the production, manufacture, or storage of materials (industrial).	
Residential/Parkland				
Commercial				
Industrial				
Do Not Know				
	Agricultural (or Wild lands			
Score	3			
ii) Uptake potential		There is potential for direct contact with contamination in surface sediments Bevers are present in the area and inside the lagoon.	If contaminated soils are located within the top 1.5 m, it is assumed that direct contact of soils with plants and soil invertebrates is an operable exposure pathway. Exposure to soils deeper than 1.5 m possible, but less likely.	
Direct Contact - Are plants and/or soil invertebrates likely exposed to contaminated soils at the site?	Yes			
Yes				
No				
Do Not Know				
Score	1			
iii) Ingestion (i.e., wildlife or domestic animals ingesting contaminated food items, soils or water)		Bevers are present in the lagoons.		
Are terrestrial animals likely to be ingesting contaminated water at the site?			Refer to an Ecological Risk Assessment for the site. If there is contaminated surface water at the site, assume that terrestrial organisms will ingest it.	
Yes				
No				
Do Not Know	Yes			
Score	1			
Are terrestrial animals likely to be ingesting contaminated soils at the site?			Refer to an Ecological Risk Assessment report. Most animals will co-ingest some soil while eating plant matter or soil invertebrates.	
Yes				
No				
Do Not Know	Yes			
Score	1			
Can the contamination identified bioaccumulate?		PAHs, DDD/DDE/DDT have log Kow greater than 4.	Bioaccumulation of contaminants within food items is considered possible if: 1) The Log(Kow) of the contaminant is greater than 4 (as per the chemical characteristics work sheet) and concentrations in soils exceed the most conservative CCME soil quality guideline for the intended land use, or 2) The contaminant in collected tissue samples exceeds the Canadian Tissue Residue Guidelines.	
Yes				
No				
Do Not Know	Yes			
Score	1			
Distance to sensitive terrestrial ecological area		National parks are considered sensitive terreestrial ecologcial areas. Bison are present in the park.	It is considered that within 300 m of a site, there is a concern for contamination. Therefore an environmental receptor located within this area of the site will be subject to further evaluations. It is also considered that any environmental receptor located greater than 5 km will not be a concern for evaluation. Review Conservation Authority mapping and literature including Canadian Council on Ecological Areas link:www.ccea.org.	Environmental receptors include: local, regional or provincial species of interest or significance; arctic environments (on a site specific basis); nature preserves, habitats for species at risk, sensitive forests, natural parks or forests.
0 to 300 m				
300 m to 1 km				
1 to 5 km				
> 5 km				
Do Not Know				
	0 to 300 m			
Score	3			
Raw Terrestrial Total Potential	10	Note if a "Known" Ecological Effects score is provided, the "Potential" score is disallowed.		
Allowed Terrestrial Total Potential	10			
B. Potential for ecological exposure (for the contaminated portion of the site)				
b) Aquatic		There is a Trumpeter Swan reintroduction program in Elk Island NP. Therefore it was rated as a sensitive aquatic environment.	"Sensitive aquatic environments" include those in or adjacent to shellfish or fish harvesting areas, marine parks, ecological reserves and fish migration paths. Also includes those areas deemed to have ecological significance such as for fish food resources, spawning areas or having rare or endangered species.	
i) Classification of aquatic environment				
Sensitive			"Typical aquatic environments" include those in areas other than those listed above.	
Typical				
Not Applicable (no aquatic environment present)				
Do Not Know				
	Sensitive			
Score	3			
ii) Uptake potential		Do not know about groundwater contaimination		
Does groundwater daylighting to an aquatic environment exceed th CCME water quality guidelines for the protection of aquatic life at the point of contact?			Groundwater concentrations of contaminants at the point of contact with an aquatic receiving environment can be estimated in three ways: 1) by comparing collected nearshore groundwater concentrations to the CCME water quality guidelines (this will be a conservative comparison, as contaminant concentrations in groundwater often decrease between nearshore wells and the point of discharge). 2) by conducting groundwater modeling to estimate the concentration of groundwater immediately before discharge. 3) by installing water samplers, "peepers", in the sediments in the area of daylighting groundwater.	
Yes				
No (or Not Applicable)				
Do Not Know	Do Not Know			
Score	0.5			
Distance from the contaminated site to an important surface water resource		Astotin lake is 220m away based on a straight line path, however flow path would be over 300 m. Because it is inside a NP it is considered to be an important SW resource. To be conservative, the 220m distance to water body was used.		Environmental receptors include: local, regional or provincial species of interest or significance, sensitive wetlands and fens and other aquatic environments
0 to 300 m			It is considered that within 300 m of a site, there is a concern for contamination. Therefore an environmental receptor or important water resource located within this area of the site will be subject to further evaluation. It is also considered that any environmental receptor located greater than 5 km away will not be a concern for evaluation. Review Conservation Authority mapping and literature including Canadian Council on Ecological Areas link:www.ccea.org.	
300 m to 1 km				
1 to 5 km				
> 5 km				
Do Not Know				
	0 to 300 m			
Score	3			
			Bioaccumulation of food items is possible if:	

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(III) Exposure (Demonstrates the presence of an exposure pathway and receptors)

Administration Area Sewage Lagoon Elk Island National Park

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
Are aquatic species (i.e., forage fish, invertebrates or plants) that are consumed by predatory fish or wildlife consumers, such as mammals and birds, likely to accumulate contaminants in their tissues?		PAHs, DDD/DDE/DDT have log Kow greater than 4.	1) The Log(Kow) of the contaminant is greater than 4 (as per the chemical characteristics work sheet) and concentrations in sediments exceed the CCME ISQGs. 2) The contaminant in collected tissue samples exceeds the CCME tissue quality guidelines.	
Yes				
No				
Do Not Know	Yes			
Score	1			
Raw Aquatic Total Potential	7.5	Note if a "Known" Ecological Effects score is provided, the "Potential" score is disallowed.		
Allowed Aquatic Total Potential	7.5			
4. Ecological Exposure Modifying Factors				
a) Known occurrence of a species at risk.		Plain Bison, Elk and Trumpeter Swan reintroduction and breeding programs occur in the park. Tiger Salamanders are also present in the park	Consult any ecological risk assessment reports. If information is not present, utilize on-line databas such as Eco Explorer. Regional, Provincial (Environment Ministries), or Federal staff (Fisheries and Oceans or Environment Canada) should be able to provide some guidance.	Species at risk include those that are extirpated, endangered, threatened, or of special concern. For a list of species at risk, consult Schedule 1 of the federal Species at Risk Act (http://www.sararegistry.gc.ca/species/schedules_e.cfm?id=1). Many provincial governments may also provide regionally applicable lists of species at risk. For example, in British Columbia, consult: BCMWLAP. 2005. Endangered Species and Ecosystems in British Columbia. Provincial red and blue lists. Ministry of Sustainable Resource Management and Water, Land and Air Protection http://srmwww.gov.bc.ca/atrisk/red-blue.htm
Is there a potential for a species at risk to be present at the site?				
Yes				
No				
Do Not Know	Yes			
	2			
Score	---			
b) Potential impact of aesthetics (e.g., enrichment of a lake or tainting of food flavor).		Not investigated		
Is there evidence of aesthetic impact to receiving water bodies?	Do Not Know		Documentation may consist of environmental investigation reports, press articles, petitions or other records.	This Item will require some level of documentation by user, including contact names, addresses, phone numbers, e-m addresses. Evidence of changes must be documented, please attach copy of report containing relevant information.
Yes				
No	---			
Do Not Know	1			
Is there evidence of olfactory impact (i.e., unpleasant smell)?	No	The lagoon has an unplesasnt smell from the sewage but not from the contaminants.	Examples of olfactory change can include the smell of a COPC or an increase in the rate of decay in an aquatic habitat.	
Yes				
No	0			
Do Not Know	---			
Is there evidence of increase in plant growth in the lake or water body?	Do Not Know	Not investigated	A distinct increase of plant growth in an aquatic environment may suggest enrichment. Nutrients e.g., nitrogen or phosphorous releases to an aquatic body can act as a fertilizer.	
Yes				
No	---			
Do Not Know	1			
Is there evidence that fish or meat taken from or adjacent to the site smells or tastes different?	Do Not Know	Not investigated	Some contaminants can result in a distinctive change in the way food gathered from the site tastes smells.	
Yes	---			
No	1			
Do Not Know				
Ecological Modifying Factors Total - Knowr	**2**			
Ecological Modifying Factors Total - Potentia	**3**			
Raw Ecological Total - Known	2			
Raw Ecological Total - Potential	20.5			
Raw Ecological Total	22.5			
Ecological Total (Max 18	**18.0**			
5. Other Potential Contaminant Receptors				
a) Exposure of permafrost (leading to erosion and structural concerns)		permafrost is not present		Plants and lichens provide a natural insulating layer which will help prevent thawing of the permafrost during the summer. Plants and lichens may also absorb less solar radiation. Solar radiation is turned into heat which can also cause underlying permafrost to melt.
Are there improvements (roads, buildings) at the site dependant upon the permafrost for structural integrity?	No		Consult engineering reports, site plans or air photos of the site. When permafrost melts, the stability of the soil decreases, leading to erosion. Human structures, such as roads and/or buildings are often dependent on the stability that the permafrost provides.	
Yes				
No	0			
Do Not Know	---			
Is there a physical pathway which can transport soils released by damaged permafrost to a nearby aquatic environment?	No	permafrost is not present	Melting permafrost leads to a decreased stability of underlying soils. Wind or surface run-off erosion can carry soils into nearby aquatic habitats. The increased soil loadings into a river can cause an increase in total dissolved solids and a resulting decrease in aquatic habitat quality. In addition, the erosion can bring contaminants from soils to aquatic environments.	
Yes				
No	0			
Do Not Know	---			
Other Potential Receptors Total - Known	**0**			
Other Potential Receptors Total - Potential	**0**			

Exposure Total		
Raw Human Health + Ecological Total - Known	2	
Raw Human Health + Ecological Total - Potential	34.5	Only includes "Allowed potential" - if a "Known" score was supplied under a given category then the "Potential" score was not included.
Raw Total	36.5	
Exposure Total (max 34)	**27.0**	

CCME National Classification System (2008, 2010 v 1.2)
Score Summary

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	4	2
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	4	---
4. Contaminant Quantity	6	---
5. Modifying Factors	7	---
Raw Total Score	29	2
Raw Total Score (Known + Potential)	31	
Adjusted Total Score (Raw Total / 40 *33)	**25.6**	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	---	7.9
2. Surface Water Movement	12	---
3. Soil	12	---
4. Vapour	---	11
5. Sediment Movement	---	4
6. Modifying Factors	---	2
Raw Total Score	24	24.9
Raw Total Score (Known + Potential)	48.9	
Adjusted Total Score (Raw Total / 64 * 33)	**25.2**	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	---	
B Potential		
a. Land Use		3
b. Accessibility		1
c. Exposure Route		
i. Direct Contact		3
ii. Inhalation		3
iii. Ingestion		4
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	14
Raw Total Human Score (Known + Potential)	14	
Adjusted Total Human Score	14.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	---	
B. Potential		
a. Terrestrial		10
b. Aquatic		7.5
4. Ecological Receptors Modifying Factors	2	3
Raw Total Ecological Score	2	20.5
Raw Total Ecological Score (Known + Potential)	22.5	
Adjusted Total Ecological Score	18.0	(maximum 18)
5. Other Receptors	0	0
Total Other Receptors Score (Known + Potential)	0	
Total Exposure Score (Human + Ecological + Other)	**32.0**	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	**23.7**	(max 34)

Site Score

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Site Letter Grade	**D**
Certainty Percentage	**63%**
% Responses that are "Do Not Know"	**19%**
Total NCSCS Score for site	**74.4**
Site Classification Category	**INS**

Site Classification Categories*:

Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.