Environment AECOM

Hudson Bay Mining and Smelting Co., Limited

Proposed Lalor Concentrator Environmental Baseline Assessment

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Project Number:

60287252 (402.19.3)

Date:

May 2013

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May 8, 2013

Mr. Stephen West
Hudson Bay Mining and Smelting Co., Limited
PO Box 1500
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Dear Mr. West:

Project No: **60287252 (402.19.3)**

Regarding: **Proposed Lalor Concentrator**
Environmental Baseline Assessment

AECOM Canada Ltd. (AECOM) is pleased to submit our report on the above referenced project. If you have any questions regarding this report, please do not hesitate to contact Mark Hadfield directly at (204) 928-9241.

Sincerely,
AECOM Canada Ltd.

Ron Typliski, P.Eng.
District Manager
Manitoba/Saskatchewan, Environment

MH:dh

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Revision Log

Revision #	Revised By	Date	Issue / Revision Description
1	M. Hadfield	April 24, 2012	Draft
2	S. Kjartanson	May 8, 2013	Final

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Executive Summary

In the fall of 2007, Hudson Bay Mining and Smelting Co., Limited (HBMS) announced the discovery of a significant zinc ore body in the vicinity of Lalor Lake, located in north-western Manitoba approximately 8 km west of the Town of Snow Lake. HBMS has subsequently proposed the development of a mining operation at the discovery site and is currently developing an Advanced Exploration Project (AEP). In May 2012, HBMS filed an *Environment Act* Proposal (EAP) with Manitoba Conservation and Water Stewardship to convert the Lalor AEP into the Lalor Mine.

In 2011, the final decision was made to proceed with constructing a new concentrator at the Lalor AEP site (*i.e.,* Lalor site). The facility would be located on the north end of the Lalor AEP site and use the existing licensed pumphouse on Snow Lake and the Anderson Tailings Impoundment Area (TIA). The potential tailings and reclaim water pipeline alignments will follow the existing Lalor Access Road, Provincial Road (PR) 395 and former rail bed to the Anderson TIA.

This document describes the physiographic settings of the proposed Lalor Concentrator site and baseline environmental conditions for the Project Area. This area encompasses the proposed site (*i.e.*, Lalor AEP site) and includes the Lalor Access Road, tailings, reclaim and fresh water return lines, pumphouses, and surrounding waterbodies.

A variety of physiographic descriptors was used to describe the setting of the proposed Lalor Concentrator development. These include geology, soils, climate, air quality, and groundwater.

The proposed Lalor Concentrator and the immediate surrounding area, which includes the waterbodies under investigation, are located in the Reed Lake Ecodistrict in the Churchill River Upland Ecoregion. The Project Region is characterized by broken, hilly to rolling bedrock, which controls relief of the area. The bedrock is partially covered by unconsolidated mineral and organic materials. Areas to the east of Lalor Lake contain extensive lacustrine deposits, while the remainder contains a mixture of lacustrine sediments, till deposits, rock exposed areas, and peatlands.

Dystric Brunisols are the dominant soils in the ecodistrict. These soils have developed over glacial till overlying the bedrock and consist of shallow, sandy, and stony veneers. Peat-filled depressions with very poorly drained Typic and Terric Fibrisolic and Mesisolic Organic soils can be found throughout the ecodistrict. These soils are overly loamy to clayey glaciolacustrine sediments. Eutric Brunisols and Gray Luvisols can be found on sandy bars, beaches, and exposed clayey deposits.

Climate at the Lalor site is typical of the region. The nearest industrial operation that releases to the atmosphere is the Stall Concentrator, located 13 km east of the Lalor AEP site. Specific measurements of air quality in the Project Region are not available. However, it is expected that the air quality in this area is considered very good compared with larger cities and commercial and industrial areas in Manitoba.

The regional shallow groundwater flow is likely controlled by the topography and bedrock surface in the region. The Manitoba Water Stewardship water well records indicate little groundwater development near the Lalor AEP site. There are 21 registered groundwater wells in use within the Project Region. These are located within the property development around Wekusko Lake (Taylor Bay, Berry Bay and along PR 392), the Town of Snow Lake, and Wekusko Falls Provincial Park. Bedrock groundwater wells, when present, are likely connected to fractures or discontinuities that are connected to the local water table and are not likely regionally interconnected. Hydrogeological testing of the bedrock near the Lalor deposit determined the hydraulic conductivity is low.

AECOM completed baseline terrestrial surveys in 2007, 2010, 2011 and 2012 that included a review of local geology, soil, vegetation, wildlife, flowering plants, and nesting songbirds located near the Lalor site, access road, along the southern portion PR 395 former rail bed, and PR 392 at Anderson Creek. Overall, the region around the Project Area is naturally a dense boreal forest, primarily Black Spruce interspersed with Jack Pine and hardwoods. Dense forest canopy has limited understory growth in all areas within the Project Region. Sphagnum forms the dominant ground cover. In general, the Lalor AEP site is typical for this region. No rare or endangered plant species were encountered and there are no indications that this area contains unique opportunities for plant growth outside of that present in the general region.

There is no specific critical wildlife value observed at the Lalor AEP site (such as calving or over-wintering areas) and based on site conditions and limited field observations, it is expected that there is no critical wildlife value in the Project Area. At both the proposed Lalor Concentrator site and along the Lalor Access Road, the low diversity of plant communities and extremely dense Black Spruce stand offers a very restricted habitat for wildlife.

Suitable nesting habitat for migratory birds in the general area is limited to the edges habitat of the Lalor AEP development and marshy margins of larger waterbodies in the area (*e.g.,* Chisel Lake). Much of the Project Site is classified as bog and floating bog, which has very low value for migratory bird nesting.

Because of varying topography created by hummocky bedrock surfaces, the drainage conditions vary considerably over short distances. Regionally the terrain falls at about 0.6 m to 1.0 m per km. Similar to much of the Boreal Shield Ecozone, contiguous and isolated bogs cover between 20% and 40% of the Lalor Lake area. Bogs are widespread and stagnant in the region.

The Project Area hydrology covers two regional watersheds and a number of localized watersheds. The proposed Lalor Concentrator site is located within the Snow Lake local watershed. Snow Lake also receives water from the south via Tern Creek and Tern Lake. Tern Creek is the drainage for two medium sized lakes, Ghost Lake and Threehouse Lake. Most of the small lakes along the rail bed have no defined drainage features and watershed mapping suggests they are contributing to Snow Lake. Nutt Lake and the Anderson TIA are within the Wekusko Lake local watershed. Wekusko Lake is the downstream receptor for the Snow Lake watershed as well, but Anderson Creek and Stall Creek join and drain into Wekusko Lake directly. To the west of the proposed Lalor Concentrator site, a watershed divide exists and lakes to the west generally drain south through Tramping Lake before draining into Wekusko Lake.

Bathymetric surveys indicate most lakes mapped in the baseline assessment show typical headwater lake bathymetry. Ghost Lake and Threehouse Lake have a more complicated bottom with island and reef structures, but the relatively shallow average depth for their surface area is more typical of a headwater lake, despite their larger than average size. Anderson Bay in Wekusko Lake, has the most complex bathymetry of all the waterbodies surveyed. Anderson Bay has numerous islands and reef structures, a steep rocky eastern shore, a gentle shallow western shore, and estuary-like features at the northern end where Anderson Creek, after its confluence with Stall Creek, discharges into Wekusko Lake.

There was some evidence of stratification at stations in Snow Lake, the deepest stations included in the baseline assessments performed in 2011 and 2012. The pattern is indicative of residual winter stratification (*i.e.*, prior to spring turnover). With the exception of the deepest spots, water was well-oxygenated. The majority of waterbodies were mesotrophic or meso-eutrophic, with higher total phosphorus concentrations in the fall as compared to spring. Arm Lake total phosphorus concentrations were below detection limit and were therefore ranked as oligotrophic. Phytoplankton biovolume was congruent with trophic status.

In 2011 and 2012, 63 water samples from 14 waterbodies in the Snow Lake region were collected and submitted for analysis of physical and chemical parameters in order to establish baseline water quality conditions. Baseline concentrations of pH, fluoride, total aluminum, total cadmium, total copper, total iron, total selenium, and total zinc exceeded the *Canadian Water Quality Guidelines* (*CWQG*) for the protection of aquatic life in at least one sample. The most frequently exceeded guideline was the *CWQG* value for aluminum and average baseline concentrations ranged from 0.01 mg/L (Gaspard Lake) to 0.24 mg/L (Anderson Creek). The *Manitoba Water Quality Standards, Objectives and Guidelines* Tier II Objectives for chronic exposure (*MWQSOG)* values were exceeded for baseline concentrations of ammonia (in Nutt Lake, Unnamed Lake 1, Stall Creek, and Unnamed Creek 1) and copper (Stall Creek).

The majority of water samples in the Project Area were classified as *Good* or *Excellent* based on Water Quality Index (WQI) values. Within Anderson Bay of Wekusko Lake, differences were observed between near- and off-shore sites for parameters such as dissolved solids and conductivity, however water conditions were good at all Anderson Bay sites. Some differences were observed between spring and fall samples; however, these differences are consistent with changes in aquatic productivity during the open water season.

A total of 177 surficial sediment samples were collected from 13 waterbodies in the Snow Lake region and analysed for particle size distribution, major elements (*e.g.*, nitrogen, phosphorus, and carbon), and chemicals of potential concern to determine baseline characteristics of the sediments in 2011 and 2012. The baseline data were analysed to determine spatial trends within and among waterbodies and to classify the sediments in terms of Sediment Quality Index (SQI) values.

The baseline concentrations of major elements (*e.g.*, nitrogen, phosphorus, and carbon) varied significantly between waterbodies, and in some areas, varied significantly between sampling stations within each waterbody and, in the case of total phosphorus, also varied seasonally. Total nitrogen, phosphorus, and carbon levels are within ranges considered acceptable for natural and slightly impacted lakes. Chemicals of potential concern show similar spatial trends, with significantly higher levels of some compounds in lakes associated with historic or current mining activity. Comparisons between sampling sites within the larger waterbodies show that these elevated levels are uniformly distributed over a large area, while at other sites (*e.g.*, Anderson Bay), differences are observed between near- and off-shore sites.

The baseline concentrations of nine of the nineteen metals for which at least one sediment quality guideline exists not exceed the guideline in any sediment sample collected in the Project Area in 2011 and 2012 (*i.e.*, antimony, barium, beryllium, molybdenum, silver, thallium, tin, uranium, and vanadium). In the 2011 and 2012 baseline samples, eight metals had concentrations that exceeded a sediment quality guideline (*i.e.*, arsenic, cadmium, cobalt, copper, mercury, nickel, selenium, and zinc). The sediment quality in the waterbodies in the Project Area complements the water quality analysis.

SQI values were calculated based on the CCME *Interim Sediment Quality Guidelines* (*ISQG*) and *Probable Effect Levels* (*PEL*) for sediments at the 14 waterbodies. SQI values based on the *ISQGs* ranged from *Poor* (Ghost Lake) to *Excellent* (Tern Ditch). Lower SQI values indicates poor sediment quality due to large and/or several concentrations that exceed the applicable sediment quality guideline. SQI improved markedly when compared to PEL values, suggesting few ongoing ecological effects to aquatic life at most sites.

In general, waterbodies that may have been impacted by land use activities demonstrate reduced water and sediment quality. The spatial variability in the baseline concentrations of potential chemicals of concern needs to be considered when developing monitoring and assessment programs.

Overall phytoplankton and zooplankton abundance and species diversity coincide with low WQI and SQI values. Diversity and abundance was not consistently different in samples collected from the same waterbodies in spring and fall. Seasonal changes are related to higher primary productivity and trophic status in fall as well as competition or predation and water physiochemistry. In addition, plankton communities in lakes and creeks were different from each other, in terms of abundance and species composition.

In general, the benthic invertebrate community was less diverse and abundant in sediments that were more complex (*i.e.,* fines, sand, gravel) such as in Anderson Creek. Creeks that had less flow and more organic sediments typically had less balanced benthic invertebrate communities than those with more complex sediments or flow. The average density (total waterbody density divided by number of stations sampled in a waterbody) ranged from 86 n/m² to 21,466 n/m², for Anderson Creek and Tern Ditch, respectively. In general, the benthic invertebrate community in waterbodies that are closer to the "reference" waterbody are more similar than those that are further away. Lakes along the former rail bed typically had less diversity and density but higher proportion of EPT taxa (*i.e.,* Ephemeroptera, Plecoptera and Tricoptera) than Anderson Bay in Wekusko Lake. In general, EPT taxa were present in low numbers, with eleven stations that had no EPT taxa. A few waterbodies along the former rail bed (*i.e.,* Arm Lake and Gaspard Lake) had higher proportion of EPT taxa, suggesting that the habitat quality is high in these areas.

Minnow traps, gill nets, and a backpack electrofisher were used to collect fish in the Project Area. In total, 17 fish species were captured. No fish were captured in Nutt Lake, Unnamed Lake 1, and Unnamed Creek 1. In general, the larger waterbodies (*i.e.*, Anderson Bay and Goose Bay, both of Wekusko Lake) had the highest species diversity. For most other waterbodies, Brook Stickleback were the most abundant (or only) species captured, typical of headwater waterbodies. In spring, several species were captured in spawning condition (*i.e.*, Yellow Perch, White Sucker, Brook Stickleback, and Pearl Dace). Large school of Young-of-Year Brook Stickleback and spawning Pearl Dace were captured and observed in Anderson Creek, adjacent to PR 392. In general, fish were in good health and condition. External parasites (white cysts or black spot) and fin erosion were present in fish from most waterbodies.

The majority of cover in these waterbodies included vegetation (overhanging, submergent, and emergent) and cobble. All lakes provided diverse cover types and varying degrees of shoreline complexity. As several fish species were captured in spawning condition, the majority of waterbodies provided spawning and rearing habitat. Foraging habitat for large-bodied fish is predominately available in Wekusko Lake (*i.e.*, Anderson Bay and Goose Bay). Although the creeks and lakes along the proposed pipeline alignment provided a diversity of habitats, their shallow depth and limited connectivity to other waterbodies suggests that they cannot support populations of large-bodied fish.

Critical fish habitat was not observed at any aquatic habitat assessment site associated with the proposed pipeline corridor. Fish habitat at stream crossings assessed provided, at most, "Marginal" aquatic habitat value. Limited cover availability and water depth limits the habitat value at these crossings. Crossings at Threehouse Creek (off-take ditch), Gaspard Creek, Ghost Creek (off-take ditch), and Tern Ditch could provide small-bodied fish with migration habitat; however, this would be limited in low water conditions. Fish were captured either at these sites or in adjoining waterbodies during the 2011 and 2012 baseline assessment. Pearl Dace were only collected in the riffle/run habitat found immediately upstream of PR 392 in Anderson Creek. This habitat is not abundant in the area included in the baseline assessments.

Information from the Historic Resources Branch of Manitoba Culture, Heritage and Tourism does not indicate any historic or heritage resources at the Lalor AEP site or in the immediate surrounding area. The nearest significant heritage resource is the Trampling Lake pictographs, approximately 20 km south of the proposed Lalor Concentrator site.

Mining, forestry, recreation, tourism, trapping, and hunting are some of the more important economic sources in the Snow Lake area. Many in the Town of Snow Lake are employed directly or indirectly at the mines in the area. Regional resource users include trappers, cottage owners, lodge owners, snowmobilers, forestry industry, and First Nations. Mathias Colomb Cree Nation, located approximately 125 km northwest of Snow Lake at the community of Pukatawagan, is the nearest First Nations community to the proposed Project Site.

This document summarizes the environmental and socio-economic aspects that are present prior to the development of the proposed Lalor Concentrator. This baseline report also summarizes the terrestrial and aquatic baseline conditions at the proposed concentrator site, access road, proposed pipeline alignments, and several waterbodies in the area. Information presented here will be utilized into the Environmental Assessment, which will identify and assess potential impacts of the proposed project and describe mitigation measure required to offset potential adverse impacts.

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List of Acronyms

AADT	Annual Average Daily Traffic
AECOM	AECOM Canada Ltd.
AEP	Advanced Exploration Project
ANOVA	Analysis of Variance
ARD	Acid rock drainage
BCI	Bray-Curtis index
BIC	Benthic Invertebrate Community
CALA	Canadian Association of Laboratory Accreditation Inc.
CCME	Canadian Council of Ministers of the Environment
CDC	Conservation Data Centre
CPUE	Catch-Per-Unit-Effort
CSQG-RP	*Canadian Soil Quality Guidelines for Residential and Parkland Use*
CWQG	*Canadian Water Quality Guidelines*
DFO	Department of Fisheries and Oceans Canada
DL	Detection Limit
EAP	*Environment Act* Proposal
EBA	Environmental Baseline Assessment
EPT	Ephemeroptera-Tricoptera-Plecoptera
FFB	Flin Flon Belt
GIS	Geographical Information System
GPS	Global Positioning System
GSD	Geometric Standard Deviations
HBMS	Hudson Bay Mining and Smelting Co., Limited
HudBay	HudBay Minerals, Inc.
ICP-MS	Inductively Coupled-Mass Spectrometry
ISQG	Manitoba Interim Sediment Quality Guidelines
masl	Metres Above Sea Level
MESA	Manitoba Endangered Species Act
MCCN	Mathias Colomb Cree Nation
MMER	Metal Mining Effluent Regulations
MWQSOG	*Manitoba Water Quality Standards, Objectives, and Guidelines*
PCA	Principal Components Analysis
PEL	*Probable Effect Level*
PP	Phytoplankton
PR	Provincial Road
PTH	Provincial Trunk Highway
PRSD	Percent Relative Standard Deviation
QA/QC	Quality Assurance/Quality Control
RCMP	Royal Canadian Mounted Police
ROW	Right-of-Way
RPMD	Relative Percent Mean Difference
RTL	Registered Trap Line
SARA	Species at Risk Act
SD	Standard Deviation
SDI	Simpson's Diversity Index
SQI	Sediment Quality Index
TIA	Tailings Impoundment Area
UTM	Universal Transverse Mercator

List of Acronyms

WMA	Wildlife Management Area
WQI	Water Quality Index
VMS	Volcanic-hosted Massive Sulphide
ZP	Zooplankton

1. Introduction

1.1 Company Profile

Hudson Bay Mining and Smelting Co., Limited (HBMS), a wholly owned subsidiary of HudBay Minerals, Inc. (HudBay), is proposing the development of a new ore concentrator facility at the Lalor Advanced Exploration Project (AEP) Site near the Town of Snow Lake, Manitoba (*i.e.*, the Project; **Drawing - 01**). HBMS operates the 777 Mine in Flin Flon, Manitoba. Trout Lake Mine in Flin Flon and the Chisel North Mine in Snow Lake underwent closure in June 2012 and September 2012 respectively.

Copper and zinc ore from the 777 Mine is concentrated in the Flin Flon Metallurgical Complex, while zinc ore from the Chisel North Mine was concentrated at the Stall Lake Concentrator located near the Snow Lake. Zinc concentrate from both Flin Flon and Snow Lake is processed to produce refined zinc in the Flin Flon Metallurgical Complex. Since closure of the Flin Flon copper smelter in June 2010, copper concentrate has been shipped out of Manitoba for further processing.

The Snow Lake area has had an active mining history for more than 50 years. HBMS has played an integral part in this history since the late 1950's by operating nine mines in the area, including Photo Lake, Rod, Chisel Lake, Stall Lake, Osborne Lake, Spruce Point, Ghost Lake, Anderson Lake, and Chisel North Mine. The mines at Rod, Osborne Lake, Spruce Point, Ghost Lake, and Anderson Lake have been fully decommissioned, and partial decommissioning has been performed at the Chisel Lake and Stall Lake mine sites.

1.2 Environmental Baseline Assessment

HBMS retained AECOM Canada Ltd. (AECOM) to complete this environmental baseline assessment (EBA) by utilizing information provided by HBMS and a variety of environmental, ecological, and geological data collected through field investigations and a comprehensive literature search.

This document describes the physiographic settings of the proposed Lalor Concentrator site (*i.e.,* Project Site) and baseline environmental conditions at the proposed site. The assessment area for the EBA (*i.e.,* Project Area) encompasses the area of the proposed concentrator site and includes the Lalor Access Road, pipeline alignments for the tailings, reclaim and fresh water return lines, fresh water pumphouse, and surrounding terrestrial and aquatic environment (**Drawing - 02**). The Project Region considered in the EBA includes the area 10 km surrounding the Project Area.

In 2007, baseline terrestrial and aquatic investigations were commenced in anticipation that discoveries in the region of the Lalor Mine could lead to future development. The investigations dealt broadly with aquatic and terrestrial resources that could be affected by future development, including local geology, soil, vegetation and wildlife and 15 waterbodies that were initially identified as being located within the potential area of influence of the Lalor discovery.

As planning of the Lalor AEP, Lalor Mine and the Lalor Concentrator proceeded in subsequent years, additional focused investigations were undertaken, including Cook Lake in 2008 and a small waterbody identified by AECOM as Tern Ditch Pond in 2010. The result of the baseline investigations carried out in 2007, 2008, 2010, and 2011 are reported on in the *Proposed Lalor Mine Environmental Baseline Assessment* (AECOM, 2012a), which was filed with the Lalor Mine EAP. In 2011 and 2012, assessments of terrestrial and aquatic resources were conducted in additional areas within and around the proposed Lalor Concentrator Project Area. These more recent investigations are the focus of this EBA report.

The aquatic baseline assessment included an evaluation of the aquatic species (from field investigation and desktop review), habitat, and baseline water and sediment chemistry within the 15 waterbodies evaluated in 2011 and 2012 (**Table 1.1, Drawing - 02**).

Table – 1.1: Waterbodies Sampled in the Project Area, 2011-2012

Lake	Creek
Anderson Bay (in Wekusko Lake)	Anderson Creek
Arm Lake	Ghost Creek
Gaspard Lake	Stall Creek
Ghost Lake	Tern Ditch
Goose Bay (in Wekusko Lake)	Threehouse Creek
Nutt Lake	Unnamed Creek 1
Snow Lake	
Threehouse Lake	
Unnamed Lake 1	

2. Project Description

2.1 Location

The Lalor deposit is located in the vicinity of the east shore of Lalor Lake, a small, shallow, headwater lake located approximately 8 km west of the Town of Snow Lake, Manitoba (**Drawing - 02**). The Lalor AEP site is 3 km west of Provincial Road (PR) 395, with a direct access road initially constructed in 2008 and further upgraded. The proposed Lalor Concentrator will be located at the north end of the existing AEP site. The proposed pipeline system (both fresh and return) will follow the Lalor Access Road to PR 395 and south to join the former rail bed towards the Anderson Tailings Impoundment Area (TIA). Fresh water for the proposed concentrator will likely come from the existing pumphouse on Snow Lake (**Drawing - 02**).

2.2 Project History

The proposed Lalor Mine site (and current AEP site) is located approximately 3 km northwest of the existing Chisel North Mine and was discovered in the spring of 2007. The initial discovery hole intersected a zinc-rich base metal horizon. Subsequent drilling confirmed the occurrence of several base metal horizons, two of which were very extensive in size. Diamond drilling has been successful in outlining these horizons and delineating to approximately 50 m to 70 m spacing. These base metal horizons are comprised primarily of zinc, with lesser amounts of copper, silver, gold and lead, which is very similar to the mineralization encountered at the operating Chisel North Mine.

In the latter part of 2008, exploration drilling encountered a gold-bearing horizon at a much deeper depth than the base metal horizons. Since the initial gold intersection, exploration drilling has been successful in intersecting additional gold-bearing horizons, all at greater depths from surface than the base metal horizons. Some of the gold-bearing horizons are located at depths greater than 1,200 m below the ground surface. Due to the great depths and complex shape of these horizons, exploration drilling from surface is limited in its ability to define the shape and grade distribution. In the fall of 2009, an exploration drill hole intersected a high-grade copper-gold zone located approximately 1,300 m below surface. Since this discovery, there has been additional diamond drilling, but exploration by this method has been met with limited success. The depths at which the gold-copper zones are encountered results in the deviation of drill holes from the target zones, resulting in difficulty in accurately defining the target zones.

On April 9, 2010, HBMS was granted approval from the Manitoba Mines Branch to conduct advanced exploration for the Lalor Project. Construction of the Lalor AEP infrastructure is currently underway. Following exploration activities, HBMS expects to convert the Lalor AEP into Lalor Mine. In that regard, HBMS filed an *Environment Act* Proposal (EAP) with Manitoba Conservation and Water Stewardship in May 2012. The EAP for the proposed Lalor Mine is still undergoing regulatory review.

At the time of discovery of the Lalor deposit in 2007 and the gold and copper zones in 2008, there were two options proposed for the concentration of ore from the Lalor deposit. The first option involved refurbishing the existing concentrator at Stall Lake which is currently processing the zinc ore from the Chisel North Mine and has a second copper circuit that is in care and maintenance (**Drawing - 02**). Converting the Stall Lake Concentrator to process the Lalor ore would require upgrading the zinc and copper circuits. The second option for processing the ore from the Lalor deposit was to build a new concentrator in proximity to the Lalor Mine. This concentrator would process the zinc and copper. In 2010, the final decision was made to proceed with developing a new concentrator at the proposed Lalor Mine site. The facility would be located on the north end of the existing Lalor AEP site and use the existing licensed Snow Lake pumphouse and the Anderson TIA, with potential future upgrades made to the dyking system to accommodate the additional storage requirements. The proposed pipeline system will follow the existing Lalor Access Road and former rail bed to the Anderson TIA (**Drawing - 02**).

3. Physical Environment

The physiographic setting for the proposed Lalor Concentrator is defined using the ecological land classification system. This hierarchical system of ecozones, ecoregions, and ecodistricts represents subdivisions of increasing ecological detail. As shown in **Drawing - 03**, the proposed Lalor Concentrator is located within the:

- **Boreal Shield Ecozone**, which contains the
- **Churchill River Upland Ecoregion**, which contains the
- **Reed Lake Ecodistrict**

The Boreal Shield Ecozone, the largest ecozone in Canada, extends from northern Saskatchewan east to Newfoundland, north and east of Lake Winnipeg and finally north of the Great Lakes and St. Lawrence River. The Churchill River Upland Ecoregion extends from the sparsely forested regions to the north, the southern edge of the Precambrian Shield to the south, and extends westward from the Grass River to the Saskatchewan border. The Reed Lake Ecodistrict extends west from Wekusko Lake to just over the Saskatchewan border.

3.1 Topography

The elevations in the Reed Lake Ecodistrict range from approximately 255 masl to 355 masl. Elevations within the region of the Lalor Deposit vary from more than 312 masl for the highest bedrock outcrops to the west to approximately 256 masl near Wekusko Lake (Department of Energy, Mines and Resources, 1985 and 1995). Slope lengths in the ecodistrict range from approximately less than 50 m to more than 150 m in length. Rocky cliffs can rise from 35 m to 40 m above the lakes and peat-filled depressions (Smith, *et al.*, 1998).

The Project Region is characterized by broken, hilly to rolling bedrock, which controls relief of the area. The bedrock is partially covered by unconsolidated mineral and organic materials. Areas to the east of Lalor Lake contain extensive lacustrine deposits, while the remainder contains a mixture of: lacustrine sediments, till deposits, rock exposed areas, and peatlands.

3.2 Geology

The regional geology of the Lalor deposit is contained within the Flin Flon Belt (FFB). According to the Manitoba Geological Survey, the FFB is in the juvenile internal zone of the Trans-Hudson Orogen and consists of Paleoproterozoic volcanic, plutonic, and minor sedimentary rocks. According to Manitoba's Mineral Resources Geological Survey, *"the Flin Flon greenstone belt extends hundreds of kilometres to the south-southwest beneath a thin, geophysically transparent Phanerozoic cover. To the north the FFB is tectonically overthrust by younger metasedimentary rocks of the Kisseynew domain and by nappes of metavolcanic rocks that are the same age as those in the FFB."* (MGS, 2011).

The tectonostratigraphic architecture of the FFB is of vital economic significance. The FFB is one of the largest Proterozoic volcanic-hosted massive sulphide (VMS) districts in the world, containing 27 copper – zinc (gold) deposits. Of these deposits, more than 162 million tonnes of sulphide have already been mined (MGS, 2011).

The Snow Lake arc assemblage that hosts the Lalor deposit is a 20 km wide by 6 km thick section that records the transition from primitive to mature arc. The mature arc Chisel Sequence that hosts the Lalor Deposit typically contains thin and discontinuous volcanoclastic deposits and intermediate to felsic flow-dome complexes. Rock units in the hanging walls of the deposit typically include mafic and felsic volcanic and volcanoclastic units, mafic wacke, fragmental and crystal tuff units. The footwall rocks have extensive hydrothermal alteration and metamorphic recrystallization that has produced exotic aluminous mineral assemblages including; chloritic and seracitic schist; and cordierite-anthophylite gneisses (Bailes & Galley, 2007).

3.3 Soils

The Reed Lake Ecodistrict extends west from Wekusko Lake to just over the Saskatchewan border. Acidic granitoid bedrock in the form of sloping uplands and lowlands can be found in this ecodistrict. Bedrock areas are subdominant and widely distributed areas of permafrost can occur in peatlands.

Dystric Brunisols are the dominant soils in the ecodistrict. These soils have developed over glacial till overlying the bedrock and consist of shallow, sandy, and stony veneers. Peat-filled depressions with very poorly drained Typic and Terric Fibrisolic and Mesisolic Organic soils can be found throughout the ecodistrict. These soils are overly loamy to clayey glaciolacustrine sediments. Eutric Brunisols and Gray Luvisols can be found on sandy bars, beaches, and exposed clayey deposits (Smith, *et al.*, 1998).

3.4 Air

Specific measurements of air quality in the Project Region are not available. However, it is expected that the air quality in this area is considered very good compared with larger cities and commercial and industrial areas in Manitoba. The nearest industrial operation that release to the atmosphere is the Stall Concentrator, located 13 km east of the Lalor site. The closest significant industrial activity is in the City of Flin Flon and the Town of The Pas, located approximately 109 km and 135 km west of the Lalor site, respectively. Occasional regional impediments to air quality, although uncommon, may occur in the Project Region. This could include smoke from forest fires and wood-burning stoves, emissions from fuel storage tanks and vehicle emissions.

3.5 Climate

Although the closest community to the Project Site is Snow Lake, the closest weather station to the site is located near Baker's Narrows at the Flin Flon airport, approximately 99 km west of Lalor Lake. The Flin Flon airport is located at an elevation of 304 masl and is considered to be climatically representative of the Project Site. The mean annual air temperature at the Flin Flon airport is -0.2°C. The daily mean temperature ranges between 18°C in July and -21°C in January. Total annual precipitation at the Flin Flon airport is composed of 339 mm of rain and 141 cm of snow. July has the highest average rainfall (77 mm), whereas November has have the highest average snowfall (25 cm) (Environment Canada, 2012a).

The average temperature, precipitation and wind conditions measured at the Flin Flon airport each month are provided in **Table 3.1**.

Table – 3.1: Climate Data for the Flin Flon A, Manitoba (1971-2000)

	Month													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
Temperature (ºC)														
Daily Average	-21.4	-16.7	-9.3	0.7	8.8	14.9	17.8	16.6	9.8	2.7	-8.4	-18.4	-0.2	A
Daily Maximum	-16.6	-11	-2.9	6.9	15	20.4	23.1	21.8	14.2	6.2	-5.1	-14	4.8	A
Daily Minimum	-26.2	-22.3	-15.8	-5.5	2.6	9.3	12.6	11.4	5.4	-0.8	-11.7	-22.6	-5.3	A
Precipitation														
Rainfall (mm)	0.1	0.3	0.9	8.6	36.9	66.6	76.5	66.6	55.3	25.6	1.4	0.4	339.2	A
Snowfall (cm)	19.6	14.6	19.1	20	3.7	0	0	0	2	13	25.4	23.9	141.3	A
Wind Conditions (km/h)														
Speed	9.4	9.7	10	10.9	11.1	11.2	10.9	10.7	12.1	12.2	11.1	9.3	10.7	A
Most Frequent Direction	NW	NW	S	S	NE	S	NW	S	NW	NW	NW	NW	NW	A

Notes:
Data obtained from Flin Flon A meteorological station, latitude 54º 41' N longitude 101º 41' W Elevation 303.90 m (Environment Canada, 2012a).
"A": World Meteorological Organization "3 and 5 rule" (i.e., no more than 3 consecutive and no more than 5 total missing for either temperature or precipitation) between 1971 and 2000.

3.6 Groundwater

There is no comprehensive report describing the regional groundwater flow system. However, based on conditions in similar environments, the regional shallow groundwater flow, in particular in the overburden, is likely controlled by the topography and bedrock surface in the region. Recharge of shallow groundwater can be expected to occur in elevated areas. From there, shallow groundwater flow will generally follow the topography and drain to the low-lying areas where it will discharge to surface waterbodies and wetlands. Shallow groundwater tables are high in most peat lands and in low areas bordering the peat lands. Shallow groundwater levels in the area are generally at or near surface in the spring and early summer and drop as the year progresses. Locally, the topography of the buried bedrock surface can have a significant effect on groundwater flow direction.

The Manitoba Water Stewardship water well records indicate groundwater utilization within the Project Region. There are 21 registered groundwater wells in use within the Project Region (Manitoba Water Stewardship, 2011). These are located within the property development around Wekusko Lake (Taylor Bay, Berry Bay and along PR 392), the Town of Snow Lake, and Wekusko Falls Provincial Park.

Hydrogeological testing of the bedrock in the vicinity of the Lalor deposit determined the bulk hydraulic conductivity of the fractured rock to be within the upper range for unfractured metamorphic or igneous rocks and the lower range for fractured metamorphic or igneous rocks ($K_{BULK} = 8.3 \times 10^{-10}$ m/s) (Golder Associates Ltd., 2009).

4. Terrestrial Environment

4.1 Vegetation

Vegetation in the Reed Lake Ecodistrict is typical of the northern Boreal forest region with Black Spruce (*Picea mariana*), Jack Pine (*Pinus banksiana*), Trembling Leaf Aspen (*Populus tremuloides*), and White Spruce (*Picea glauca*). The bog peat-lands have stunted Black Spruce, moss, and ericaceous shrub vegetation, while fens have sedge (*Carex* sp.), shrub, and Tamarack (*Larix laricina*) in varying mixtures. Forest composition is reflective of a forest fire history (Smith, *et al.*, 1998).

The general area of the Lalor site and along the former rail bed is a boreal forest biome typical of the rocky outcrop and bog landscape. Rocky outcrops are primarily igneous and common, forming open lichen woodlands of White Spruce and Jack Pine. Black Spruce bog has developed in the areas between rocky outcrops and created deep deposits of sphagnum moss that restrict drainage. The bog is mature with large areas of even-aged Black Spruce stands. One indication of tree stand density is the relative lack of understory shrubs. Speckled Alder (*Alder rugosa*) dominates the shrub layer in openings created by watercourses. There were no Hazel, Saskatoon, Chokecherry, or other typical understory shrubs noted during the survey. Ground cover is moss with typical boreal ground plants such as Bunchberry (*Cornus canadensis*) and Solomon's Seal (*Polygonatum biflorum*). Soil development has occurred in pockets between rock outcrops with good drainage. Jack Pine grows in sporadic open sandy areas (**Drawing - 04**).

The general historical disturbance in this area has opened the forest canopy. However, most of this activity has been limited to narrow cut lines and drag roads that grow in rapidly. Re-growth in such areas is largely hardwoods, but these areas also offer some growth opportunity for shrubs that were largely lacking in other parts of the forest stand. The historical re-growth in this area is a minor part of the forest canopy, however, it is extensive and likely important in terms of offering linear features that present more diversity than the surrounding forest and providing openings in an otherwise dense canopy.

Expected plant species for the area is shown in **Appendix A, Table – 01**. A list of confirmed vegetation (based on desktop review and supported by field observation in 2007, 2010, 2011 and 2012) is provided in **Table 4.1**. It should be noted that the spring 2012 survey did not reveal any species not previously observed in the work conducted in 2007, 2010 and 2011.

Table – 4.1: Vegetation Observed in the Project Area (2007, 2010, 2011 and 2012)

Awned Hair Cap Moss (Polytrichum piliferum)	Marsh Cinquefoil (Potentilla palustris)
Balsam Fir (Abies balsamea)	Mountain Cranberry (Vaccinium visit-idaea)
Bearberry (Arctostaphylos uva-ursi)	Northern Reindeer Lichen (Cladina stellaris)
Black Spruce (Picea mariana)	Paper Birch (Betula papyrifera)
Bog Cranberry (Vaccinium vitis-idaea)	Perennial Sow Thistle (Sonchus arvensis)*
Bunchberry (Cornus canadensis)	Reed Canary Grass (Phalaris arundinacea)
Canada Anemone (Anemone canadensis)	Rough Cinquefoil (Potentilla norvegica)
Canada Bluejoint (Calamagrostis canadensis)	Sedge (Carex sp.)
Canada Buffaloberry (Sheperdia canadensis)	Shore-Growing Peat Moss (Sphagnum riparium)
Canada Thistle (Cirsium arvense)*	Snowberry (Symphoricarpos albus)
Cladonia (Cladonia sp.)	Solomon's Seal (Polygonatum biflorum)
Common Reed Grass (Phragmites australis)	Speckled Alder (Alder rugosa)
Common Cattail (Typha latifolia)	Sphagnum moss (Sphagnum sp.)
Drooping Wood-Reed (Cinna latifolia)	Squarrose Peat Moss (Sphagnum squarrosum)
Dwarf Billberry (Vaccinium caespitosum)	Stiff Club Moss (Lycopodium annotinum)
Early Blue Violet (Viola adunca)	Stinging Nettle (Urtica dioica)*
Fern (Matteuccia sp.)	Tall Cotton-Grass (Eriophorum angustifolium)
Finger Felt Lichen (Peltigera neopolydactyla)	Tamarack (Larix laricina)
Girgensohn's Peat Moss (Sphagnum girgensohnii)	Trembling Leaf Aspen (Populus tremuloides)
Ground Cedar (Lycopodium complanatum)	Tufted Moss (Aulacomium palustre)
Ground Pine (Lycopodium obscurum)	Velvet Leaf Blueberry (Vaccinium myrtilloides)
Jack Pine (Pinus banksiana)	Wavy Dicranum (Dicranum undulatum)
Labrador Tea (Ledum groenlandicum)	Wax Paper Lichen (Parmelia sulcata)
Large Cranberry (Vaccinium macrocarpon)	White Spruce (Picea glauca)
Leatherleaf (Chamaedaphne calyculata)	Wild Mint (Mentha arvensis)
Lily of the Valley (Maianthemum canadense)	Wintergreen (Pyrola asarifolia)

** Invasive species*

Overall, the region around the Lalor site and former rail bed is naturally a dense boreal forest, primarily Black Spruce interspersed with Jack Pine and hardwoods. Dense forest canopy has limited understory growth in all areas within the Project region. Sphagnum moss forms the dominant ground cover. In general, the Lalor site is typical for this region. No rare or endangered plant species were encountered at the Lalor site. There are no indications that this area contains unique opportunities for plant growth outside of that present in the general region.

4.1.1 Terrestrial Field Surveys

AECOM completed a baseline terrestrial survey in September 2007 that included a review of local geology, soil, vegetation, and wildlife located near the Lalor site and access road. The survey consisted of a random meander survey by qualified AECOM biologists. In July 2010, AECOM conducted a follow-up terrestrial survey of the Lalor AEP site and access road and immediately surrounding habitat. The Lalor site, access road and former rail bed and surrounding habitat were re-examined for flowering plants and nesting songbirds in 2011 and 2012, by qualified AECOM biologists. Representative photos taken as part of the terrestrial surveys can be found in **Appendix A**.

4.1.1.1 Lalor Site

The main concentrator building, the jaw crusher, the concentrate load-out shed, the electrical yard, and the paste backfill module, will all be located within the footprint of the existing Lalor site. A detailed terrestrial survey was conducted in the general area of the Lalor site in 2011 and re-visited in 2012. The Lalor site is located in a typical boreal stand common throughout the Project Area. Tree growth is primarily small Black Spruce on bog, high stand density and poor species diversity due to the relatively low productivity of this environment. No unusual plant communities and no species at risk were observed during the terrestrial surveys of the Lalor site.

The Lalor site creates an abrupt edge to the forest environment, where the Black Spruce stand is generally very dense with some openings to the west and along local lakes and wetlands. There is typically little variety in these stands. There were numerous White Birch (mostly dead stands) surrounding the Lalor site. This may indicate a general increase in wetness in the general area, possibly due to blockage of local drainage by beavers, which pre-dates development at the Lalor site.

The terrestrial surveys conducted in the area surrounding the Lalor site did not reveal any rare or endangered plants, or any specific habitats or floral communities that are unique, or may harbour such species.

4.1.1.2 Pipeline System

The majority of the pipeline system will run alongside existing right-of-ways (ROWs) (*i.e.,* Lalor Access Road, PR 395, the former rail bed, existing road to former Anderson Mine from PR 395).

The Lalor Access Road is located in very similar plant communities to those around the Lalor site. The Lalor Access Road is supported by crushed rock that fills the extremely wet areas through which the road passes. As with the Lalor site, the low diversity of plant communities and extremely dense Black Spruce stand offers a very restricted habitat for wildlife. A road from the existing Lalor Access Road to a ventilation shaft for the Lalor AEP is located in similarly wet bog with crushed rock as the fill and surface of the road.

The terrestrial environment along PR 395, between the Lalor Access Road and the former rail bed, is similar to what characterizes the Lalor site. The road itself has a wide ROW with pads for infrastructure and drilling developed along the road. Along the east side of PR 395 is a wet, closed canopy forest stand of mixed Black Spruce and Trembling Leaf Aspen interspersed with Tamarack. Ground cover alternates from wet Alder (*Alnus crispa*) bog to rocky outcrops. Adjacent to the forest stand along the east side of the highway is an upland mixed forest. Large tree sizes suggest a more productive forest environment than that surrounding the Lalor site. The west side of PR 395 is an open Black Spruce upland founded on a deep moss layer. This side of PR 395 is dry with a dense forest canopy and typical sparse boreal ground cover. Fairy Slipper Orchids (*Calypso bulbosa*) were noted throughout the forest floor on the west side of PR 395 (**Appendix A, Photograph 47**). This forest stand is fairly uniform from the Chisel North Mine to the crossover point to the former rail bed.

The former rail bed to the Anderson TIA is currently being used as an access road to a sand quarry and is only maintained to that point. An existing road to the former Anderson Mine runs parallel to the former rail bed near the former mine site. An existing power line (H-line with wood poles) crosses the former rail bed near the western portion of the route, close to the Chisel Water Treatment Plant. A major new power line crosses close to the existing power line with a wide cleared right of way of 100 m in width as it crosses the former rail bed.

The former rail bed is an old disturbed site, used for many years for access to the former Anderson, Osborne and Stall Mines and recently as part of the Snow Lake area recreational trail network. The rails have been removed and the bed itself is used for a road to access the sand quarry. The route is heavily overgrown on the sides with secondary growth, but it still shows the effects of disturbance (**Appendix A, Photograph 39**). The route runs primarily through lowland mixed woods developed on mineral soil with some wet bog crossed by rock fill. There are rock outcrops towards Anderson TIA that have been blasted and cut in the past to allow room for the rail bed (**Appendix A, Photograph 40**). Acid rock drainage (ARD) was not observed along the former rail bed.

The former Anderson Mine site (which has undergone closure) is adjacent to the Anderson TIA (**Appendix A, Photograph 41**). This area is primarily open with grassy understory, some shrubby growth and re-growth of poplar and brushy species. The shoreline of Anderson TIA supports a typical Aspen stand with extensive shrubby growth along the edge of the water.

The existing Snow Lake pumphouse is located on the south shore of Snow Lake in a well-cleared area, serviced by an all-weather access road. There is a rocky shoreline area adjacent to the pumphouse that is covered in a Black Spruce stand with a deep moss ground layer.

Overall, the region around the Project Site is naturally a dense boreal forest, primarily Black Spruce interspersed with Jack Pine and hardwoods. Dense forest canopy has limited understory growth in all areas within the Project Region. Sphagnum moss forms the dominant ground cover. In general, terrestrial vegetation in the Project Site is typical for this region. No rare or endangered plant species were encountered at the Project Site, and there are no indications that the Project Site or Project Area contains unique opportunities for plant growth outside of that present in the overall region.

4.2 Wildlife and Wildlife Habitat

The Churchill River Upland Ecoregion provides habitat for Moose (*Alces alces*), Boreal Woodland Caribou (*Rangifer tarandus caribou*), Black Bear (*Ursus americanus*), Lynx (*Lynx lynx*), Timber Wolf (*Canis lupus*), Beaver (*Castor canadensis*), Muskrat (*Ondatra zibethicus*), and Snowshoe Hare (*Lepus americanus*). Various bird species including Sandhill Crane (*Grus canadensis*), grouse, waterfowl (*i.e*., ducks, geese, and pelicans) along with many other birds are found in this ecoregion (Smith, *et al.*, 1998). Wildlife species expected to be found in this region are presented in **Appendix A, Table – 02**.

During the field studies conducted in September 2007 in the Project Region, signs of Black Bear and Moose in the area were apparent. Wildlife directly observed included Coyote (*Canis latranus*), Red Fox (*Vulpes fulva*), Whitetail Deer (*Odocoileus virginianus*), Timber Wolf, River Otter (*Lutra canadensis*), Beaver, eagles, American White Pelican (*Pelicanus erthrorhyncos*), cranes (*Grus* sp.), loons (*Gavia* sp.), and frogs. With the exception of a variety of waterfowl, there were no signs of wildlife observed within 1 km of the Lalor site at the time of the field investigation in 2010. In 2010, Common Raven (*Corvus corax*) were seen in the area, however terrestrial wildlife was largely absent during the survey. The densely forested Black Spruce bog offers little in the way of nesting habitat for birds and very few were seen or heard in the area during the 2011 survey. No species were observed in the 2012 survey that was not previously recorded.

The density of the forest canopy and poor diversity of plant life under the trees make this a poor area in terms of wildlife diversity in general. This is especially true for nesting birds, which benefit from the edge effects of different tree stands and open areas. Warblers and other insectivorous birds benefit from open areas that promote insect flight. The general region around the Lalor site has some variation in terms of upland rocky outcrops that promote hardwood growth and open areas in lichen outcrops.

Wildlife populations have open access to a large area of natural woodland in the region that provides river and lakeshore edge habitat and many burned areas in various stages of re-growth. Such areas provide a large diversity of habitats that favours wildlife populations and adjoin the immediate areas. Wildlife species can make use of the area near the proposed Lalor Mine site or former rail bed to the extent that it benefits them and there is no restriction on wildlife species to move to more favourable areas in the region.

There is no specific critical wildlife value observed at the proposed Lalor Mine site (such as calving or over-wintering areas) and based on site conditions and limited field observations, it is expected that there is no critical wildlife value in the Project Area. At both the Lalor site and along the access road, the low diversity of plant communities and extremely dense Black Spruce stand offers a very restricted habitat for wildlife. The absence of suitable waterbodies for waterfowl in the general area makes it unlikely that they are nesting anywhere within the immediate area of the Lalor site.

4.3 Protected Species

The Manitoba CDC provides a ranking of species of conservation concern for the Churchill River Upland Ecoregion. The term "species of concern" includes species that are rare, distinct, or at risk throughout their range or in Manitoba and need further research. Species are evaluated and ranked based on their range-wide (global) status, and their province-wide (sub-national) status according to a standardized procedure used by all Conservation Centres and Natural Heritage Programs. Twenty species of fungi, plants, and vertebrate animals are listed as species of special concern in the Churchill River Upland Ecoregion by the Manitoba CDC (**Table 4.2**).

No species listed as species of special concern by the Manitoba CDC were observed in the areas examined during the terrestrial baseline surveys conducted in 2007, 2010, 2011 and 2012.

Table – 4.2: List of Species of Special Concern in the Churchill River Upland Ecoregion

Common Name	Scientific Name	Rank
Flooded Jellyskin	Leptogium rivulare	Globally and provincially, the species is not ranked.
Bog Adder's-mouth	Malaxis paludosa	Globally ranked demonstrably widespread, abundant, secure throughout its range, and provincially ranked very rare.
Few-Flowered Sedge	Carex pauciflora	Globally ranked demonstrably widespread, abundant, secure throughout its range, and provincially ranked uncommon.
Few-Fruited Sedge	Carex oligosperma	Globally ranked demonstrably widespread, abundant and secure throughout its range and provincially ranked uncommon but status is uncertain.
Fragrant Shield Fern	Dryopteris fragrans	Globally ranked demonstrably widespread, abundant, and secure throughout its range, provincially ranked uncommon to widespread, abundant, and apparently secure.
Limestone Oak Fern	Gymnocarpium robertianum	Globally ranked demonstrably widespread, abundant, secure throughout its range, and provincially ranked very rare.
Long-Fruited Sedge	Carex michauxiana	Globally ranked demonstrably widespread, abundant, secure throughout its range, and provincially ranked rare.
Moor Rush	Juncus stygius ssp. americanus	Globally ranked demonstrably widespread, abundant and secure throughout its range and provincially ranked very rare, but status is uncertain.
Northern Oak Fern	Gymnocarpium jessoense	Globally ranked demonstrably widespread, abundant, and secure throughout its range, provincially ranked uncommon to widespread, abundant, and apparently secure.
Northern Woodsia	Woodsia alpina	Globally ranked widespread, abundant, apparently secure throughout its range, and provincially ranked very rare.
Oregon Cliff Fern	Woodsia oregana ssp. cathcartiana	Globally ranked demonstrably widespread, abundant, secure throughout its range while its subspecies is widespread, abundant, and apparently secure throughout its range, and provincially ranked very rare.
Pallas Buttercup	Ranunculus pallasii	Globally ranked widespread, abundant, apparently secure throughout its range, and provincially ranked rare.
Round-Leaved Bog Orchid	Platanthera orbiculata	Globally ranked demonstrably widespread, abundant, secure throughout its range, and provincially ranked uncommon.
Small Water-Lily	Nymphaea tetragona	Globally ranked demonstrably widespread, abundant, secure throughout its range, and provincially ranked rare.
Smooth Woodsia	Woodsia glabella	Globally ranked demonstrably widespread, abundant, apparently secure throughout its range, and provincially ranked rare.
Spatulate Moonwort	Botrychium spathulatum	Globally ranked uncommon throughout its range and provincially ranked very rare.
Wahlenberg's Wood-rush	Luzula wahlenbergii	Globally ranked widespread, abundant, apparently secure throughout its range, and provincially ranked rare.
White Beakrush	Rhynchospora alba	Globally ranked demonstrably widespread, abundant and secure throughout its range and provincially ranked uncommon but status is uncertain.
Boreal Woodland Caribou	Rangifer tarandus caribou	Globally ranked demonstrably widespread, abundant, secure throughout its range while its subspecies is widespread, abundant, and apparently secure throughout its range, provincially ranked widespread, abundant, and apparently secure.
Shortjaw Cisco	Coregonus zenithicus	Globally ranked uncommon throughout its range and provincially ranked uncommon.

Source: Manitoba Conservation, 2012a

Of the 20 species listed as species of special concern by the Manitoba CDC (**Table 4.2**), six are protected species. Protected species are species that are endangered, threatened or are of special interest as defined by either Federal or Provincial legislation. In the Province of Manitoba, endangered, threatened or special interest species are protected by the *Manitoba Endangered Species Act* (*MESA*), which may have species that overlap with the federal *Species at Risk Act* (*SARA*). The protected species in the Churchill River Upland Ecoregion is included in **Table 4.3**.

Table – 4.3: List of Protected Species within the Churchill River Upland Ecoregion

Common Name	Scientific Name	SARA Status	MESA Status
Boreal Woodland Caribou	Rangifer tarandus caribou	Threatened	Threatened
Flooded Jellyskin	Leptogium rivulare	Threatened	Not Ranked
Monarch	Danaus plexippus	Special Concern	Not Ranked
Northern Leopard Frog	Lithobates pipiens	Special Concern	Not Ranked
Shortjaw Cisco	Coregonus zenithicus	Threatened	Not Ranked
Yellow Rail	Coturnicops noveboracensis	Special Concern	Not Ranked

Source: Manitoba Conservation, 2011a and Government of Canada, 2011

According to Manitoba Conservation Fact Sheets, Manitoba recognizes three varieties of caribou: Coastal, Barren-ground and Boreal Woodland. The Boreal Woodland Caribou was designated as threatened under *The Endangered Species Act* in June 2006 (Manitoba Conservation, 2011a). The Reed herd is the closest herd to the Project Region (Manitoba Conservation, 2005), whose range is located west of the Project Region. In the federal recovery strategy plan, Environment Canada identifies 51 known ranges of Woodland Boreal Caribou in Canada (Environment Canada, 2012b). One of the ranges, Manitoba North, overlaps with the Project Region but is identified as a conservation unit, reflecting the low level of certainty regarding the boundaries of the range. Although the Project Area contains potentially suitable habitat for Boreal Woodland Caribou, there are no known herds whose range overlaps with the Project Area.

The extent of the recently discovered population of Flooded Jellyskin near Flin Flon, Manitoba is not known. This lichen was found in Peyuk Lake, 30km east of Flin Flon and 93km west-south-west from the Lalor site (COSEWIC, 2004). This is also the northern-most occurrence of this species. There is no overlap with this species' range with the Project Region.

The range of the Monarch butterfly can extend to the 54º Latitude in the Prairie Provinces. However, the bulk of their occurrences are south of the 50º Latitude. Recorded occurrences are limited to Thompson, The Pas and Grand Rapids, however, these are generally considered vagrants (COSEWIC, 2010). The Project Region falls within the limits of the species' distribution; however no monarch butterfly were spotted during the terrestrial investigations.

The range of the Northern Leopard Frog does overlap with the Project Region and none were spotted during the terrestrial investigations.

According to the COSEWIC status report, occurrences of Shortjaw Cisco in Manitoba include (distance and direction from Lalor site in parenthesis): Athapapushkow Lake (104km WSW), Clearwater Lake (106km SW), Reindeer Lake (288km NW), George Lake (603km SE), Lake Winnipeg (409km SE), and Lake Winnipegosis (306km S) (COSEWIC, 2003). There have been no reported occurrences in the Grass River sub-basin in the Nelson River Basin, within which the Lalor site resides.

The known distribution of the Yellow Rail in Manitoba is scattered in locations south of the Boreal Shield Ecozone and is concentrated in the Boreal Plains and Aspen Parkland portions of the Prairie Ecozone (COSEWIC, 2009). There is potential for them to occur in the Ecozone, but there are no known occurrences of Yellow Rail within the Project Region.

As confirmed through field observations conducted in 2007, 2010, 2011 and 2012, the wildlife habitats within the Project Area were considered typical for the region, with no unique or rare habitats encountered. No protected species were observed during the terrestrial baseline surveys conducted by AECOM in the area.

4.4 Migratory Birds

This type of habitat at the Lalor site is manly edge habitat where the developed AEP site is boarderd by the mature forest and open wetland areas. The area surrounding the site is classified as bog and floating bog, which has very low value for migratory waterfowl nesting. Open water lakes such as Lalor Lake and Chisel Lake provide some nesting habitat in shoreline areas, and brood water along the shoreline of lakes. A survey of area surrounding the Anderson TIA recorded four species of ducks, mergansers, loons, grebes, geese and two species of gull. Nesting and brooding of these species is largely confined to the major lakes in the Project Area. The immediate site of the Lalor site and the surrounding Black Spruce bog offer little value for waterfowl at any stage of nesting and brooding.

The drainages that cross under the Lalor Access Road offer potential brooding areas for waterfowl. However, suitable brood water must be located reasonably close to nesting sites. Common Goldeneye (*Bucephala clangula*) are tree nesters that make use of boreal areas. They would be the most likely species making use of the drainages in the Project Area. However, previous terrestrial surveys conducted by AECOM have not observed Common Goldeneye. This species prefers larger trees, available in mixed upland woods around the margins of the larger lakes in the Project Area. Mixed upland woods in this area are isolated by the large Black Spruce bogs, making them unattractive to this species since there are no nearby waterbodies offering suitable brood areas for young ducks.

Mallards (*Anas platyrhynchos*) are ubiquitous across western Canada and will nest in all available habitats. They prefer ground nesting in heavy cover but will also nest in shrubs and trees on rare occasions. Mallards prefer marshy areas on the margins of lakes and are most likely to nest in the major lakes in the Project Area. No Mallards were seen in the vicinity of the Lalor site during the previous terrestrial environmental surveys. One Mallard was seen on Anderson TIA in June 2012.

Canada Geese (*Branta canadensis*) are also boreal nesters, and one was seen on Anderson TIA in June 2012. Geese do not nest in trees, preferring large accumulations of reeds and grass. They have been known to nest on beaver lodges. The dense boreal forest cover in the Project Region is not suitable goose nesting habitat. The margins of the larger lakes in the region could be potential goose nesting and brooding habitat.

Loons, mergansers and grebes are strictly over-water nesters and require large open wetlands or lake margins. The dense nature of the Black Spruce bog around the Lalor site does not present nesting habitat appropriate for waterfowl. The most common nesting habitat in the Project Region is the marshy edges of major lakes, and the mixed upland woods common around the margin of these lakes.

4.5 Terrain Analysis

4.5.1 Terrain Units

A review of existing reports and documents was conducted to determine what soil types would likely underlay different vegetative areas and the geologic processes that would contribute to soil formation. The vegetation cover types present in the general Project Area were identified using the digital provincial forest inventory map (**Drawing - 04**). This Geographical Information System (GIS) data was used to correlate the terrain units documented in the existing reports with vegetation types to extrapolate the probable soil units of the area. A terrain map based on this analysis has been provided as **Drawing - 05**.

The analysis determined the following terrain units:

Till (T)
The till unit in the areas are generally thin and discontinuous sandy loam to loamy sand. Varying quantities of gravel to stone sized coarse fragments are contained within the matrix. The till is generally derived from Precambrian bedrock and is neutral to moderately acidic. Deeper deposits are found on the lee side of bedrock outcrops and in bedrock depressions. Vegetation is a mix of Jack Pine, Black Spruce and some White Birch or Trembling Leaf Aspen. The Trembling Leaf Aspen areas tend to occur in the better-drained areas, due primarily to increased slope, while the spruce areas occur in the low-lying areas where drainage is more limited. Calcareous clay textured lacustrine sediments are found in areas of shallower slope and are indicated by areas of black spruce mixed with Jack Pine and Trembling Leaf Aspen. Most lacustrine deposits occur as pockets and blankets of limited extent. Extensive areas can be found east of Lalor Lake. Isolated willow groves and fields/meadows occur in this unit as well. The fields and meadows are primarily caused by anthropomorphic or recent fire action and the willow area occurs in areas that are less well drained or where the water table is high.

Till over Rock (T/R)
The till over rock unit occurs primarily on the crests of hills where local relief has reduced the thickness of the till overburden to typically less than 1 m. Bedrock is frequently exposed as outcrop, typically over more than 50% of the area. Vegetation cover is predominately Jack Pine due to fire history and widespread, shallow, coarse textured soils with little water holding capacity. Black spruce can become dominant if there is no history of fire or depressions where deposits are deeper.

Organics (O)
The organics unit consists primarily of areas of peat. The peat is generally moderately well decomposed with a slightly decomposed surface peat. Most are a layered mixture of peats formed in fen, swamp, and bog environments. Most peatlands in the area may have started as fens and later evolved into treed fens, swamps, or bogs. These areas usually occur in the low-lying areas and valley bottoms where drainage is restricted. Thickness of organics can be significant.

Organics over Till (O/T)
The organics over till unit consists primarily of areas of treed muskeg. These areas usually occur in the low-lying areas or valley bottoms where drainage is restricted and accumulation of organic matter over the lacustrine deposits and tills has occurred. Thickness of organics can be significant.

Organics (peat) over Water (O/W)
The organics over water unit consists primarily of bogs and fens where the drainage is poor enough to allow open water to cover a portion of the area or where an O/T unit is bounded by water from a large water body.

Water (W)

The water unit consists primarily of open water areas either natural or otherwise. Included in these areas are beaver floods and small lakes within O/W units (*i.e.*, marshes and fens).

Unclassified (U)

The unclassified unit consists primarily of area that have been modified by anthropogenic activities, which have either removed the original vegetation cover or modified the ground surface to make terrain analysis difficult. Underlying surficial geology can be identified by inference by extrapolating from the surrounding unmodified terrain units. Included in these areas are power lines, urban development, roads, and other area clearing activities.

5. Aquatic Environment

5.1 Hydrology

5.1.1 Regional Hydrology

The Reed Lake Ecodistrict lies within the glacial Lake Agassiz basin and is part of the Nelson River drainage system. The region drains generally eastward through medium sized lakes and an irregular bedrock-controlled network of streams to Wekusko Lake that are all part of the Grass River watershed (Smith, *et al.*, 1998).

5.1.2 Project Area Hydrology

The Project Area hydrology covers a number of localized, and two more regional, watersheds (**Drawing - 06**). The proposed Lalor Concentrator site is located within the Snow Lake local watershed. Lalor Lake is a small headwater lake 200 m west of the proposed Lalor Concentrator site, which drains north into Maw Lake, Varnson Lake, and Squall Lake. Squall Lake then drains south via Snow Creek and eventually into the Snow Lake Narrows, which makes up the west arm of Snow Lake. Snow Lake also receives water from the south via Tern Creek and Tern Lake. Tern Creek is the drainage for two medium sized lakes, Ghost Lake and Threehouse Lake. Both waterbodies are connected to Tern Creek via artificial drainage channels, as is Tern Ditch Pond, an intermittent waterbody that is an intermittent drainage feature for the wetlands to the southeast of the Lalor Site. The water level in Tern Ditch Pond has become more stable due to drainage channels connecting to and from the pond. Most of the small lakes along the former rail bed (Arm Lake and Gaspard Lake) have no defined drainage features and watershed mapping suggests they are contributing to Snow Lake.

Wekusko Lake is also the downstream receptor for the Snow Lake watershed, through Snow Creek. Anderson Creek and Stall Creek join before draining into Anderson Bay in Wekusko Lake directly, separate from the Snow Lake drainage (**Drawing - 06**).

To the west of the proposed Lalor Concentrator, a watershed divide exists and lakes to the west generally drain south through lakes such as Cook Lake and Chisel Lake to Reed Lake then Tramping Lake before draining into Wekusko Lake.

Because of varying topography created by hummocky bedrock surfaces, the drainage conditions vary considerably over short distances. Regionally the terrain falls at about 0.6 m to 1.0 m per km. Locally, runoff from bedrock and upland areas collects in peat-filled lows (bogs), which slowly release excess water to surrounding lakes and creeks. Groundwater tables are high in most bogs and in low areas bordering the bogs (Smith, *et al.*, 1998). Similar to much of the Boreal Shield Ecozone, contiguous and isolated bogs cover between 20% and 40% of the Lalor Lake area. Bogs are widespread and stagnant in the region.

5.2 Aquatic Field Surveys

AECOM conducted an aquatic survey to establish baseline conditions in waterbodies surrounding the proposed Concentrator site, access road and pipeline alignment corridors. A number of aquatic components were included to establish baseline conditions, including water and sediment chemistry, lower trophic level (*i.e.*, phytoplankton, zooplankton and benthic invertebrates) community structure, fish community structure and fish habitat (**Table 5.1**). Waterbodies were selected based on their proximity to the potential effects of the proposed Lalor Concentrator and associated tailings and freshwater lines (**Drawing - 02**):

Table – 5.1: Aquatic Baseline Surveys Conducted in Project Area in 2011 and 2012

Waterbody	Bathymetry	Water & Sediment Quality			Aquatic Invertebrates		Fish Community & Health		
	Spring 2011	Spring 2011	Fall 2011	Summer 2012	Spring 2011	Fall 2011	Spring 2011	Fall 2011	Summer 2012
Anderson Bay (in Wekusko Lake)	X	X	X		ZP, PP	ZP, PP, BIC	X	X	X**
Arm Lake	X	X	X		ZP, PP	ZP, PP, BIC	X		
Gaspard Lake	X	X	X		ZP, PP	ZP, PP, BIC	X		
Ghost Lake	X	X	X		ZP, PP	ZP, PP, BIC	X		X**
Goose Bay (in Wekusko Lake)								X	X**
Nutt Lake	X	X	X		ZP, PP	ZP, PP, BIC	X		
Snow Lake		X*	X*						
Threehouse Lake	X	X	X		ZP, PP	ZP, PP, BIC	X		
Unnamed Lake 1	X	X	X		ZP, PP	ZP, PP, BIC	X		
Anderson Creek		X	X	X	ZP, PP	BIC	X		
Ghost Creek		X	X		ZP, PP	BIC	X		
Stall Creek		X	X		ZP, PP	ZP, PP, BIC	X		
Tern Ditch		X	X		ZP, PP	BIC			
Threehouse Creek		X	X		ZP, PP	BIC	X		X**
Unnamed Creek 1		X	X		ZP, PP	BIC	X		

Notes:
** = Sediment samples were not collected from Snow Lake (only water samples). ** = Fish were submitted for whole-body metals analysis.*
ZP = zooplankton; PP = phytoplankton; BIC = benthic invertebrate community.

AECOM sampled sites in both spring and fall in order to quantify any seasonal differences in terms of water and sediment chemistry. Samples for phytoplankton and zooplankton community analysis were collected in both spring and fall for all lakes (except Goose Bay in Wekusko Lake) and Stall Creek and only in spring for all other creeks. Benthic invertebrate samples were collected from all waterbodies (except Goose Bay in Wekusko Lake) in only the fall 2011 program. Fishing effort was attempted in all waterbodies in the spring and was attempted only in fall 2011 for Anderson Bay and Goose Bay, both in Wekusko Lake. Fishing effort was attempted in Goose Bay, in order to provide a comparison waterbody for Anderson Bay. In 2012, fishing effort was conducted in four waterbodies and fish were submitted for whole-body analysis of metals.

5.3 Lake Bathymetry

Bathymetric surveys were performed on the following lakes during the 2011 field program (**Drawing - 07 to 13**):

- Anderson Bay (in Wekusko Lake)
- Arm Lake
- Gaspard Lake
- Ghost Lake
- Nutt Lake
- Threehouse Lake
- Unnamed Lake 1

AECOM field staff conducted the bathymetric surveys using a boat with motor and a chart plotting sonar attachment, which was used to log position and depth to bottom. The chart plotter utilizes a built in Global Positioning System (GPS) to allow a significant number of points to be collected with both horizontal position (3 m to 5 m accuracy) and depth (0.1 m accuracy) collected simultaneously and automatically. The sonar was set to collect a data point every 10 m to allow an even collection of points independent of the speed of the boat or the track taken. The survey was conducted by first travelling near to the shore to delineate the near shore depth and then infilling the resulting perimeter shots with a series of tracks to cover the reminder of the lake. This allowed a collection many points to aid in modelling the lake bottom surface.

Anderson Bay had the greatest maximum depth (5.3 m) and Unnamed Lake 1 had the shallowest maximum depth (1.2 m) (**Table 5.2**). Of the lakes along the former rail bed, Threehouse Lake had the largest volume, area, and relatively homogenous bottom topography with a low average grade. Bottom topography in Unnamed Lake 1 was somewhat heterogeneous, with the highest average grade among all waterbodies included in the bathymetric surveys (**Table 5.2**).

Table – 5.2: Summary of Bathymetric Surveys, 2011

Waterbody	Year Assessed	Maximum Depth (m)	Average Depth (m)	Area (m^2)	Volume (m^3)	Average Grade (%)
Anderson Bay (in Wekusko Lake)	2011	5.3	2.3	1,106,100	2,583,400	1.7
Arm Lake	2011	1.3	0.8	127,800	107,100	2.2
Gaspard Lake	2011	1.6	1.1	88,000	93,700	2.3
Ghost Lake	2011	4.4	1.6	607,100	967,700	2.6
Nutt Lake	2011	1.4	0.9	63,000	59,600	2.5
Threehouse Lake	2011	2.8	1.3	1,065,400	1,401,200	1.5
Unnamed Lake 1	2011	1.2	0.8	22,800	19,200	3.1

Notes: m = metre.

Most lakes mapped in the study (Arm Lake, Gaspard Lake, Nutt Lake, and Unnamed Lake 1) show typical headwater lake bathymetry, *i.e.*, steep slopes near shore, an immediate transition to gentle slopes, and shallow depth. Ghost Lake and Threehouse Lake have a more complicated bottom with island and reef structures, but their relatively shallow average depth for their surface area (**Table 5.2**) is more typical of a headwater lake, despite their larger than average size. Anderson Bay, located in Wekusko Lake, has the most complex bathymetry of all the waterbodies surveyed. Anderson Bay has numerous islands and reef structures, a steep rocky eastern shore, a gentle shallow western shore, and estuary like features at the northern end where the combined Anderson Creek and Stall Creek discharge into Wekusko Lake.

5.4 Aquatic Methodology

The following sections provide detailed descriptions of methods related to field sampling, laboratory analysis, and data analysis. AECOM accessed sampling sites by boat, road, or helicopter. Using a hand-held Garmin GPSmap 76CSx unit sampling site locations as Universal Transverse Mercator (UTM) Zone 14U NAD83 coordinates were recorded.

5.4.1 Water Quality

The objective of the water quality sampling program was to collect *in situ* measurements and submit water samples for analysis from sites in the proposed Lalor Concentrator area to describe baseline water quality in several waterbodies in the Project Area (**Drawing - 07 to 21**).

In situ water quality parameters, including pH, temperature, specific conductance, turbidity, dissolved oxygen, and total dissolved solids were measured using a Horiba U-53 Multi-Parameter Unit. AECOM recorded weather, Secchi disk depth, qualitative descriptions of the site and UTM coordinates at each sampling site.

Field crews collected water samples for analysis from the surface at nearly all sites, by directly submerging the water bottles. Some sampling sites in Anderson Bay and Snow Lake were deep enough to collect a mid-depth water sample using a Kemmerer water sampler. Field crews immediately added preservatives, if required, to the sample and mixed. For analysis of dissolved mercury and metals, the majority of samples were not filtered in the field (filtering and preservation was done at the analytical laboratory upon receipt of the samples). Field crews kept samples cool and out of direct exposure to the sun. Samples were shipped to ALS Laboratory Group in Winnipeg within the specified 48 hour (minimum) holding time for analysis of the following parameters:

- Routine parameters (*e.g*., physical and nutrients).
- Major ions (*i.e*., chloride, sulphate, bromide and silicate).
- Total and dissolved metals by inductively coupled-mass spectrometry (ICP-MS).
- Total and dissolved mercury by cold-vapour atomic fluorescence spectrometry.
- Biological (*i.e.,* chlorophyll *a* and pheophytin *a*).

AECOM compared the water chemistry data to national guidelines for various water quality parameters: the Canadian Council of Ministers of the Environment (CCME) *Canadian Water Quality Guidelines* (*CWQG*) for the protection of aquatic life (CCME, 2011a) and the *Manitoba Water Quality Standards, Objectives and Guidelines* Tier II Objectives for chronic exposure (*MWQSOG*, Williamson, 2011). In addition, we described the trophic status of each waterbody using the categories based on total phosphorus concentrations as developed by CCME (2004) (**Table 5.3**):

Table – 5.3: Trophic Categories for Freshwater Aquatic Ecosystems Based on Total Phosphorus (mg/L) Concentrations (CCME, 2004)

Trophic Status	Total Phosphorus (mg/L)
Ultra-Oligotrophic	<0.004
Oligotrophic	0.004 – 0.01
Mesotrophic	0.01 – 0.02
Meso-eutrophic	0.02 – 0.035
Eutrophic	0.035 – 0.10
Hyper-eutrophic	>0.10

AECOM performed statistical analysis with Systat 11.00.01 (Systat Software, Inc. San Jose California). Values below detection limits were assigned values equal to one-half the detection limit (DL) for the calculation of mean values and other statistical tests. Where >50% of the samples in a group (*e.g.*, a specific site) were below detection, the mean was stated as <DL and the site was excluded from more robust tests (*i.e.*, Analysis of Variance; ANOVA). Elements that were below detection in a large proportion of samples were removed prior to any statistical analysis.

Concentration data in environmental surveys (*e.g.*, surface water, soils, biota) are usually log-normally distributed and geometric means (with geometric standard deviations; GSD) are the standard method to report site-specific concentrations of elements and contaminants of concern. Health Canada (2004) recommends that summaries of surveys that may be used for risk assessment purposes report minimum, maximum, and arithmetic averages with the number of samples analysed. Data is reported as arithmetic means in this report in compliance with this recommendation, however, where appropriate, concentration data will be log-transformed prior to statistical tests to retain normality of the data.

The Water Quality Index (WQI) is a tool developed by the CCME to summarise the results of measured concentrations of chemicals of concern from a waterbody (CCME, 2001a; CCME, 2001b). Factors such as the number of compounds that exceed a guideline, the number of times they exceed (frequency), and the amount by which they exceed (amplitude) are combined to give a single value. The WQI is a general indicator of water quality, where lower values indicate a higher probability of ecological effects. Water quality is ranked, based on the WQI, into one of five categories:

- **Excellent (>95):** Absence of threat or impairment; close to natural or pristine conditions; nearly all measurements are below guideline values.

- **Good (80-94):** Only minor degree of threat or impairment; conditions rarely depart from natural conditions.

- **Fair (65-79):** Occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.

- **Marginal (45-64):** Frequently threatened or impaired; conditions often depart from natural or desirable levels.

- **Poor (<44):** Almost always threatened or impaired; conditions usually depart from natural or desirable levels.

5.4.2 Sediment Quality

AECOM collected samples of surficial sediments using a Petit Ponar or Ekman dredge (sampling area of 0.0232 m^2) to establish baseline sediment quality conditions in several waterbodies in the Project Area. Field crews retrieved acceptable grab samples to the surface and decanted water from the sampler. Field crews homogenized the entire grab and filled sediment jars directly, leaving as little headspace as possible. Sampling equipment was rinsed prior to and following sampling at each site with ambient water. Sediment jars were kept cool, out of direct sun, and submitted to ALS Laboratory Group in Winnipeg for analysis of the following parameters:

- Total metals by ICP-MS.
- Total mercury by cold vapour techniques.
- Nutrients (*i.e.*, phosphorus, nitrogen and total organic carbon).
- Moisture.
- Particle size by pipette method.

At each sampling site, field crews collected three sediment replicates equally spaced 10 m to 20 m apart and recorded qualitative descriptions of the sediments (*i.e.*, colour, odour, and composition), water depth, and UTM coordinates for each sediment replicate.

Baseline sediment quality data was compared to the CCME *Canadian Soil Quality Guidelines* for the Protection of Environmental and Human Health for Residential/Parkland land use (*CSQG-RP*; CCME, 2011b) and the *MWQSOG Interim Sediment Quality Guidelines* (*ISQG*) and *Probable Effect Level* (*PEL*) (Williamson, 2011).

AECOM performed statistical analysis on sediment replicate data using Systat 11.00.01 (Systat Software, Inc. San Jose California). Statistical analysis involved analyzing the variability between sampling dates and replicates at each location and reporting mean concentrations where appropriate. The sampling program, with three replicates collected at one or more stations allows the analysis of within- and between- sampling sites and allows for the definition of trends that will influence assessment of the sites.

Values below detection limits were assigned values equal to one-half DL for the calculation of mean values and other statistical tests. Where >50% of the samples in a group (*e.g.*, a station) were below detection, the mean was stated as <DL and the site was excluded from more robust tests (*i.e.*, ANOVA). Elements that were below detection in a large proportion of samples were removed prior to any statistical analysis. Individual waterbodies were selected (*e.g.*, Anderson Bay) to illustrate environmental trends that may affect site-specific assessments.

Chemical concentration data in environmental surveys (*e.g.*, surface water, soils, biota) are usually log-normally distributed and geometric means (with GSD) are the standard method to report site-specific concentrations of elements and contaminants of concern. Health Canada (2004) recommends that summaries of surveys that may be used for risk assessment purposes report minimum, maximum, and arithmetic averages with the number of samples analysed. This report presents data as arithmetic means in compliance with this recommendation, however, where appropriate, chemical concentration data will be log-transformed prior to statistical tests to retain normality of the data.

The Sediment Quality Index (SQI) is a tool developed by the CCME to summarise the results of measured concentrations of chemicals of concern from a waterbody (CCME, 2001a). Factors such as the number of compounds that exceed a guideline, the number of times they exceed (frequency), and the amount by which they exceed (amplitude) are combined to give a single value. The SQI is a general indicator of sediment quality, where lower values indicate a higher probability of ecological effects and is modelled after the equations developed for the WQI (CCME, 2001a). The same ranking system, as applied to the baseline WQI values was used to characterize baseline SQI values.

5.4.3 Phytoplankton

AECOM retrieved phytoplankton samples by directly filled sample bottles (provided by the analytical laboratory) at approximately 0.3 m below the water surface in conjunction with water quality sampling. In spring 2011, field crews collected a sample from all waterbodies (except Goose Bay in Wekusko Lake). In fall 2011, field crews collected samples from only the lakes. The field crews preserved each sample with sufficient quantities of Lugol’s solution to form a tea-coloured solution and submitted to ALS Laboratory Group in Winnipeg for analysis of biomass and taxonomic identification.

5.4.4 Zooplankton

AECOM retrieved zooplankton in conjunction with phytoplankton sampling. In spring 2011, zooplankton samples were collected using a 0.48 m long, 63 µm mesh size conical net with a weighted PVC cod-end and an opening diameter of 0.18 m. In fall 2011, zooplankton samples were collected using a 0.90 m long, 63 µm mesh size conical net with a weighted cod-end and an opening diameter of 0.30 m. For both seasons in 2011, field crews performed a horizontal tow, whereby the net is lowered into the water and pulled horizontally two lengths of 3 m. Upon retrieval, field crews washed captured zooplankton into the sample jar, fixed with 70% ethanol, and shipped to ALS Laboratory Group in Winnipeg for analysis of biomass and taxonomic identification. Sampling equipment was rinsed prior to and following sampling at each site with ambient water.

AECOM estimated the abundance of each taxon per tow by calculating the number of individuals per litre of water (n/L). The volume of water filtered by is calculated multiplying the net mouth area (0.025 m^2 or 0.071 m^2) by the distance of the horizontal tow.

5.4.5 Benthic Invertebrate Community

AECOM collected benthic samples to characterize the benthic invertebrate community (BIC) only in fall 2011, with sample locations corresponding with sediment quality replicate sites. At each replicate station, two samples of surficial sediments were collected using an Ekman dredge or Petit Ponar (sampling area of 0.0232 m^2), depending on substrate. Field crews submitted the first replicate for metals analysis and the second (taken from the other side of the boat to ensure the grab was from undisturbed sediments) for BIC identification and enumeration. Acceptable grab samples were retrieved to the surface and decanted water from the sampler. Grab samples were deposited in a 500 µm sieve bucket to remove fine materials. The Ekman and Petit Ponar samplers were triple-rinsed with ambient water between replicates. Field crews labelled and preserved the sediment jars with 70% ethanol and submitted the first replicate for benthic invertebrate taxonomic identification and enumeration.

Benthic habitat was characterized in the field using descriptions of colour, odour, substrate type (*e.g.*, fines or organics), and presence of aquatic vegetation. The BIC descriptors that were calculated and reported were recommended by Environment Canada (2002) and include total invertebrate diversity; taxon (family) richness, evenness, Simpson's Diversity Index (SDI), and Bray-Curtis Index (BCI). Total invertebrate diversity is the total number of individuals of all taxonomic categories collected at the station expressed per unit area (*i.e.*, n/m^2). Taxon (family) richness is the total number of families collected at the station. Individuals that were not identified at the family level were included from calculations of BIC descriptors only if there were no other families identified in the order.

Evenness is a measure of the distribution of organisms among identified taxa. A more even distribution indicates a stable community that is not dominated by one particular taxon. The Evenness values are lower when communities are less balanced (*i.e.,* dominated by few taxa). Evenness is calculated for each station, as below:

$$E = 1 / \Sigma (p_i)^2 / S$$

Where:

E = Evenness
p_i = proportion of the i^{th} taxon at the station
S = number of taxa at the station

The SDI expresses both abundance patterns and taxonomic richness by determining for each taxonomic group at a station, the proportion of individuals that it contributes to the total in the station. Higher SDI values are associated with more diverse communities. SDI is calculated for each station, as below:

$$SDI = 1 - \Sigma (p_i)^2$$

Where:

SDI = Simpson's Diversity Index
p_i = proportion of the i^{th} taxon at the station

The BCI is a measure of dissimilarity between two sites, where a maximum value of 1 for two (2) sites indicates different communities and a minimum value of 0 for two (2) sites indicates identical communities. BIC descriptors such as taxon diversity, taxon richness, evenness and SDI were calculated for all lakes and creeks sampled in 2011. The BIC descriptors were compared among all lakes and among all creeks to identify the lake or creek with median values for the majority of BIC descriptors. For the purposed of calculating BCI, the median lake or creek was used as the "reference" waterbody, where all other waterbodies were compared to it. Arm Lake was selected as the “reference” lake and Ghost Creek was selected as the “reference” creek. The BCI is calculated for each station, relative to the appropriate “reference” waterbody, as below:

$$BCI = \frac{\Sigma \mid Y_{i1} - Y_{i2} \mid}{\Sigma (Y_{i1} + Y_{i2})}$$

Where:

BCI= Bray-Curtis Index
Y_{i1} = count for species i at station 1
Y_{i2} = count for species i at station 2

Additional descriptors that were calculated to describe the benthic invertebrate community include: percentage of Ephemeroptera, Plecoptera and Tricoptera (% EPT) and percentage of unidentified organisms (% unid). The EPT orders contain taxa considered to be the least tolerant of environmental stress or pollutants and their presence can be an indication of habitat health or quality.

5.4.6 Fish Community

Field crews conducted a comprehensive fish study in waterbodies located within the area, using several types of sampling gear, including:

- Small gang gill nets: three 10 m long by 1.8 m deep panels of 13 mm, 19 mm, and 25 mm twisted nylon stretched mesh.
- Standard gang index gill nets: six 22.9 m long by 1.8 m deep panels of 38 mm, 51 mm, 76 mm, 89 mm, 102 mm, and 127 mm twisted nylon stretched mesh.
- Smith-Root LR-24 Backpack Electrofisher.
- Baited Gee minnow traps.

Fish were collected under Scientific Collection Permit Numbers 24-11 and 40-12 issued by the Manitoba Water Stewardship Aquatic Ecosystem Section. AECOM characterized fish habitat along with UTM coordinates, water depth, depth of sampling gear and limnological parameters. Field crews identified captured fish to species and enumerated, measured, and weighed them and retained a small sub-sample of forage fish species for taxonomic verification in the laboratory at AECOM.

To standardize the effort expended for each fish species, AECOM calculated catch-per-unit-effort (CPUE). The CPUE for gill nets (panels calculated individually) and minnow traps were calculated as number of fish per hour. CPUE for the backpack electrofisher was calculated as number of fish per second.

Condition factor (K) was calculated for individual fish as follows (Environment Canada, 2002):

$$K = 100 * (W/L^3)$$

Where:

K = Condition factor
W = weight (g)
L = fork length (mm)

In addition to CPUE calculations, summary statistics (*i.e.*, mean, standard deviation, minimum and maximum) of length, weight, and K of captured fish were calculated. All captured fish were identified to species, enumerated, measured, and weighed. External and internal abnormalities (*e.g.,* deformities, fin erosion, lesions and parasites) were noted if present. Sex and maturity were recorded for fish submitted for metals analysis.

The least squares regression analysis on $\log_{10}$ transformed lengths and weights as follows:

$$\text{Log}_{10} W = b*(\text{Log}_{10} L) + a$$

Where:

W = weight (g)
L = fork length (mm)
a = Y-intercept
b = slope of the regression line

Fishing effort was expended in Goose Bay, located south of Anderson Bay in Wekusko Lake, in order to compare fish community composition and meristics of large-bodied fish from Anderson Bay.

Water depths and habitat characteristics such as cover types and substrates were documented at all fishing efforts during the 2011 surveys.

5.4.7 Metal Residues in Fish

Fish were collected in 2012 from Ghost Lake, Threehouse Creek, Anderson Bay (in Wekusko Lake) and Goose Bay (in Wekusko Lake). Samples were submitted to ALS Laboratory Group in Winnipeg for analysis of total metals and moisture.

Results are presented as wet weights (w.w.). The analytical detection limits varied between samples for the same parameter due to matrix interferences. Laboratory tissue requirements necessitated submission of whole fish, rather than separate samples of liver and muscle for metals analysis.

Metal residues of whole-body forage fish were compared to *MWSQOG* aquatic life tissue residue guidelines for human consumption (Willamson, 2011). The applicable guidelines include arsenic (3.5 mg/kg) and lead (0.5 mg/kg).

5.4.8 Aquatic Habitat Assessments

Aquatic habitat assessments were completed at the location of the Lalor site, along the pipeline system, at the Snow Lake pumphouse, Lalor Access Road, along PR 395 between the Lalor Access Road and the former rail bed, the proposed alignment for the relocation of PR 392, and the Manitoba Hydro power line corridor. **Drawing - 25** identifies all aquatic habitat assessment locations.

Aquatic habitat assessments were conducted in June 2011, September 2011, October 2011, and June 2012.

Sites were selected based on the presence of culverts, large areas of standing water, or identified drainage features on NTS maps. Crossings were named sequentially according to the alignment on which they were accessed (*e.g.*, Lalor Access Road = LR, former rail bed = RB, Manitoba Hydro power line corridor = PL, PR 392 crossing = HWYAN; former Anderson Mine roads = AD). General aquatic habitat observations, measurements, and culvert conditions were recorded at each crossing.

Habitat indicators, including *physical habitat variables* (depth, flow, cover, etc.), *connectivity* to fish bearing waters and *water quality* (pH, dissolved oxygen) were considered in the evaluation for fish habitat following guidance in Fisheries and Oceans Canada (1998). Watercourses provided **Critical**, **Important**, **Marginal** or **No Fish Habitat** as follows:

Critical Habitats are rare or unique habitats that support a life stage that is limited to the recruitment of a species, or to the overall productive capacity of a fishery.

Important Habitats are those that provide habitat for one or more life stages of one or more fish species, but are not immediately limiting to the fisheries they support. As described by Fisheries and Oceans Canada (1998), important habitats include abundant habitat types that are readily available to the local stock. Habitats designated as important may include:

- Habitats in close enough proximity to large, fish-bearing waters, without major barriers to fish passage between habitats.
- Open-water watercourses with cross-sectional areas large enough to carry flows substantively greater than those in the flooded peat fens surrounding them. These watercourses were deemed to have water volumes sufficient to overcome some of the habitat limitations inherent in the smaller headwater fen habitats, although limitations to fish passage were often present in the form of beaver dams.
- Waterbodies that were bordered by vegetated floodplain composed of grasses or other vegetation over mineral soils (as opposed to saturated fen). These habitats were considered to provide potential spawning habitat for Northern Pike.
- Habitats that provided rock substrate. Coarse, hard substrata, generally present only in the larger streams along the pipeline system, provide habitat diversity and possible spawning habitat for species requiring riffle habitats for spawning.

Marginal Habitats as described by Fisheries and Oceans Canada (1998) have low productive capacity and contribute marginally to fish production. An example is a headwater beaver-pond or fen habitats that have severe limitations to their productivity as fish habitat, and support only a small number of forage species that likely contribute little to the sport and commercial fisheries in the area.

No Fish Habitat is fish habitat that does not provide one or more of the habitat indictors mentioned above. Such as, habitats that clearly have no fish-passable connection to other open-water habitats, are too shallow to resist freezing solid in winter and have dissolved oxygen concentrations less than approximately 2 mg/L. These habitats include small, isolated pools less than approximately one metre deep, with minimal flow and no beaver lodges present to indicate greater depths.

5.5 Aquatic Results

5.5.1 Water Quality

A total of 63 water samples were collected from 32 stations in 14 waterbodies in the Project Area in 2011 and 2012 (**Appendix B, Table - 01**):

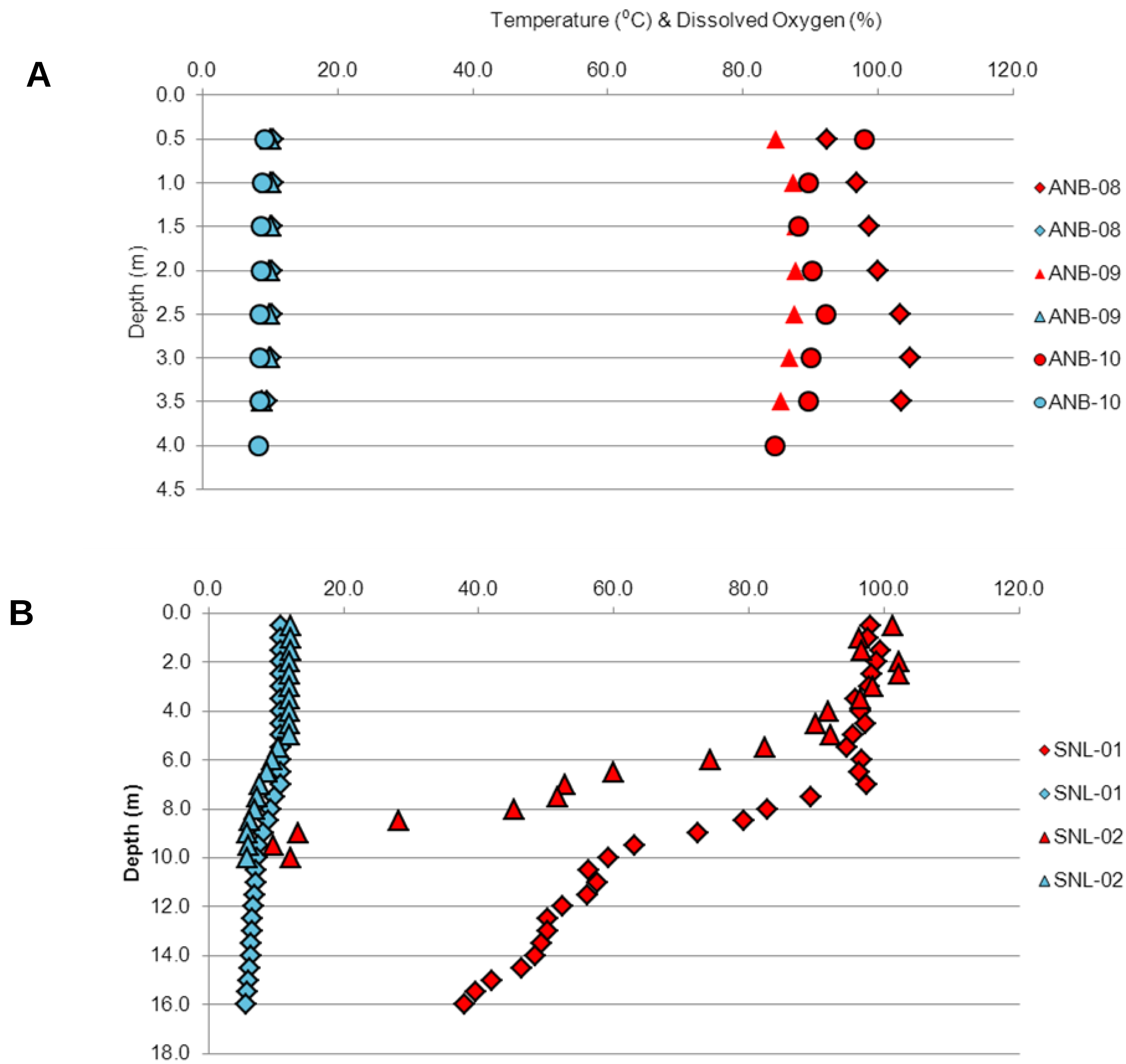
- Ten sites in Anderson Bay (in Wekusko Lake)
- One site in Arm Lake
- One site in Gaspard Lake
- Three sites in Ghost Lake
- One site in Nutt Lake
- Two sites in Snow Lake
- Three sites in Threehouse Lake
- One site in Unnamed Lake 1
- Three sites in Anderson Creek
- One site in Ghost Creek
- Three sites in Stall Creek
- One site in Tern Ditch
- One site in Threehouse Creek
- One site in Unnamed Creek 1

Waterbodies ranged from Ghost Lake in the west to Anderson Bay of Wekusko Lake in the east and included several streams draining the lakes (**Drawing - 02**). Water samples were analysed for a broad range of physical and chemical characteristics, including 34 chemicals of potential concern.

Waterbodies sampled during the aquatic surveys were generally alkaline, with pH values ranging from 6.9 (THC-01 in fall) to 9.7 (ANB-02 in fall; **Appendix B, Table - 01**). Hardness ranged from soft waters (*e.g.*, Threehouse Lake and Anderson Bay) to very hard (*e.g.*, Anderson Creek), with hardness ranging from 25 mg/L to 790 mg/L.

Several stations in Anderson Bay, with depths in excess of 3.5 m, did not exhibit any stratification in spring (Figure 5.1). There was some evidence of oxygen stratification in Snow Lake in spring (**Figure 5.1**). However, with no thermal stratification to coincide with the oxygen stratification, this pattern is indicative of residual winter stratification (*i.e.*, prior to spring turnover) in Snow Lake (**Figure 5.1**). In fall, a similar (but muted) pattern of oxygen stratification in Snow Lake was observed (**Appendix B, Table - 02**).

Figure – 5.1: Dissolved Oxygen (red) and Temperature (blue) Profiles in (A) Anderson Bay and (B) Snow Lake, Spring 2011.



Most waterbodies in the Project Area were mesotrophic or meso-eutrophic based on the concentration of total phosphorus (**Table 5.4**). Total phosphorus concentrations in Arm Lake were either at or below detection limit (0.01 mg/L), characterizing this waterbody as oligotrophic. Chlorophyll *a* or pheophytin *a* concentrations did not coincide with trophic status (*i.e.*, Unnamed Creek 1, characterized as eutrophic did not have the highest chlorophyll *a* concentration, **Appendix B, Table - 01**). Trophic status for most waterbodies was higher in fall as compared to spring, when nutrient concentrations were higher due to increased primary productivity (**Table 5.4**).

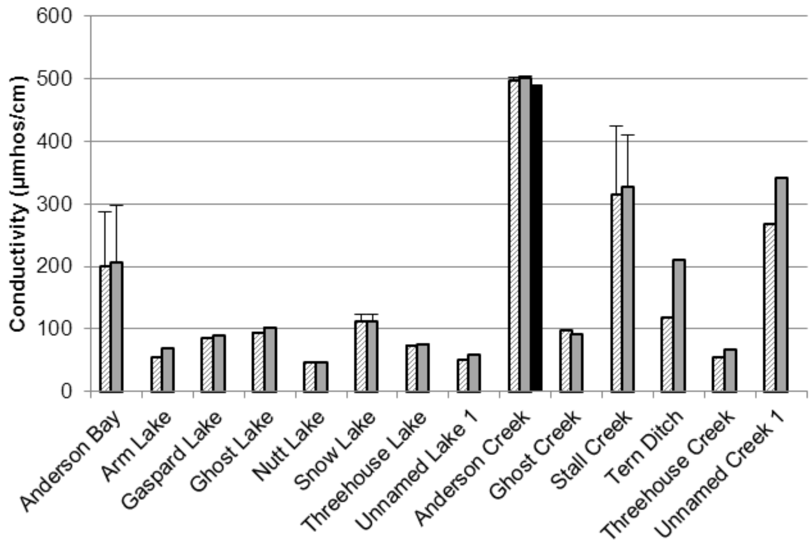
Table – 5.4: Average Total Phosphorus Concentrations (mg/L) and Trophic Status of Waterbodies in the Project Area, 2011-2012

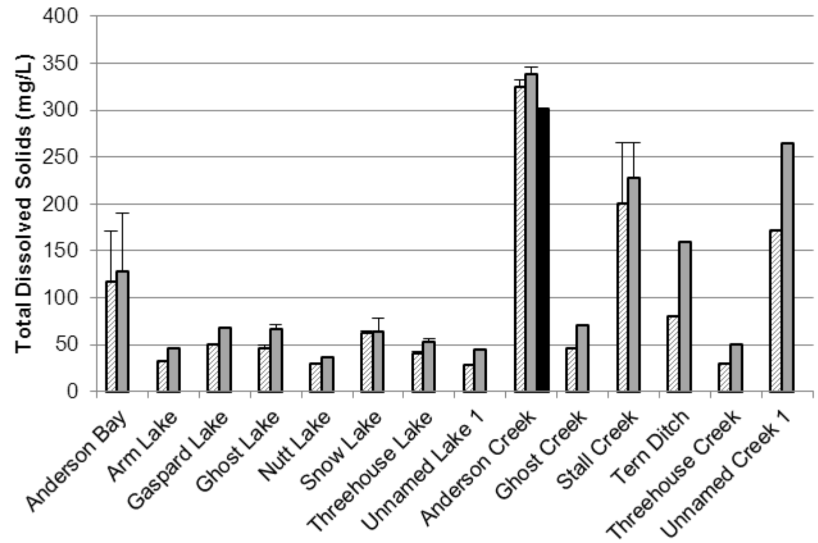
Waterbody	Spring 2011		Fall 2011		Summer 2012	
Anderson Bay	0.022	Meso-eu	0.027	Meso-eu	-	-
Arm Lake	<0.010	Oligo	<0.010	Oligo	-	-
Gaspard Lake	0.016	Meso	0.011	Meso	-	-
Ghost Lake	0.015	Meso	0.010	Oligo	-	-
Nutt Lake	0.016	Meso	0.011	Meso	-	-
Snow Lake	0.015	Meso	0.024	Meso-eu	-	-
Threehouse Lake	0.017	Meso	0.012	Meso	-	-
Unnamed Lake 1	0.024	Meso-eu	0.024	Meso-eu	-	-
Anderson Creek	0.015	Meso	0.017	Meso	0.024	Meso-eu
Ghost Creek	0.030	Meso-eu	0.053	Eu	-	-
Stall Creek	0.024	Meso-eu	0.064	Eu	-	-
Tern Ditch	0.018	Meso	0.032	Meso-eu	-	-
Threehouse Creek	0.022	Meso-eu	0.038	Eu	-	-
Unnamed Creek 1	0.042	Eu	0.144	Hyper-eu	-	-

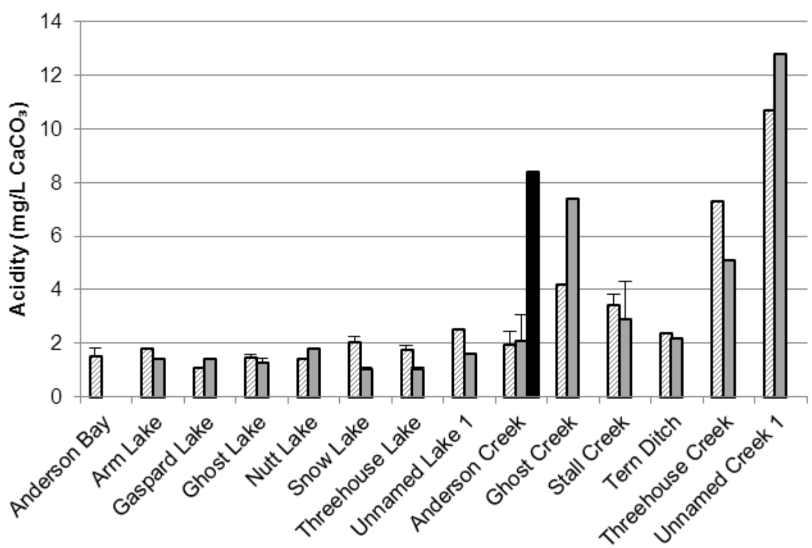
A full range of water quality parameters were measured in each surface water sample collected in the spring and fall sampling events (**Appendix B, Table - 01**). Most parameters remained within a relatively narrow range for most sites. Although it was not possible to test temporal trends statistically, no substantial differences were observed in major parameters between the spring and fall sampling periods (**Figure 5.2**). Both chloride and sulfate were below detection in many of the small lakes in the area. Mean concentrations for the water quality parameters are summarized for each site and season in **Appendix B, Table - 03**.

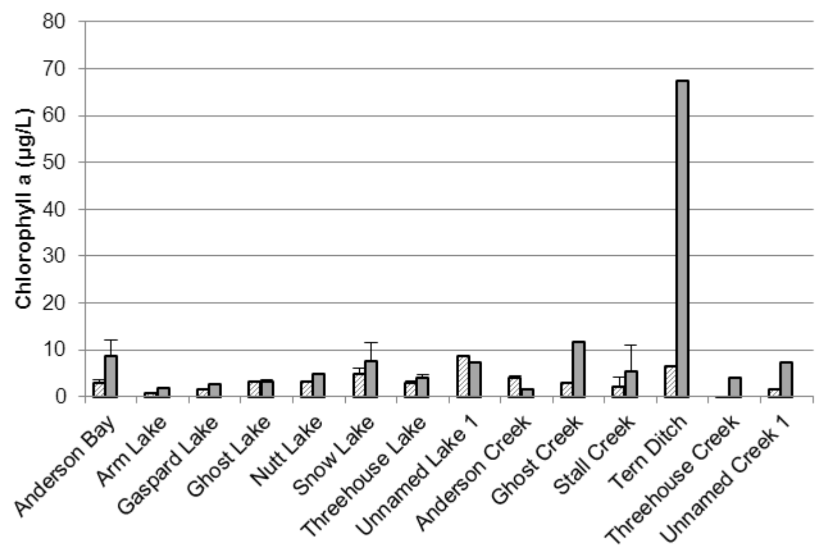
Some variability was observed within at least one of the larger waterbodies, with inshore stations in Anderson Bay showing higher levels of some parameters, including dissolved solids, chloride, and sulfate (**Figure 5.3**). The data also show differences between the spring and fall samples for some water quality parameters, suggesting that average values for each water body should be applied with caution. It is not possible to determine if similar spatial variability is present at other sites because of the relatively few samples collected at each site at each period.

Figure – 5.2: Mean (± Standard Deviation) Concentrations of Four Water Quality Parameters[1]



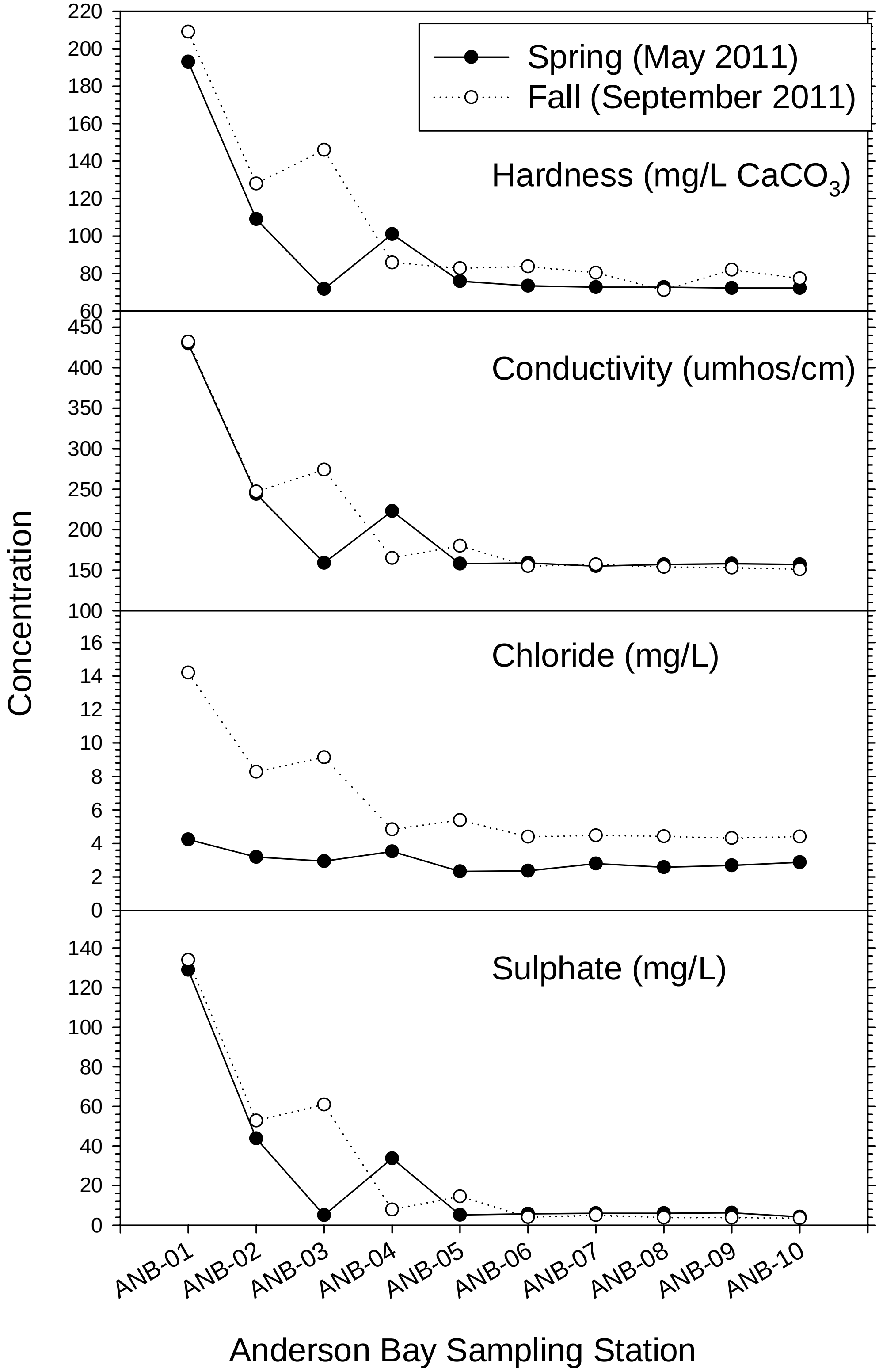






[1] *Spring 2011 is represented in patterned bars; Fall 2011 is represented by grey bars; Summer 2012 is represented by black bars. Bars without error bars are reported as detection limits or if only one sample was collected at that time.*

Figure – 5.3: Mean Concentrations of Four Water Quality Parameters in Anderson Bay



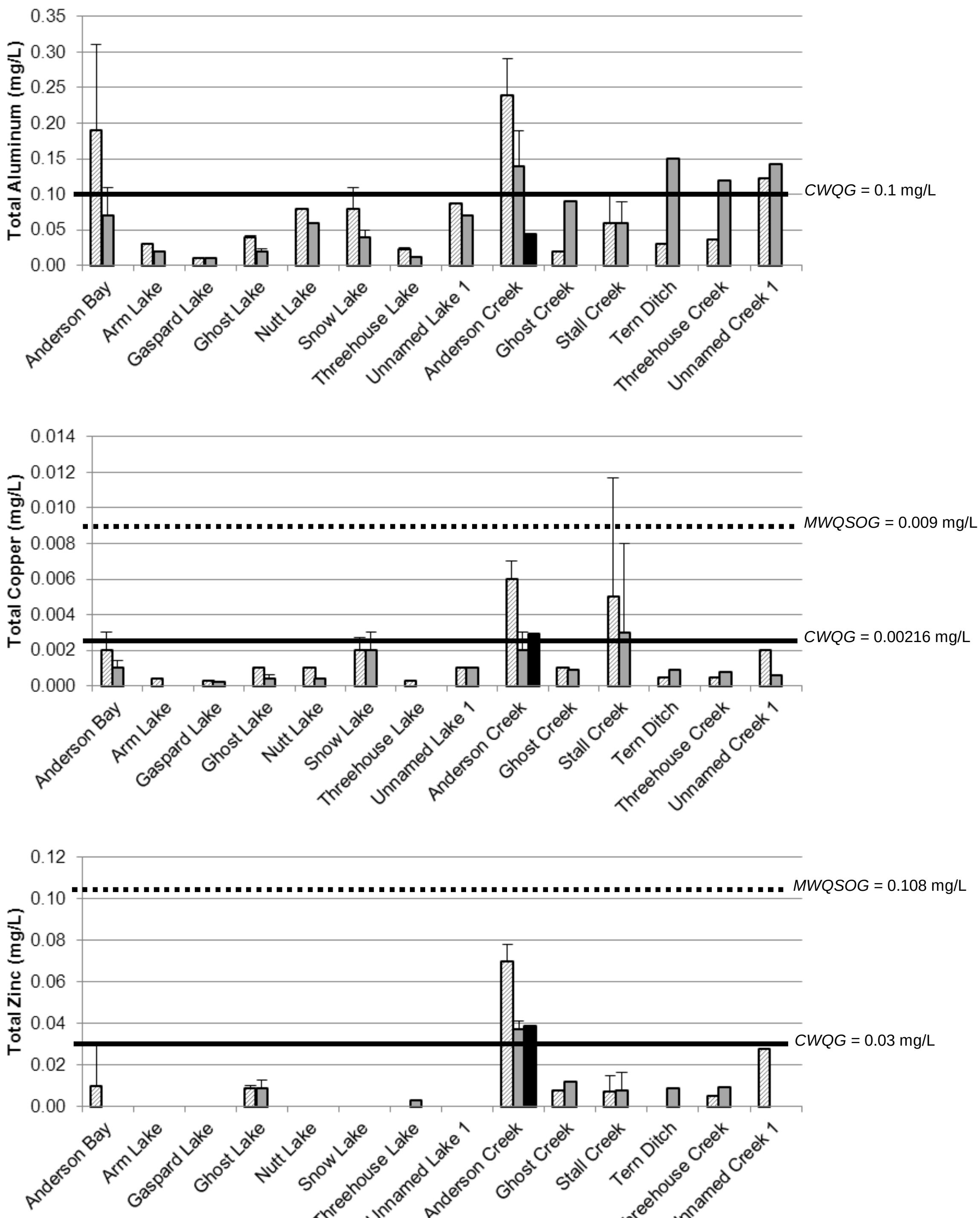
Several metals had baseline concentrations below detection limits in all samples tested. Bismuth (DL=0.0002 mg/L), chromium (DL=0.001 mg/L), mercury (DL=0.00005 mg/L), phosphorus (DL=0.2 mg/L), silver (DL=0.0001 mg/L), tellurium (DL=0.0002 mg/L), thallium (DL=0.0001 mg/L) and tungsten (DL=0.001 mg/L) were below detection limits in all samples. Other elements, such as beryllium (DL=0.0002 mg/L), cesium (DL=0.0001 mg/L), nickel (DL=0.002 mg/L) and uranium (DL=0.0001 mg/L) were only detected at a few sites. Antimony (DL=0.0002 mg/L) was only detected in Anderson Bay and Anderson Creek. Arithmetic mean values (with standard deviation; SD) of all elements are reported in **Appendix B, Table – 03**.

Baseline water quality was screened against *CWQG* and *MWQSOG* values (**Appendix B, Table – 01**). Total aluminum, cadmium, copper, iron, selenium, and zinc concentrations in water samples exceeded the *CWQG* value in at least one sample. In addition, pH and fluoride concentrations exceeded *CWQG* value. The most frequently exceeded guideline was the *CWQG* value for aluminum and average baseline concentrations ranged from 0.01 mg/L (Gaspard Lake) to 0.24 mg/L (Anderson Creek). Baseline concentrations of metals in many waterbodies examined in 2011 and 2012 (e.g., Gaspard Lake, Ghost Lake, Nutt Lake, and Snow Lake) had one *CWQG* exceedance in at least one sample (**Appendix B, Table - 01**). There were no exceedances in Arm Lake samples. *MWQSOG* values were exceeded for baseline concentrations of ammonia (in Nutt Lake, Unnamed Lake 1, Stall Creek, and Unnamed Creek 1) and copper (Stall Creek).

Statistical comparisons were not possible between sites; however, major elements that exceeded *CWQG* guidelines were compared to determine spatial trends (**Figure 5.4**). Aluminum, copper, and zinc approached or exceeded the guidelines in some samples.

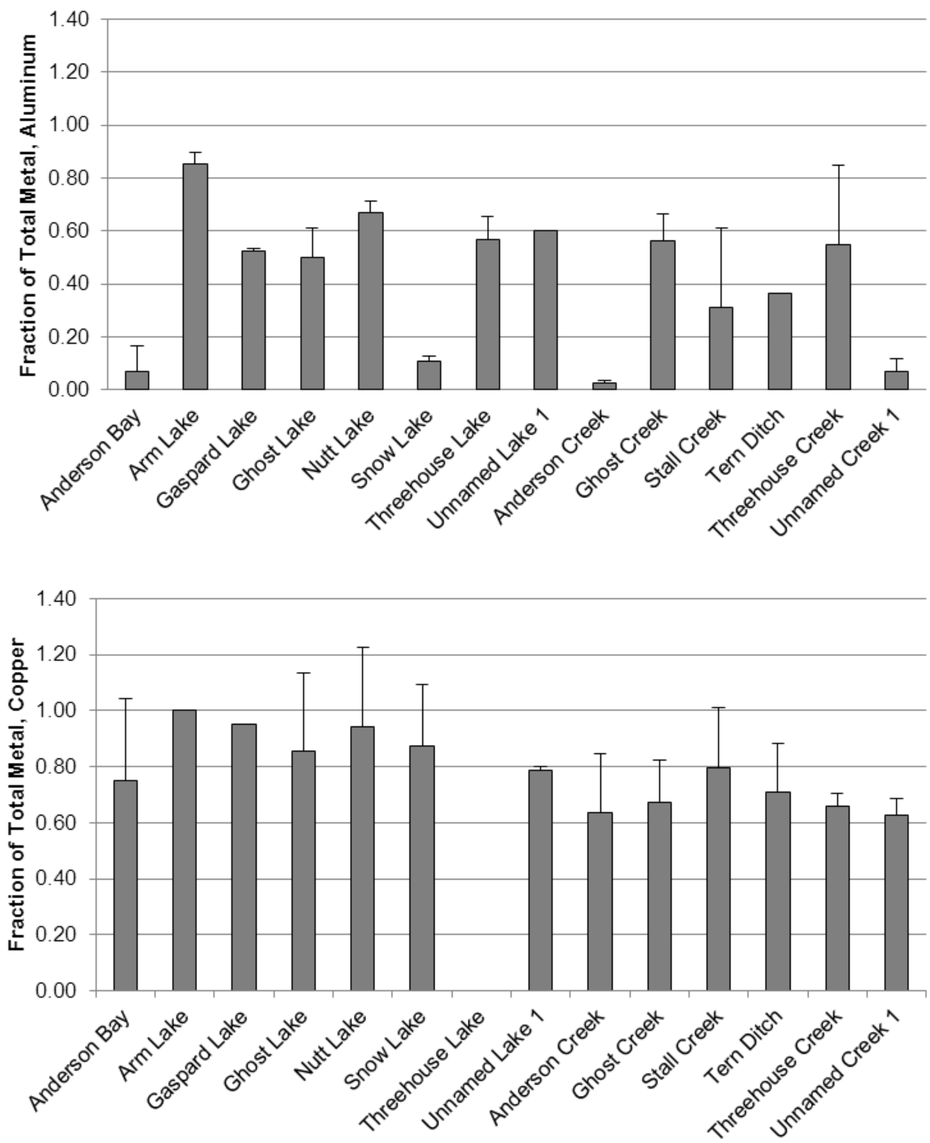
The fraction of total metals that is in the more toxic dissolved form was calculated for elements in which both the dissolved fraction and total value were above detection limit in either the spring or the fall sample collections (*e.g.,* aluminum and copper). No clear trends are evident for either metal; with values varying from predominantly all metal in the dissolved phase to virtually 100% in the particulate phase (**Figure 5.5**). For example, aluminum, which exceeds the *CWQG* value in Anderson Bay, is predominantly in the particulate phase, possibly due to high particulate loads during runoff in spring, while aluminum at other sites is largely in the dissolved phase. No clear relationship between dissolved fraction and total metal and other water quality parameters (*e.g.*, pH, total dissolved solids, etc.) are evident for either aluminum or copper.

Figure – 5.4: Mean (±SD) Concentrations of Aluminum, Copper, and Zinc in the Snow Lake region[2]



[2] *Spring 2011 is represented in patterned bars; Fall 2011 is represented by grey bars; Summer 2012 is represented by black bars. Bars without error bars are reported as detection limits or if only one sample was collected at that time. Solid line indicates the CWQG and the dashed line indicates the MWQSOG.*

Figure – 5.5: Dissolved Fractions in Total Metal for Aluminum and Copper



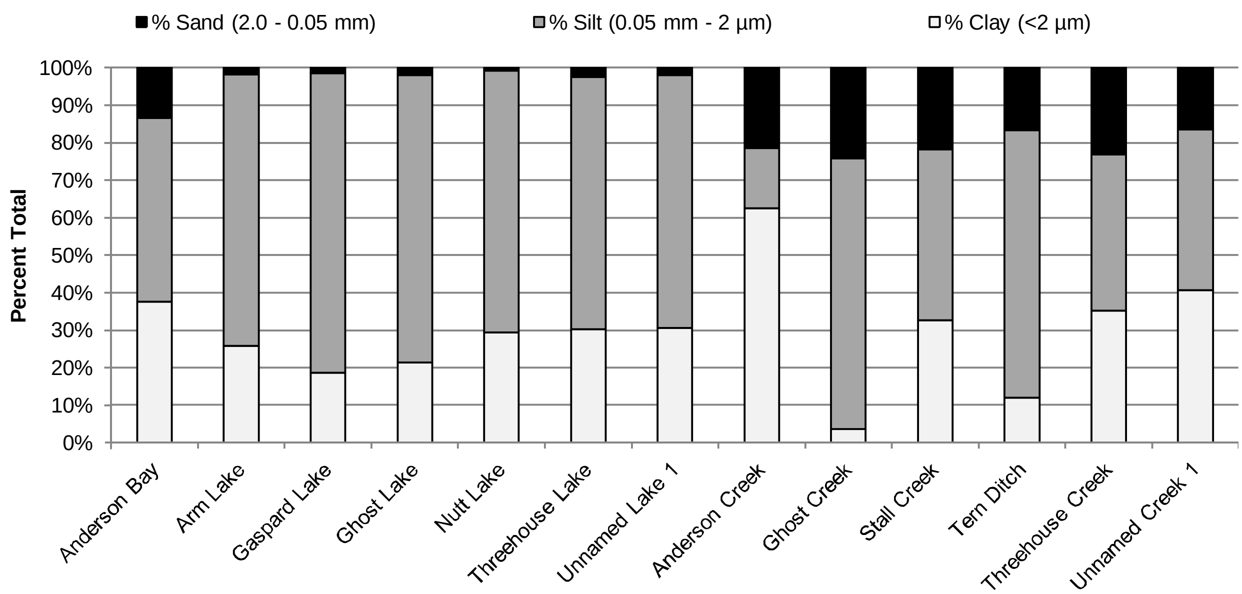
Baseline WQI values were calculated based on both seasons combined, as there were no statistical differences between spring and fall chemical composition. The majority of water samples were classified as *Good* or *Excellent* water quality, based on the WQI value (**Appendix B, Table - 04**; **Drawing - 22**). In waterbodies examined during the baseline aquatic assessments in 2011 and 2012, baseline WQI values ranged from 92 (at two stations in Anderson Bay) to 100 (in several waterbodies). Though there were differences in baseline WQI values between spring and fall, the differences were not consistent for all waterbodies (data not shown).

5.5.2 Sediment Quality

A total of 177 surficial sediment samples were collected in triplicate from 30 sites in 13 waterbodies located in the Project Area in 2011 and 2012 (**Drawing – 23 to 24**). All analysis is presented in **Appendix B, Table - 05**.

Particle size distribution showed that the composition of the surficial sediments was dominated by silt and clay but varied among waterbodies and sampling location (**Figure 5.6**). Values varied considerably between sampling sites within those waterbodies. For example, sand comprised only 0.5% of sediment at ANB-04 in Anderson Bay, but increased to over 50% at deeper sites (*i.e.*, ANB-08 and ANB-10). Similarly, in Stall Creek sand ranged from 2% to 68%. This variability indicates the presence of erosional and depositional zones that may influence the transport and distribution of chemicals of concern.

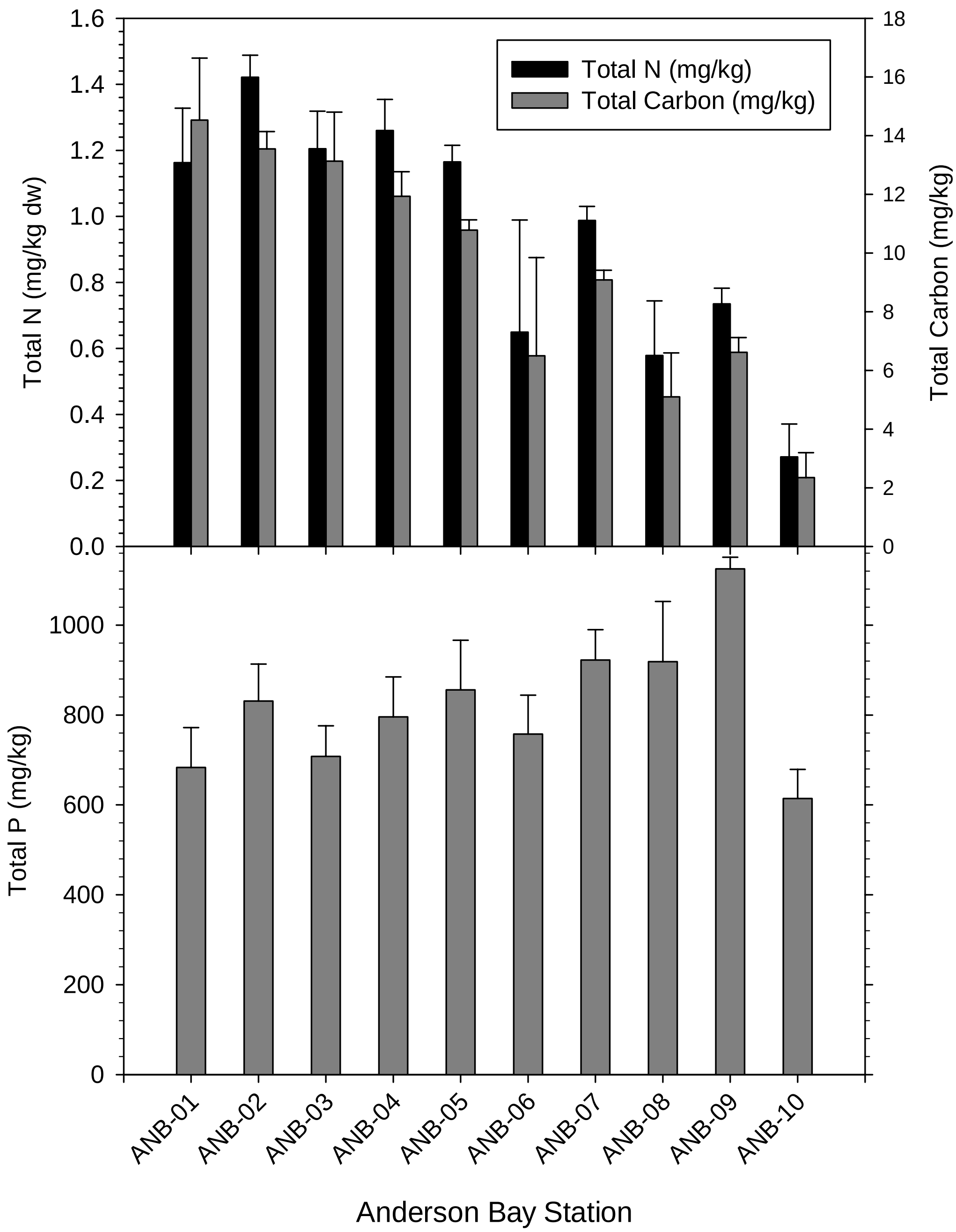
Figure – 5.6: Mean Particle Size Distribution of Surficial Sediments



Average moisture levels in most sediment replicate samples (seasons combined) ranged between 85% to 90%, however lower moisture levels were observed at Unnamed Creek 1 (69%) and Anderson Creek (43%) (**Appendix B, Table - 06**). Each station is characterized individually as all other major chemical components varied significantly among and sometimes within locations.

Statistical analysis detected significant differences among sites in larger waterbodies (*i.e.*, Ghost Lake, Threehouse Lake, and Anderson Bay) for several chemical parameters and contaminants of potential concern. In general, chemical parameters were uniform in the smaller waterbodies, *i.e.*, fewer differences between sampling sites. For example, moisture, total nitrogen, total and organic carbon concentrations were significantly different among stations in Anderson Bay (**Figure 5.7**), with ANB-10 having significantly lower levels of these components than the other nine stations. Total phosphorus levels increased significantly ($p<0.001$) from ANB-01 to ANB-09 and then declined to a much lower concentration at Station ANB-10 (**Figure 5.7**). In contrast, comparisons between stations at Ghost Lake and Threehouse Lake showed some significant differences for these parameters but the magnitude of the differences was much less (data not shown).

Figure – 5.7: Mean (± SD) Baseline Concentrations of Total Nitrogen (N), Phosphorous (P) and Carbon (C) in Anderson Bay Surficial Sediments



The data for elemental analysis (*i.e.*, total nitrogen, phosphorous and carbon) were analysed for the major sites by two-way ANOVA using waterbody and date of sampling (*i.e.*, spring or fall) as factors. Total nitrogen, calcium carbonate, inorganic carbon, total carbon and organic carbon were not significantly different ($p>0.05$) between sampling dates, but were highly variable between waterbodies, with significant differences ($p<0.01$) observed for each variable. Total phosphorus concentrations were significantly different between waterbodies ($p<0.001$) and sampling dates ($p<0.01$), with sediments collected in spring having significantly higher levels of phosphorus than those collected in fall (data not shown). These higher phosphorus levels in September may be associated with primary productivity in the water column during the summer, and the settling of plankton to the bottom after the summer blooms.

Average concentrations, with the observed range for major elements (*i.e.*, nitrogen, phosphorus, and carbon) at the respective waterbodies are presented in **Appendix B, Table - 06**. AECOM combined data from the two sampling periods to increase the statistical power of subsequent comparisons. No clear trends emerged in the comparisons between waterbodies for the major elements. Total nitrogen concentrations were highest in Threehouse Lake (3.2 mg/kg dry weight) and lowest in Anderson Creek (0.18 mg/kg dry weight). Total phosphorus concentrations were highest in Unnamed Lake 1 (971 mg/kg dry weight) and lowest in Anderson Creek (534 mg/kg dry weight). Total carbon concentrations were dominated (*i.e.*, >95%) by organic carbon, with inorganic carbon comprising a very small fraction of measured carbon. Inorganic carbon was below detection in samples from several sites, including Anderson Bay. Due to the variability within the waterbodies (*i.e.*, between stations), averages reported for the major elements (**Appendix B, Table - 06**) should be applied with caution at the larger sites, such as Anderson Bay, for all major elements.

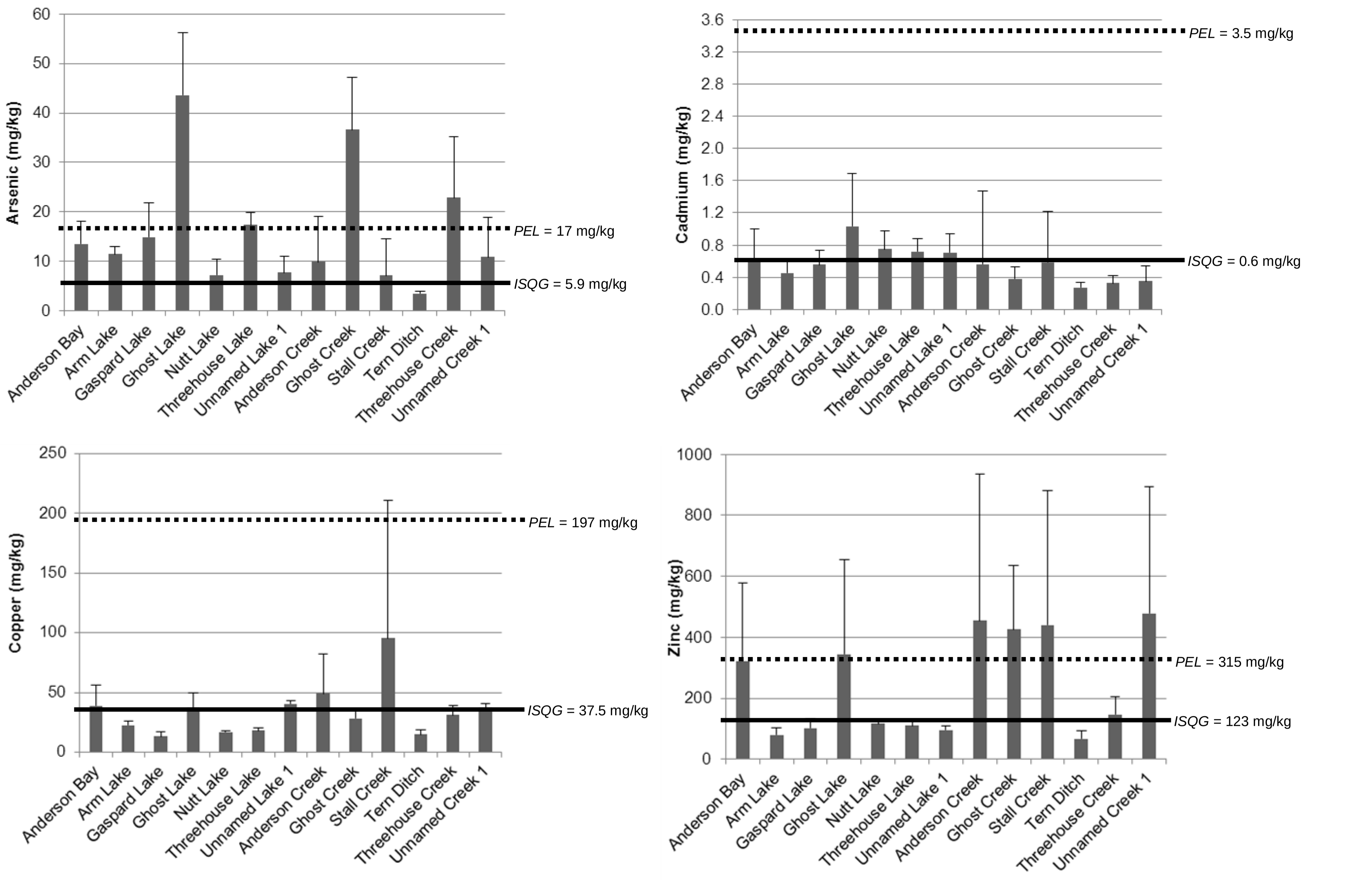
Thirty-four chemicals of potential concern were analysed in all the sediment samples. Tin was the only element that was observed below detection (*i.e.*, 5 mg/kg dry weight) in virtually all samples, with the exception of one sample in Tern Ditch (11 mg/kg dry weight). Beryllium (DL=0.1 mg/kg dry weight) and tellurium (DL=0.1 mg/kg dry weight) were below detection at most sites but consistently above detection limits at other sites which probably accurately reflects differences between sites. Similarly, thallium concentrations were detected consistently in Anderson Bay, Anderson Creek and Stall Creek but below detection (DL=0.1 mg/kg dry weight) at most other sites, reflecting true spatial distribution for the element.

Data were analysed for the major sites by two-way ANOVA using waterbody and date of sampling as factors, for all elements that were above detection in >95% of samples. However, results presented in this report are only for the seven elements for which *ISQG* and *PEL* have been published (**Appendix B, Table - 05**). No significant differences ($p>0.05$) were observed between seasons, but significant differences were observed among waterbodies ($p<0.05$). Elements that exceeded *ISQG* and *PEL* values in at least one site were compared (**Figure 5.8**).

Concentrations of antimony, barium, beryllium, molybdenum, silver, thallium, tin, uranium, and vanadium in surficial sediment samples did not exceed any applicable sediment quality guideline (**Appendix B, Table – 05**). The most frequently exceeded guideline was the *ISGQ* of arsenic (5.9 mg/kg dry weight), where over 80% of concentrations exceeded the guideline (**Appendix B, Table – 05**). Concentrations of lead and mercury did not exceed the *CSQG-RP* or *PEL* for all samples. Concentrations of lead exceeded the *ISQG* value (35 mg/kg dry weight) in samples collected from GHL-02 and GHL-03 in Ghost Lake (**Appendix B, Table – 05**). Concentrations of mercury exceeded the *ISQG* value (0.17 mg/kg dry weight) in 5% of samples (*i.e.*, in Gaspard Lake, Ghost Lake, and Unnamed Lake 1) (**Appendix B, Table – 05**).

Exceedances were more frequent in Stall Creek, where concentrations of eight of the nineteen metals for which there were applicable guidelines exceeded the guideline (*i.e.*, arsenic, cadmium, chromium, cobalt, copper, nickel, selenium, and zinc; **Appendix B, Table – 05**). Only selenium exceeded the CCME guideline in Tern Ditch.

Figure – 5.8: Mean (±1 SD) Concentrations of Four (4) Chemicals of Concern in Surficial Sediments



In order to determine spatial trends within each of the major waterbodies, AECOM compared concentrations of chemicals of potential concern using one-way ANOVA comparisons between stations in each waterbody. The results indicate that few spatial trends are evident in Ghost Lake and Threehouse Lake (**Table 5.5**). However, there were significant differences among stations in Stall Creek and Anderson Bay (**Figure 5.9**; **Table 5.5**). The analytical laboratory measured elevated concentrations of the elements arsenic, cadmium, copper, and zinc in the smaller waterbodies (*e.g.*, Ghost Lake), but concentrations were more heterogeneous in Anderson Bay (**Table 5.5**). Trends of copper and zinc concentrations illustrate the spatial differences within the respective sites (**Figure 5.9**). Among the ten sites sampled in Anderson Bay in 2011, arsenic concentrations ranged from 4 mg/kg dry weight to 23 mg/kg dry weight (**Appendix B, Table - 05**).

Table – 5.5: Summary of Inter-Station Comparisons of the Select Contaminants of Concern in Surficial Sediments.

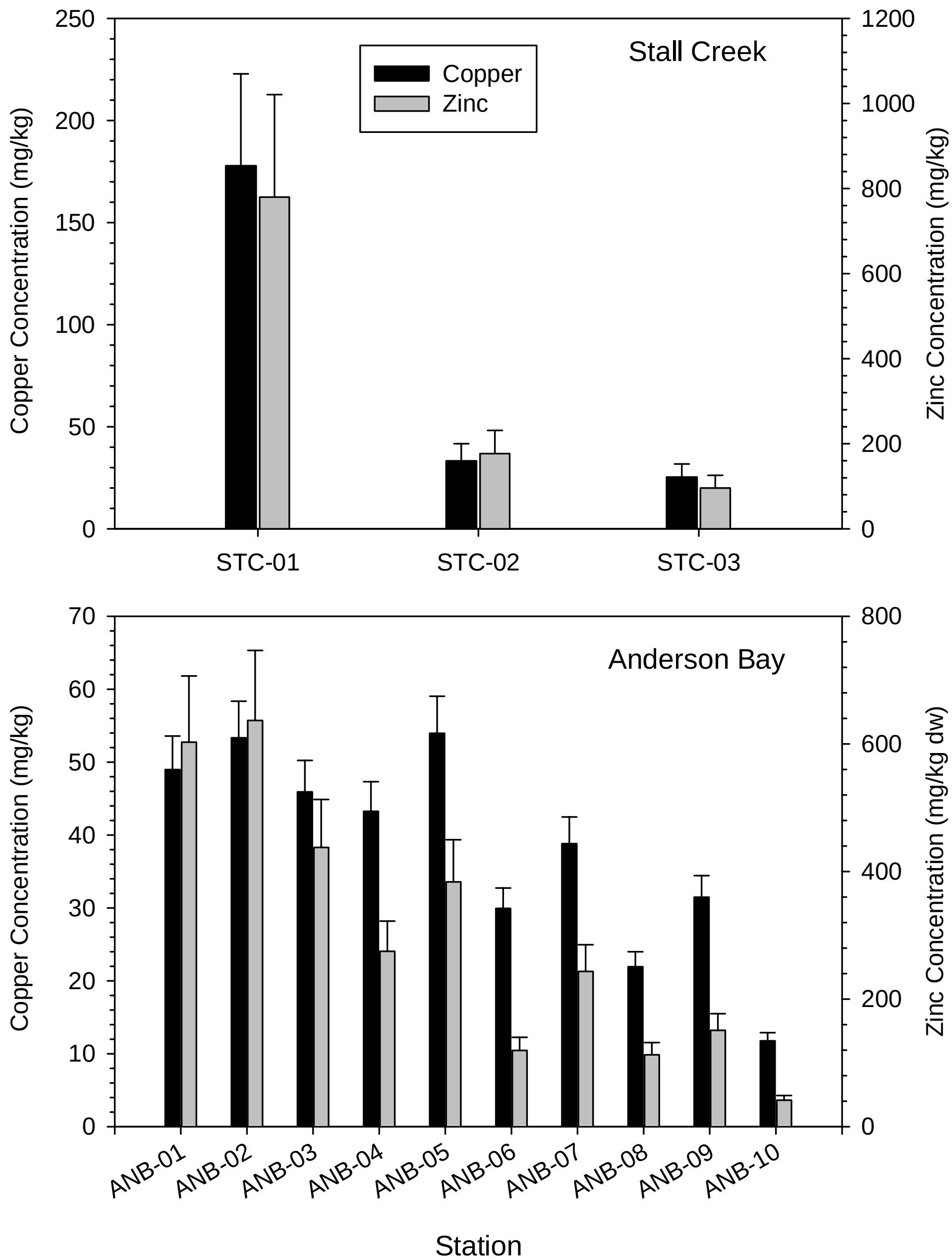
Element	Anderson Bay	Ghost Lake	Threehouse Lake	Stall Creek
Arsenic	p<0.0001	NS	p<0.01	p<0.0001
Cadmium	p<0.0001	NS	NS	p<0.01
Chromium	p<0.0001	NS	NS	p<0.0001
Copper	p<0.0001	NS	p<0.001	p<0.0001
Lead	p<0.0001	NS	NS	p<0.0001
Zinc	p<0.0001	NS	p<0.01	p<0.0001

Notes:
NS = no significant difference in concentration among stations; p<0.01 = significant difference in concentrations at the designated level of significance.

Sediment quality varied markedly between sites, ranging from 100 (excellent quality) in Tern Ditch to a low value of 29 in Ghost Lake based on the *ISQG* (**Appendix B, Table – 04; Drawing - 23**). Sites in Anderson Bay also showed exceedances over the guidelines for arsenic, cadmium, chromium and copper and zinc, however the magnitude of the exceedances was less than in Ghost Lake, resulting in an SQI values, based on ISQG, ranging from 34 (ANB-02) to 83 (ANB-10) (**Appendix B, Table - 04**).

SQI values based on PEL were considerably higher than those based on the ISQG, and probably more accurately reflect the potential for ongoing impact to aquatic life. The SQI values for most sites were greater than 70, indicating moderate to good sediment quality (**Appendix B, Table - 04**; **Drawing - 24**).

Figure – 5.9: Least-Square Mean Concentrations (±1 GSD) of Copper and Zinc in Surficial Sediments



5.5.3 Phytoplankton

AECOM field crews submitted fourteen and nine phytoplankton samples for taxonomic identification in May and September 2011, respectively (**Appendix B, Table - 07**). The analytical laboratory identified nine classes of phytoplankton in samples collected, with Chrysophyceae (yellow-green algae) as the most abundant overall and Euglenophyceae (flagellates) as the least abundant overall. Phytoplankton community, in terms of relative abundance, was different in fall as compared to spring. In general, abundance was highest in the fall as compared to spring, corresponding to higher primary productivity in fall. The relative abundance of the classes between seasons did not change significantly, though there were more Cyanophyceae (blue-green algae) in fall, as compared to spring.

A summary of the total abundance and species diversity in waterbodies in the Project Area from which phytoplankton samples were collected is shown in **Table 5.6**.

Table – 5.6: Phytoplankton Community in Waterbodies in the Project Area, 2011

Waterbody	Total Abundance (x 10^6 n/L)		Species Diversity	
	Spring	Fall	Spring	Fall
Anderson Bay	2.0	7.4	25	33
Arm Lake	2.5	7.4	30	29
Gaspard Lake	1.5	6.6	18	17
Ghost Lake	7.9	7.3	26	25
Nutt Lake	7.0	15	23	34
Threehouse Lake	6.1	18	22	26
Unnamed Lake 1	7.7	24	33	31
Anderson Creek	1.6	-	16	-
Ghost Creek	6.8	-	28	-
Stall Creek	2.5	0.11	15	8
Tern Ditch	7.7	-	24	-
Threehouse Creek	1.1	-	29	-
Unnamed Creek 1	0.7	-	11	-

In spring, Unnamed Creek 1 had the lowest total species abundance (6.9 x 10^5 n/L) and Ghost Lake had the highest total species abundance (79 x 10^5 n/L). In fall, Stall Creek had the lowest total species abundance (1.1 x 10^5 n/L) and Unnamed Lake 1 had the highest total species abundance (244 x 10^5 n/L). On average, there were more species in the fall samples as compared to the spring samples. Across both seasons, Stall Creek and Nutt Lake had the lowest and highest species diversity, respectively with 8 and 34 species, respectively.

AECOM field staff collected phytoplankton samples from all lakes (and Stall Creek) in both spring and fall. Phytoplankton abundance was higher in fall, congruent with trophic status. Community composition was also different between the two seasons in Anderson Bay and Gaspard Lake. In fall, Cyanophyceae replaced the second most abundant phytoplankton class in spring (Fragilariophyceae, pennate diatoms) in both Anderson Bay and Gaspard Lake. Seasonal changes in primary productivity, competition and/or water physiochemistry (*e.g.*, temperature, total suspended solids) can cause shifts in phytoplankton community structure and abundance.

Creek phytoplankton communities were slightly different from those of the lakes. In general, there were more Bacillariophyceae (diatoms) in the creeks than in the lakes, in spring. In spring, Fragilariophyceae was the dominant phytoplankton class in Anderson Creek but was present in very low numbers in all other waterbodies.

5.5.4 Zooplankton

AECOM field crews submitted fourteen and nine zooplankton samples for taxonomic identification in May and September 2011, respectively (**Appendix B, Table - 08**). The percentage of individuals that were either damaged, too young to identify or unidentified to species ranged from 0.06% (GSL-01 in fall) to 94% (UC1-01 in spring). The analytical laboratory identified 44 species in five Phyla, with Monogononta (rotiferans) as the dominant zooplankton class in almost all samples (though it was absent in Unnamed Creek 1). Ciliata (ciliated protists) was the most abundant zooplankton class, largely due very high numbers in Unnamed Creek 1.

A summary of the total abundance and species diversity in waterbodies in the Project Area from which phytoplankton samples were collected is shown in **Table 5.7**.

Table – 5.7: Zooplankton Community in Waterbodies in the Project Area, 2011

Waterbody	Total Abundance (n/L)		Species Diversity	
	Spring	Fall	Spring	Fall
Anderson Bay	8	202	10	16
Arm Lake	116	91	13	12
Gaspard Lake	128	412	13	12
Ghost Lake	82	110	8	13
Nutt Lake	117	101	13	18
Threehouse Lake	73	226	15	17
Unnamed Lake 1	158	169	12	20
Anderson Creek	74	-	14	-
Ghost Creek	43	-	14	-
Stall Creek	9	0.1	16	6
Tern Ditch	22	-	17	-
Threehouse Creek	28	-	23	-
Unnamed Creek 1	11,720	-	3	-

In spring, Anderson Bay had the lowest total species abundance (8 n/L) and Unnamed Creek 1 had the highest total species abundance (11,720 n/L). In fall, Stall Creek had the lowest total species abundance (0.1 n/L) and Gaspard Lake had the highest total species abundance (411 n/L). Threehouse Creek had the highest species diversity (23) and Unnamed Creek 1 had the lowest (3). In general, there were no consistent trends in terms of abundance or zooplankton community composition between spring and fall.

Creek samples typically had lower abundance than lake samples, with the exception of Ciliata and Euglenoidea. Ciliata had higher abundance in fall (average of 63 n/L) as compared to spring with an average of 3 n/L, excluding Unnamed Creek 1 which had an extremely high abundance of Ciliata (11,080 n/L). Euglenoidea was present only in Ghost Creek (0.07 n/L) and Unnamed Creek 1 (640 n/L).

5.5.5 Benthic Invertebrate Community

Field crews collected 96 samples from 32 stations in fourteen waterbodies in the area of the proposed Lalor Concentrator for taxonomic identification of benthic invertebrates; however, only one replicate from each station was submitted to the analytical laboratory. AECOM archived the remaining two replicates per station for one year after analytical data were received. No additional replicates were submitted for analysis.

Sediments in the waterbodies along the former rail bed (*e.g.,* Ghost Lake, Nutt Lake, and Threehouse Creek) were highly organic with aquatic vegetation. More complex substrates (*i.e.,* fines, sand, gravel) dominate more frequently in creeks with observed flow such as Anderson Creek and Stall Creek and larger waterbodies such as Anderson Bay, in Wekusko Lake (**Appendix B, Table - 09**).

In total, there were 24 orders of benthic invertebrates identified in the samples collected in September 2011 (**Appendix B, Table - 10**). The dominant order for all waterbodies was Diptera with the exception of the BIC in Nutt Lake, which was dominated by Amphipoda (**Table 5.8**). The sub-dominant order in lakes was Ephemeroptera, Diptera, Clodocera/Veneroida, or Amphipoda, where the sub-dominant order in creeks was Copepoda, Ostraocoda, Veneroida, or Cladocera. The two most dominant orders accounted for 52% (Anderson Bay) to 97% (Unnamed Lake 1) of the total density. The average density (total waterbody density divided by number of stations sampled in a waterbody) ranged from 86 n/m² to 21,466 n/m², for Anderson Creek and Tern Ditch, respectively (**Table 5.8**).

Table – 5.8: Summary of Benthic Invertebrate Community Structure, 2011

Waterbody	Average Density (n/m²)	Dominant Order	Sub-Dominant Order	Relative Density of Dominant & Sub-Dominant (%)
Anderson Bay	2,862	Diptera	unidentified	52
Arm Lake	1,724	Diptera	Ephemeroptera	93
Gaspard Lake	129	Diptera	Ephemeroptera	83
Ghost Lake	224	Diptera	Ephemeroptera	65
Nutt Lake	1,897	Amphipoda	Diptera	68
Threehouse Lake	409	Diptera	Cladocera/Veneroida	93
Unnamed Lake 1	3,297	Diptera	Amphipoda	97
Anderson Creek	86	Diptera	Copepoda	75
Ghost Creek	3,060	Diptera	Copepoda	94
Stall Creek	2,787	Diptera	Copepoda	62
Tern Ditch	21,466	Diptera	Ostracoda	81
Threehouse Creek	1,638	Diptera	Veneroida	92
Unnamed Creek 1	4,569	Diptera	Cladocera	69

Notes: n = count of species; % = percent; n/m³ = individuals per cubic metre. Average density is the average of total density in the waterbody divided by the number of stations.

Tern Ditch was less balanced (evenness of 0.17) than other waterbodies, but also had a high density (21,466 n/m²) and family richness (15) (**Appendix B, Table - 11**). In other words, the BIC in Tern Ditch was dominated by few taxa, *i.e.,* over 80% of the total density is in two orders (**Table 5.8**). Conversely, the BIC at other stations, such as GHL-02A, GHL-03A, and ANC-02A had high evenness values. These stations had lower density (station density ranged from 86 n/m² to 129 n/m²) and were distributed evenly among the fewer taxa identified at these stations (richness ranged from two to three) (**Appendix B, Table - 11**). Diversity (as measured by SDI values) ranged from 0.16 (GHC-01A) to 0.83 (ANB-09A).

Ghost Lake was least similar to Arm Lake, with BCI values of 0.95 at two of three stations where Threehouse Lake was most similar to Arm Lake, with BCI value of 0.39 (**Appendix B, Table - 11**). For the creeks, Threehouse Creek was most similar to Ghost Creek, with BCI value of 0.48 while Anderson Creek (ANC-01B) was least similar to Ghost Creek, with BCI value of 0.97 (**Appendix B, Table - 11**). In general, waterbodies that are closest to the “reference” waterbody are more similar than those that are further away.

In general, EPT taxa (i.e., Ephemeroptera, Plecoptera and Tricoptera) were present in low numbers. Gaspard Lake had the highest %EPT (33%) while eleven other stations had no EPT taxa. There were a number of unidentified taxa in the samples submitted, with percent of unidentified ranging from 0% (for nine stations) to 66% (ANB-09A).

Linear regression analysis showed very weak relationships between SQI values and various BIC descriptors (data not shown).

5.5.6 Fish Community & Habitat

In 2011 and 2012, a total of 18 gill nets, 7 electrofishing transects, 71 minnow traps were employed during the baseline study (**Appendix B, Table - 12**). In total, 2,470 individuals representing 17 fish species were captured in eleven of the fourteen waterbodies fished in 2011 and 2012 (**Appendix B, Table - 13; Table 5.9**). Fishing effort did not capture fish in Nutt Lake, Unnamed Lake 1, and Unnamed Creek 1 (**Appendix B, Table - 13**). Brook Stickleback comprised the majority of the fish captured (62%). Fishing efforts captured large-bodied fish in only Wekusko Lake (Anderson Bay and Goose Bay). For most other waterbodies, Brook Stickleback was the only species captured.

Table – 5.9: Fish Species Captured in the Project Area, 2011 and 2012

Species Name	Common Name	Abbr
Culaea inconstans	Brook Stickleback	BKSB
Notropis heterolepis	Blacknose Shiner	BNSH
Coregonus artedi	Cisco	CISC
Notropis atherinoides	Emerald Shiner	EMSH
Pimephales promelas	Fathead Minnow	FTMW
Etheostoma exile	Iowa Darter	IWDT
Etheostoma nigrum	Johnny Darter	JHDT
Coregonus clupeaformis	Lake Whitefish	LKWF
Catostomus catostomus	Longnose Sucker	LNSK
Esox lucius	Northern Pike	NRPK
Margariscus margarita	Pearl Dace	PRDC
Notropis blennius	River Shiner	RVSH
Notropis hudsonius	Spottail Shiner	STSH
Percopsis omiscomaycus	Trout-perch	TRPR
Sander vitreus	Walleye	WALL
Catostomus commersoni	White Sucker	WHSK
Perca flavescens	Yellow Perch	YLPR

Catch per unit effort (CPUE) was calculated for each sampling method in each waterbody (**Appendix B, Table - 13**). The highest overall CPUE was with the 13 mm panel in the small gang gill net set in Anderson Bay in the summer 2012 (18.9 n/hr) (**Appendix B, Table - 13**). Gill nets (both gang sizes) were successful in the larger waterbodies, where minnow traps were more successful in smaller watercourses.

Anderson Bay had the widest species diversity with twelve species (**Appendix B, Table - 13**). For most other waterbodies, Brook Stickleback was the only species captured (**Drawing - 07 to 21**). This is typical for headwater waterbodies (Stewart & Watkinson, 2004).

Several species were in spawning condition, including Yellow Perch (*Perca flavescens*), White Sucker (*Catostomus commersoni*), Brook Stickleback (*Culaea inconstans*), and Pearl Dace (*Margariscus margarita*). AECOM field crews observed large schools of Young-of-Year Brook Stickleback adjacent to PR 392 in Anderson Creek. Most fish captured were in good health however, there was a general occurrence of a black spot parasite, infesting mainly Brook Stickleback (**Appendix B, Table - 14**). Black spot parasite is common in earthen bottom waterbodies and was widely distributed across the waterbodies examined. As this parasite requires piscivorous birds, snails and fish to complete its life cycle, its presence indicates a healthy ecosystem. In general, the presence of this parasite in a fish does not affect its growth or survival. However, massive infestations can cause increased stress, increased susceptibility to other infections or infestations and mortality.

Condition was generally lowest for Brook Stickleback and highest among the large-bodied fish (**Appendix B, Table – 14**). Variability among species reflect differences in body shape, energy allocation, and overall health, while variability among waterbodies (within a species) reflect differences in health, food source, age distribution and environmental conditions.

Brook Stickleback was selected as a representative species to demonstrate regional trends in condition, length, and weight (**Table 5.10**). Brook Stickleback from Gaspard Lake had the highest mean length and weight (65 mm and 2.1 g, respectively). Brook Stickleback from Anderson Bay had the lowest average condition (0.6 g/mm^3) and Brook Stickleback from Arm Lake had the highest average condition (1.1 g/mm^3).

The regression equations for the relationship between $\log_{10}$ transformed length and weight of Brook Stickleback is presented in **Table 5.11**. The same factors as condition, as described above, influence the slope of the regression equations. The correlation coefficient ranges from 0.47 (Anderson Bay and Threehouse Creek) to 0.89 (Gaspard Lake). For the same total length of 60 mm, Brook Stickleback were lightest in Anderson Bay of Wekusko Lake (1.2 g) and heaviest in Arm Lake (2.2 g).

Table – 5.10: Summary Statistics for Brook Stickleback in the Proposed Lalor Concentrator Area

Waterbody	Length (mm)					Weight (g)					Condition (g/mm³)				
	n	Min	Max	Mean	SD	n	Min	Max	Mean	SD	n	Min	Max	Mean	SD
Anderson Bay (in Wekusko Lake)	111	39	65	52.4	4.7	111	0.1	1.9	0.92	0.29	111	0.07	1.35	0.64	0.19
Arm Lake	14	46	69	55.6	7.5	14	1.2	3.7	1.91	0.84	14	0.73	1.36	1.07	0.18
Gaspard Lake	100	44	86	65.7	10.1	100	0.5	4.9	2.06	0.88	100	0.36	1.03	0.69	0.11
Ghost Lake	110	50	79	64.0	5.9	110	0.6	4.2	1.98	0.67	110	0.38	1.20	0.74	0.14
Goose Bay (in Wekusko Lake)	2	43	47	45.0	2.8	2	0.8	1.00	0.90	0.14	2	0.96	1.00	0.98	0.03
Threehouse Lake	28	49	72	59.3	6.1	28	0.7	2.4	1.54	0.51	28	0.40	1.20	0.73	0.18
Anderson Creek	143	20	65	40.9	13.8	143	<0.1	1.8	0.95	0.36	143	0.06	1.31	0.67	0.15
Ghost Creek	100	44	76	57.9	7.2	100	0.6	3.6	1.60	0.58	100	0.54	2.11	0.81	0.19
Stall Creek	17	34	57	47.4	7.3	17	0.2	1.8	0.92	0.44	17	0.44	1.01	0.80	0.16
Tern Ditch	47	46	71	62.0	5.2	47	0.8	2.5	1.76	0.44	46	0.57	1.02	0.73	0.09
Threehouse Creek	70	45	78	56.7	7.7	70	0.1	3.8	1.41	0.70	70	0.08	1.75	0.74	0.19
Overall	742	20	86	55.6	12.2	742	<0.1	4.9	1.52	0.74	742	0.06	2.11	0.72	0.18

Notes:
Summary statistics calculated only when count is greater than five.
mm = millimetre; g = gram; n = count; Min = minimum; Max = maximum; SD = standard deviation.

Table – 5.11: Brook Stickleback Log_{10} Transformed Length-Weight Regression Equation and Correlation Coefficient

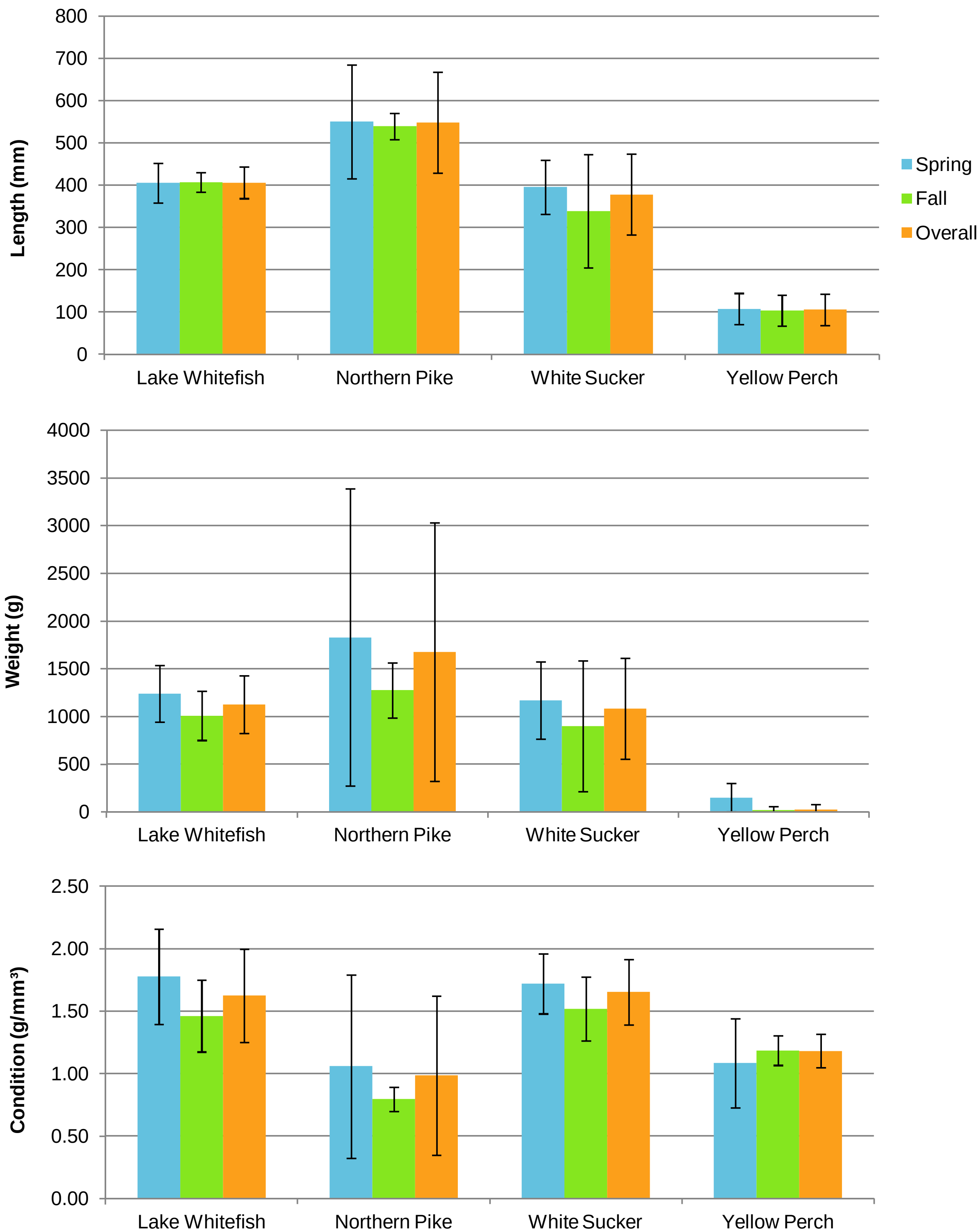
Waterbody	Regression Equation	Regression Coefficient (R^2)	Weight (g) for 60 mm
Anderson Bay (in Wekusko Lake)	y = 2.01x – 3.51	0.39	1.16
Arm Lake	y = 2.63x - 4.34	0.80	2.21
Gaspard Lake	y = 2.78x - 4.77	0.89	1.50
Ghost Lake	y = 3.05x - 5.23	0.67	1.56
Threehouse Lake	y = 2.46x - 4.20	0.52	1.52
Anderson Creek	y = 2.84x - 4.93	0.60	1.36
Ghost Creek	y = 2.44x - 4.11	0.74	1.67
Stall Creek	y = 3.46x - 5.87	0.87	1.89
Tern Ditch	y = 2.86x - 4.89	0.81	1.56
Threehouse Creek	y = 2.93x - 5.04	0.47	1.46
Overall	y = 2.92x - 5.01	0.75	1.52

Notes: Brook Stickleback #055 from Anderson Bay was removed as an outlier from regression equation. Goose Bay (in Wekusko Lake) included in overall regression analysis (only 2 individuals were captured).

AECOM examined seasonal differences in length, weight, and condition for fish captured in Anderson Bay in both spring and fall 2011 (*e.g.*, Lake Whitefish, Northern Pike, White Sucker, and Yellow Perch). On average, weight and condition were higher in spring than in fall; however, there was significant overlap between the two seasons in 2011 (**Figure 5.10**). Therefore, it has been assumed seasonal differences were negligible and not included in comparisons between fish captured in Anderson Bay and Goose Bay.

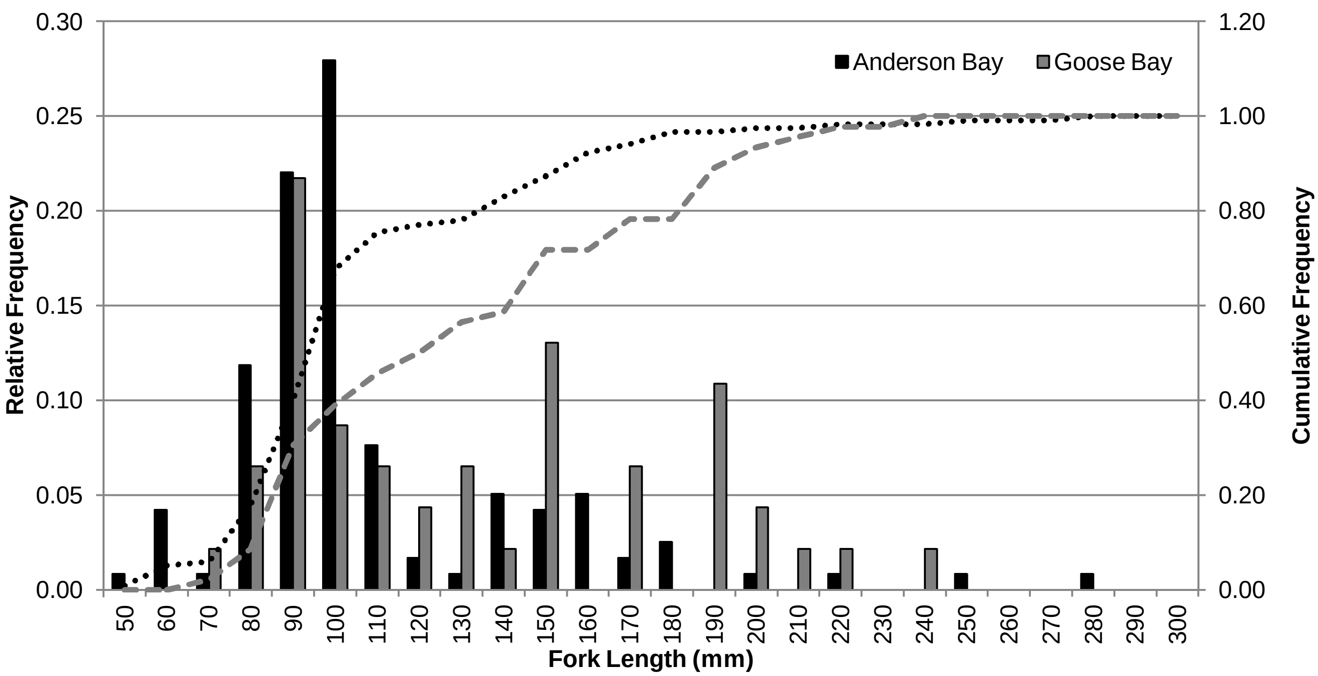
In general, fish captured in Anderson Bay were larger (*i.e.*, longer and heavier) and had higher condition values than those captured in Goose Bay (**Appendix B, Table - 14**). Exceptions include White Sucker fork length, River Shiner weight, and Yellow Perch fork length and condition. Larger fish in Anderson Bay (as compared to those in Goose Bay) could be the result of differences in habitat availability, nutrient enrichment, general fish health, inter- and intra-specific competition (related to habitat availability and fish community composition), food type and availability, and season (including spawning condition).

Figure – 5.10: Mean (±SD) Length, Weight and Condition, of Large-Bodied Fish in Anderson Bay by Season, 2011



Length-frequency distributions demonstrate year-class strength, growth, and reproductive and mortality rates. Each peak in relative frequency suggests an individual year-class, though there may be overlap among year-classes. Yellow Perch were used as an example fish species to examine differences in length-frequency distribution between Anderson Bay and Goose Bay in 2011 (**Figure 5.11**). Anderson Bay fork lengths for Yellow Perch ranged from 50 mm to 275 mm, with three modal points at 50 mm to 69 mm, 70 mm to 129 mm and 130 mm to 189 mm. Goose Bay fork lengths for Yellow Perch ranged from 46 mm to 238 mm, with three modal points at 70 mm to 129 mm, 140 mm to 179 mm and 180 mm to 229 mm. Assuming that catch probabilities are equal between Anderson Bay and Goose Bay, differences in length-frequency distribution suggests differences in habitat quality (*i.e.*, more suitable refuge for Age 0+ fish in Anderson Bay) or less inter- or intra-specific competition (*i.e.*, more larger adults in Goose Bay).

Figure – 5.11: Length Frequency Histograms for Yellow Perch, 2011



Note: Bars are relative frequency of length groups and dashed lines are cumulative frequency of length groups.

At each fish sampling location, habitat observations and measurements were recorded (**Appendix B, Table - 15** and **Photos**). While the majority of sampling locations were in lakes, a wide variety of cover, substrate, and riparian vegetation was present. Overhanging vegetation and boulders provided the most abundant cover types. Organic material, such as decomposing leaves or peat, was the most common substrate. Smaller lakes, dominated by organic substrate that provides limited fish habitat and cover, had no fish captured, including Nutt Lake and Unnamed Lake 1.

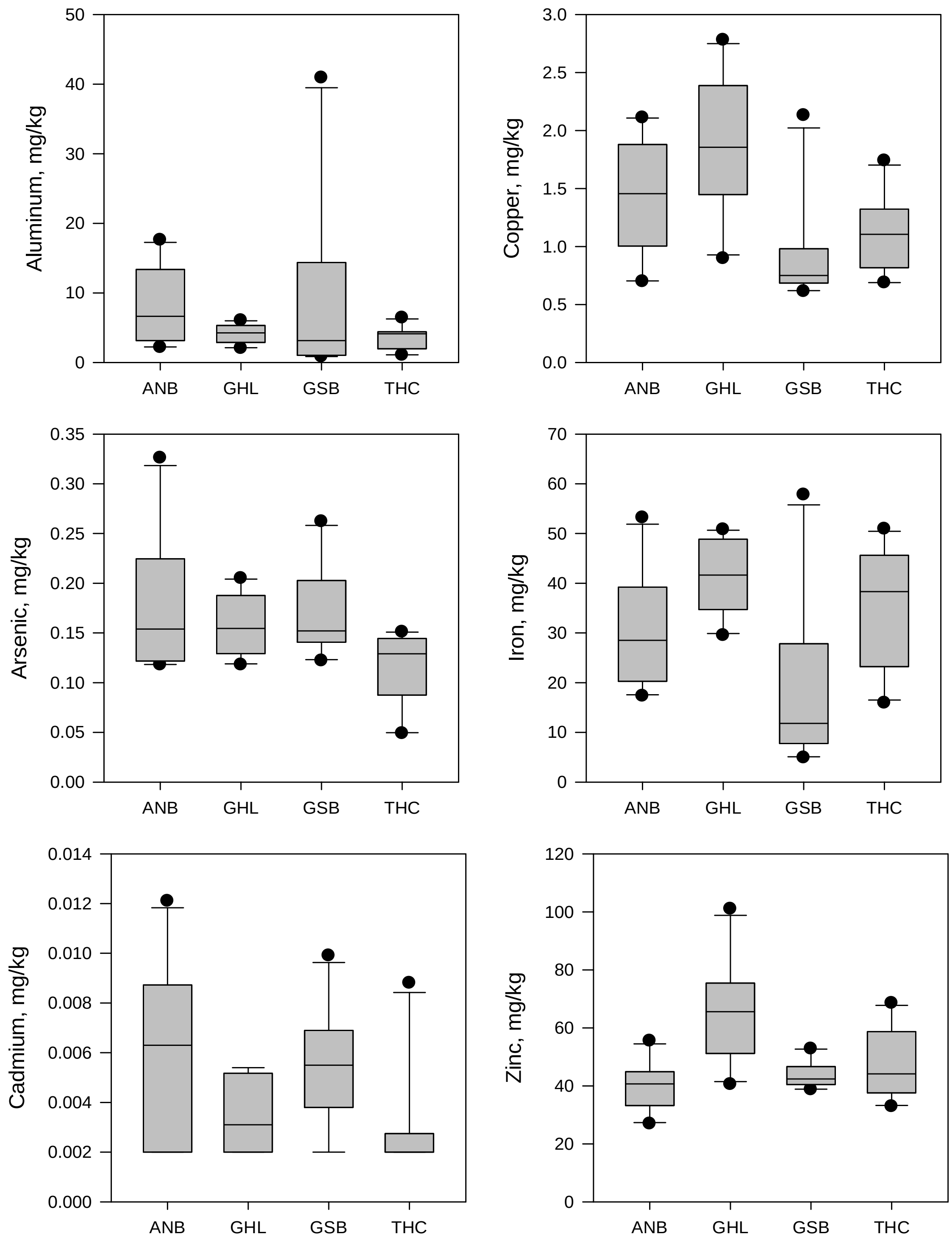
5.5.7 Metal Residues in Fish

Fish were collected from Anderson Bay (in Wekusko Lake), Goose Bay (in Wekusko Lake), Ghost Lake and Threehouse Creek in June 2012 (**Appendix B, Table - 12**). Ten individuals from each waterbody were submitted to ALS Laboratories in Winnipeg, Manitoba for analysis of moisture and total metals (**Appendix B, Table - 16**). Brook Stickleback was the most common species captured except in Goose Bay, where Spottail Shiner dominated the catch. For the purposes of this assessment, it is assumed that there are no differences in terms of metal residue content among the difference species analyzed for metals (*i.e.,* Brook Stickleback and Spottail Shiner).

Antimony, beryllium, bismuth, lithium, nickel, silver, tellurium, thallium, thorium, uranium, vanadium and zirconium were at, or below, detection limits in at least 90% of the samples tested. Lead was detected in only 11 of 40 samples, 8 of which were in Ghost Lake fish (mean concentration of 0.05 mg/kg ± 0.02 mg/kg; **Appendix B, Table - 17**). Nickel was detected only in six of ten Anderson Bay fish (maximum concentration of 0.13 mg/kg; **Appendix B, Table - 17**). None of the concentrations of arsenic or lead exceeded the *MWSQOG* aquatic life tissue residue guidelines for human consumption (**Appendix B, Table - 16**).

Ghost Lake fish had the highest median whole-body concentration of copper, iron and zinc compared to the other waterbodies sampled in 2012 (**Figure 5.12**). Median concentrations of aluminum, copper and iron were lowest in Goose Bay, compared with the other waterbodies sampled in 2012 (**Figure 5.12**). There was generally overlap among the waterbodies with respect to whole-body concentrations of the selected chemicals of concern (**Figure 5.12**).

Figure – 5.12: Box Plots of Six Elements in Whole-Body Concentrations of Fish in Project Area, June 2012[3]



[3] *ANB = Anderson Bay (Wekusko Lake); GHL = Ghost Lake; GSB = Goose Bay (Wekusko Lake); THC = Threehouse Creek.*

To determine the variability between sampling locations during the June 2012 survey, concentrations in whole-body fish samples were compared using one-way analysis-of-variance (ANOVA) for six chemicals of potential concern. Chemicals of potential concern were identified from environmental quality guideline exceedances in water and sediment quality samples collected in 2011 from the Snow Lake area and included: aluminum, arsenic, cadmium, copper, iron, and zinc. Lead and nickel were originally included on this list but had a high incidence of non-detectable concentrations and were thus excluded from the subsequent analysis. The results indicate that significant differences ($p < 0.05$) exist in whole-body concentrations of arsenic, cadmium, copper, iron and zinc (*i.e.,* all but aluminum) (**Table 5.12**).

Table – 5.12: Comparison of Whole-Body Metal Concentrations in Small-Bodied Fish Captured from Four Waterbodies in the Project Area, 2012

Element	Statistical Difference	Significant Pairwise Comparisons
Aluminum	n.s.	n/a
Arsenic	p = 0.008	THC vs ANB THC vs GSB
Cadmium	p = 0.025	ANB vs THC
Copper	p < 0.001	GHL vs GSB GHL vs THC ANB vs GSB
Iron	p = 0.010	GHL vs GSB
Zinc	p = 0.004	GHL vs ANB GHL vs GSB

Notes:
ANB = Anderson Bay (Wekusko Lake); GHL = Ghost Lake; GSB = Goose Bay (Wekusko Lake); THC = Threehouse Creek.

The results of the multiple pairwise comparisons (post hoc Tukey test) conducted are as follows (**Table 5.12**):

- The mean concentration of arsenic in Threehouse Creek (0.11 mg/kg) was significantly different from both Anderson Bay (0.18 mg/kg) and Goose Bay (0.17 mg/kg).
- Cadmium concentrations between Anderson Bay and Threehouse Creek were significantly different; however, this may be skewed as nine of ten fish from Threehouse Creek had concentrations of cadmium less than the detection limit.
- Ghost Lake mean copper concentration (1.9 mg/kg) was significantly different from Goose Bay (0.9 mg/kg) and Threehouse Creek (1.1 mg/kg). Goose Bay mean copper concentration was significantly different from Anderson Bay (1.4 mg/kg).
- Ghost Lake mean iron concentration (41 mg/kg) was significantly different from Goose Bay (19 mg/kg).
- Ghost Lake mean zinc concentration (65 mg/kg) was significantly different from Goose Bay (44 mg/kg) and Anderson Bay (40 mg/kg).

Concentrations of metals in Yellow Perch liver were compared among Trampling Lake, Anderson Bay and Goose Bay as part of the focussed monitoring program conducted by Stantec in 2009 (Stantec, 2010). Stantec concluded that, in general, liver metal concentrations in Yellow Perch from Goose By were higher than those from Anderson Bay (Stantec, 2010).

Fish tissue concentrations in the Snow Lake area are influenced by a variety of sources (natural and anthropogenic). Ghost Lake sediment and fish tissue have elevated metal concentrations compared to other waterbodies along the former rail bed and could be the result of historical mining that occurred in the area (waste rock storage), potential influence from materials used in the former rail bed or naturally elevated elements. The results presented here coincide with those previously presented that show Anderson Bay not having the highest concentrations compared to other waterbodies in the area (Stantec 2010).

5.5.8 Aquatic Habitat Assessment

In total, information was recorded at 24 sites in the Project Area (**Drawing - 25**). Several sites (e.g., Lalor site) were examined for the presence of aquatic habitats but none were observed. Detailed site cards summarize information for crossings that were either fish bearing or had connectivity to fish bearing waters (**Appendix C**). Representative photos of each aquatic habitat site are included in **Appendix C**.

5.5.8.1 Lalor Site

In search of aquatic habitat, a random meander examination around the proposed area of expansion of the Lalor site to the north and east was completed in June 2012. The area is generally low lying and wet, typical of the surrounding area. There does not appear to be any connectivity to surrounding waterbodies and given the shallow depths, which would freeze to bottom in winter, and inadequate substrate and cover, there is **No Fish Habitat** within the Lalor site.

5.5.8.2 Lalor Access Road

Two watercourse crossings, LR01 and LR02*,* along the Lalor Access Road from PR 395 to the Lalor site were assessed for aquatic habitat.

LR01

This crossing was along the Lalor Access Road where it crosses over Tern Ditch, which connects Tern Ditch Pond to Snow Lake (**Drawing - 25**). The channel was uniform, approximately 5 m wide and up to 2 m deep. Vertical banks contained the stream with little to no riparian habitat. The substrate was highly organic with the occasional undercut bank or small woody debris providing limited cover. Two 0.9 m diameter culverts were perched above the stream substrate by approximately 0.2 m on the north side of the road. Cobble covered the channel bed approximately 5 m from the base of the culverts on either side of the road before the natural, highly organic substrate began. Although the cobble provides unique habitat in the channel, it was virtually inaccessible on the north side of the road due to the perched culvert and low water levels. Fishing effort conducted during the spring 2011 baseline assessment produced Brook Stickleback in Tern Ditch. LR01 provides **Marginal Fish Habitat** as the cover and water depth may provide habitat for small-bodied species, but fish passage and utilization is limited by low water levels through a perched culvert (**Appendix C, Site Card - LR01**).

LR02

This crossing was a stream crossing near the quarry along the Lalor Access Road. Installation of the 0.6 m diameter culvert has channelized the water from the saturated lowland surrounding the road to create a stream. The channel on the south side of the road has been excavated adjacent to the tree line and a channel has been created to connect a wetter area to the west to the culvert location. The culvert opening on the north side of the road was perched 0.4 m, with water running down gravel before reaching the natural channel. A thick white gelatinous residue, of unknown origin and composition, coated the substrate along the gravel. There was little observed instream habitat or cover. Due to poor connectivity to fish bearing waterways, shallow water that likely freezes to the bottom in winter, and impediments to fish passage, there was **No Fish Habitat** at crossing LR02 (**Appendix C, Site Card - LR02**).

5.5.8.3 PR 395 South of the Lalor Access Road

The proposed tailings pipeline route along either side of PR 395 from the Lalor Access Road south to the crossover point to the former rail bed was surveyed for aquatic habitat. The area was typical of the Project Area with bedrock outcrops and low-lying areas. Along PR 395, small impounded low lying areas were observed which were likely created during development of the road. Tadpoles were observed in these wet areas but it is unlikely that they would support fish due to the lack of connectivity to larger waterbodies and the shallow water depth, which would freeze to the bottom in winter. The substrate and surrounding vegetation was dominated by terrestrial species. The area along PR 395 provides **No Fish Habitat**.

5.5.8.4 Manitoba Hydro Power Line Corridor

One low-lying saturated area was identified along the edge of the Manitoba Hydro power line corridor (PL01) and a small channel on the edge of the right-of-way (ROW) (LP01).

PL01

Water appears to be draining from the surrounding highlands into the low area and draining into wetland type areas. Aquatic vegetation present at some points (**Appendix C, Photograph 49-51**) indicates that this area is frequently wet (**Appendix C, Table – 01**). However, lack of connectivity and shallow water that likely freezes to bottom in winter, indicates that this site provides **No Fish Habitat**.

LP01

A channel was found within 10 m from the edge of the right-of-way (ROW) **(Appendix C, Photographs 52-54)** during the assessment conducted in June 2012 (LP01, **Drawing - 25**). During rain events, the low-lying area observed within the transmission line ROW could drain into this channel, but it is unlikely that the area is used by fish. The channel was approximately 50 cm below the forest floor, with no banks containing the channel. Substrate was organic with marsh marigolds and various emergent vegetation present. Although it appears this channel is a permanent fixture, due to the same reasons given at site PL01, this site provides **No Fish Habitat**.

5.5.8.5 Former Rail Bed

Seventeen stream crossings were identified along the former rail bed by the presence of culverts, large areas of standing water, or streams on NTS maps. A portion of the existing rail bed is used by trucks to access the sand pit approximately halfway to the former Anderson Mine site from PR 395. This section of rail bed is graded and maintained and therefore crossings and culverts were easy to access and identify. East of the sand pit, the rail bed is more overgrown which limited access and visibility.

The land surrounding the former rail bed is typical of mature boreal forest found throughout the area. Wetlands are interspersed between bedrock outcroppings and old growth spruce stands. Prior to the development of the rail bed the low-lying areas would have been somewhat uniformly saturated, collecting water from the surrounding higher areas. Installation of culverts and excavation of ditches, such as Ghost Creek and Threehouse Creek, provided an area for water to collect and small shallow pools have developed.

Of the seventeen crossings examined along the existing rail bed, twelve were characterized as drainage features; essentially shallow, stagnant ponds, which formed after the installation of culverts and excavation of off-take ditches. The limited availability of cover, lack of connectivity and low water depths (sometimes even dry channels such as at RB01 and RB11), are classified as **No Fish Habitat**. These sites include:

- RB01
- RB04
- RB05
- RB06
- RB08
- RB09
- RB10
- RB11
- RB12
- RB13
- RB14
- RB17

Six culverts (RB04, RB08, RB09, RB10, RB12, and RB14) were buried by accumulation of sediment, rocks, or overgrowth in a similar fashion to the culvert at RB07. Photos for each of these sites can be found in **Appendix C**. No site cards were created for these crossings as they provide **No Fish Habitat**.

Two crossings (*i.e.*, RB15 and RB16) were large areas of standing water alongside the former rail bed due to beaver activity.

RB15

This crossing is along the former rail bed where it crosses Unnamed Creek 1 and was an active beaver impoundment that appears to be part of a small drainage system. The site was initially selected from an NTS map that indicated the presence of an unnamed stream crossing the former rail bed. There was a large pond on the north side of the former rail bed and a smaller pond (5 m by 5 m) on the south side of the former rail bed. Beaver dams created both ponds. While there was no clearly defined channel, a small channel, up to 1.5 m wide, ran over a substrate of fallen and decomposing leaves. The water depth was no more than 0.25 m (**Appendix C, Table - 01**). Minnow traps, deployed as part of the baseline assessment in spring 2011, were set in both north and south ponds, but did not produce any fish. Low water levels and soft substrate prevented any other fishing effort. Due to the lack of connectivity, suitable substrate and shallow water depths (sometimes even dry channels) there is no suitable fish habitat at crossing RB15 (**Appendix C, Site Card - RB15**).

RB16

This crossing was an old beaver impoundment with a large ponded area on the north side of the former rail bed, similar to RB15. The culvert was visible on the south side of the former rail bed, but not visible on the north side of the former rail bed, either having been buried or submerged. There was a large pond on the north side of the road and a smaller pond (5 m by 5 m) on the south side of the road. Beaver dams created both ponds. While there was no clearly defined channel, a 0.5 m to 1.5 m stream of water ran over a substrate of decomposing leaves. The water depth was no more than 0.25 m in the deepest spots (**Appendix C, Table - 01**). In June 2011, there did not appear to be any active beavers at this site but there was evidence of recent beaver activity observed in October 2011. For the same reasons as RB15, there was no suitable fish habitat at crossing RB15 (**Appendix C, Site Card - RB16**).

Three creeks crossed the former rail bed (RB02, RB03 and RB07) and were identified as potentially fish bearing due to their connectivity to larger fish bearing waters (or successful fishing attempts) and sufficient depth to prevent freezing to the bottom (**Appendix C, Table - 01; Drawing - 25**).

RB02

This crossing was along the former rail bed as it crosses Ghost Creek, which originates upstream from Ghost Lake and flows approximately 700 m north to join with Threehouse Creek to form Tern Creek. Tern Creek drains northward into Tern Lake and ultimately, to Snow Lake (**Drawing - 25**). There were two 1.6 m diameter culverts at RB02 (**Appendix C, Table - 01**). The channel was uniform at 7 m wide and ~1 m deep. The banks were vertical and provided little riparian habitat. Upland vegetation was a mix of wetland, grasses, deciduous forest, and coniferous trees. The substrate was highly organic but small woody debris, overhanging vegetation and in-stream vegetation provided moderate amounts of cover. Fishing effort during the 2011 baseline assessment produced Brook Stickleback. RB02 provides **Marginal Fish Habitat** as the limited cover and water depth may provide habitat for small-bodied species. However, it is unlikely that large-bodied species utilize this watercourse (**Appendix C, Site Card - RB02**).

RB03

This crossing was along the former rail bed as it crosses Threehouse Creek, which originates upstream from Threehouse Lake and approximately 300 m north of the former rail bed, it runs alongside Arm Lake. Approximately 400 m past Arm Lake, Threehouse Creek joins Ghost Creek to form Tern Creek which drains into Tern Lake and ultimately, into Snow Lake. There are two 1.95 m culverts at RB03 (**Appendix C, Table - 01**). Threehouse Creek was straight, 5 m wide and 2 m deep with vertical banks. Threehouse Creek flowed through a fen as it approached the south side of the former rail bed. There was a 3 m wide beaver dam approximately 5 m upstream from the former rail bed across Threehouse Creek. At the time of assessment, water appeared at equilibrium across the culverts. The substrate was highly organic, but small woody debris, overhanging vegetation, and instream vegetation provides moderate amounts of cover. Fishing effort at this location during the 2011 and 2012 baseline assessments produced Brook Stickleback. RB03 provides **Marginal Fish Habitat** as the limited availability of cover and water depth may provide habitat for small-bodied species, but it is unlikely that large-bodied species utilize this watercourse (**Appendix C, Site Card - RB03**).

RB07

This crossing was at a channel draining northward to Gaspard Lake, immediately east of the sand pit. The culvert was located almost immediately under a steep rise in elevation (2 m to 3 m) of the former rail bed. The 0.86 m diameter culvert was blocked on the south side due to the accumulation of sediment (**Appendix C, Table - 01**). On the north side of the former rail bed, the straight channel is 0.3 m deep and 1.0 m wide in the direction of Gaspard Lake and acts as a snowmobile trail in winter. South of the former rail bed, a channel runs east along the former rail bed before dispersing into a wetland area. Water likely meanders around the blocked culvert, through the low spot in the former rail bed and back into the channel, on the north side. During the spring 2011 baseline assessment, there was no fishing effort directly in this channel, but minnow traps in the adjoining Gaspard Lake produced Brook Stickleback. The limited cover and shallow water depth and lack of connectivity to Gaspard Lake means RB07 provides no fish habitat (**Appendix C, Site Card - RB07**).

5.5.8.6 Former Anderson Mine Site

The proposed reclaim pipeline follows one of the supporting roads from the former Anderson Mine. Another pipeline runs parallel to the road before redirecting into Anderson TIA. AD-02 and AD-03 are watercourse crossings sites along the same unnamed waterway.

AD02

AD02 is at a culvert along the road. The culvert is blocked causing a small ponded area on the north side. On the south side of the road, water trickles towards Anderson TIA through an ill-defined channel overgrown with deciduous trees. AECOM field teams followed the waterway 150 m north at which point they encountering a second culvert and road (AD03). Water in the channel between the culverts is shallow with low flow. The culverts were perched 0.6 m and 0.4 m and there are several small waterfalls which would prevent fish passage upstream. Substrate is sand and silt with no defined channel. Water is shallow (0.02 m) with no instream vegetation and no fish cover. AD02 provides **No Fish Habitat** (**Appendix C, Site Card - AD02**) as there is no suitable fish cover and water would freeze to bottom in winter.

AD03

AD03 is a large drainage channel to the north of the proposed reclaim pipeline. The channel is uniform 5 m in width with organic substrate. The water is darkly tannin-stained with no noticeable flow. Banks are roughly vertical with grasses and coniferous trees. Grasses, lilypads and woody debris provide cover in the channel. To the east, the channel ends at PR 392. To the west, beaver dams were observed which likely regulate water discharge to the creek running through AD02. Due to sufficient depth preventing freezing to bottom and suitable cover and habitat, the channel at AD03 potentially supports forage fish but with no connection to fish bearing waters provides no fish habitat (**Appendix C, Site Card - AD03**).

5.5.8.7 Snow Lake Pumphouse and Fresh Water Pipeline

Access to the existing pumphouse is by a short access road off PR 395. A qualified fisheries biologist inspected the shoreline immediately north of the pumphouse and approximately 10 m on either side. The area surrounding the pumphouse is mature coniferous forest with thick moss undergrowth. Mature trees grow up to the edge of the water exposing bedrock that slopes steeply into the lake. Cover is available as overhanging vegetation and large woody debris from falling or fallen trees.

The existing pumphouse sits on a flattened section of shore approximately 10 m from the water's edge (**Appendix C, Photograph 55**). Bedrock was leveled during construction of the pumphouse to provide a flat area for the associated buildings. The shoreline in this area is comprised of riprap which provides cover for fish and drift wood that has accumulated along the shore (**Appendix C, Photograph 60**). Approximately 5 m off-shore, the water is approximately 15 m deep. The condition of the pipe and intake structure is unknown as it was not visible from shore.

Snow Lake supports a sportfish population and is used for recreational fishing. According to the DFO guidelines (1998), the habitat in and around the pumphouse and intake structure would be classified as **Important Fish Habitat** due to the presence of sportfish which are of importance recreationally in Snow Lake.

At the time of the baseline assessment in 2011, the southern shoreline in the northwest arm of Snow Lake was assessed for fish habitat. This location was identified as a potential alternative location for a pumphouse on Snow Lake to provide fresh water for the proposed Lalor Concentrator. Bedrock steeply slopes into the lake in the northwest arm of Snow Lake. Most of the bedrock is covered with a thick layer of moss and the tree stand is characterized as mixed forest (*i.e.,* coniferous and deciduous trees). Water depth within 5 m of shore ranged from 3 m to 6 m. Large boulders were visible in shallower sections. Boulders, overhanging vegetation and large woody debris, provided cover for fish.

There were three bays which provided sandy shallow water habitat in the southern shoreline in the northwest arm of Snow Lake. Large woody debris, cobble and overhanging vegetation provided cover for fish. These bays were unique habitat for fish given the otherwise uniform nature of the southern shoreline of the northwest arm of Snow Lake (**Appendix C, Photographs 57-58**). The shallow, sheltered water provides nursery or rearing habitat for a variety of fish species. This alternate location was assessed as having **Important Fish Habitat**.

A proposed pipeline from the pumphouse to the proposed new concentrator would cross PR 395 and continue down an existing access road to the former Anderson Mine. The proposed fresh water pipeline then turns to cut through previously undeveloped forest on a direct route to the former rail bed where it would join the tailings and reclaim water pipeline alignments. There were several saturated low-lying areas, but **No Fish Habitat** was observed during ground surveys conducted in September 2011 and October 2011.

5.5.8.8 PR 392 at Anderson Creek

As the potential relocation alignment of PR 392 was not available at the time of the stream crossing assessment, the area of assessment extended from the weir, which controls discharge from Anderson TIA into Anderson Creek, to ANC02, a baseline assessment station on Anderson Creek located approximately 450 m downstream of the PR 392 crossing. The area of assessment also included the PR 392 as it crosses over Anderson Creek, approximately 50 m downstream of the weir.

HWYAN

Anderson Creek originates at the Anderson TIA and drains to the east into Anderson Bay of Wekusko Lake (**Drawing – 25**). Discharge from the TIA into Anderson Creek is regulated through a weir. The discharge pipe is perched, which creates a barrier to fish passage upstream from Anderson Creek into TIA. Water flows down a moderately steep bank due to the development of a dyke to impound the TIA. This riffle/run section runs over boulders, fallen trees, gravel, and sand. A large backwater area has developed on the upstream side of PR 392. Downstream of the culvert the channel is uniform in width (1.5 m) and depth (~1.0 m) for approximately 75 m before spreading across a wide floodplain. Substrate in the channel is predominately sand and gravel near PR 392, but increases in organic composition further away. Boulders, overhanging vegetation and woody debris provide cover for fish. Backpack electrofishing and minnow traps in Anderson Creek captured Pearl Dace, Brook Stickleback, Iowa Darter, and Fathead Minnow in spring 2011 as part of the baseline assessment. Abundant instream vegetation provides cover for small-bodied species for spawning and foraging, when adequate water levels exist but use of the area for large-bodied fish is unlikely. This crossing provides **Marginal Fish Habitat** (**Appendix C, Site Card - HWYAN**) due to lack of upstream connectivity as a result of the perched discharge culvert at the weir and limited availability of habitats for large-bodied fish.

5.5.9 Summary of the Aquatic Environment

There was some evidence of stratification in Snow Lake in spring 2011, the deepest waterbody included in the survey. The pattern is indicative of residual winter stratification (*i.e.*, prior to spring turnover). With the exception of the deepest spots, water was well oxygenated. The majority of waterbodies were mesotrophic or meso-eutrophic, with higher total phosphorus concentrations in the fall as compared to spring. Total phosphorus concentrations in Arm Lake were below detection limit and were ranked as oligotrophic. Phytoplankton bio-volume was congruent with trophic status.

In 2011 and 2012, 63 water samples in the Snow Lake region were collected and submitted for analysis of physical and chemical parameters in order to establish baseline conditions. Total aluminum, cadmium, copper, iron, selenium, and zinc concentrations exceeded the *CWQG* guideline in at least one sample. Concentrations of ammonia, fluoride and pH also exceeded applicable water quality guidelines in at least one sample.

The quality of the majority of water samples in the Project Area were classified as *Good* or *Excellent* based on the ranking system in CCME (2001). Within Anderson Bay, large differences were observed between near shore and offshore sites for parameters such as dissolved solids and conductivity, however water conditions were good at all Anderson Bay sites. Some differences were observed between spring and fall samples; however, these differences are consistent with changes in aquatic productivity during the open water season.

A total of 177 surficial sediments were collected from 13 waterbodies in the Snow Lake region and analysed for particle size distribution, major elements and chemicals of potential concern to determine baseline characteristics of the sediments in 2011 and 2012. The data were analysed to determine spatial trends within and among waterbodies and to classify the sediments in terms of sediment quality index.

The concentrations of major elements varied significantly between waterbodies, and in some areas, varied significantly between sampling stations within each site and, in the case of total phosphorus, also varied seasonally. Total nitrogen, phosphorus, and carbon levels are within ranges considered acceptable for natural and slightly impacted lakes. Chemicals of potential concern show similar spatial trends, with significantly higher levels of some compounds in lakes associated with historic or current mining activity. Comparisons between sampling sites within the larger waterbodies show that these elevated levels are uniformly distributed over a large area, while at other sites (*e.g.*, Anderson Bay) differences are observed between near shore and offshore sites.

Sediment Quality Index values were calculated from the *ISQG* and *PEL* for sediments at the 13 waterbodies. Indexes based on the *ISQGs* ranged from 29 at Ghost Lake, poor baseline sediment quality due to large exceedances from arsenic, copper and zinc to 100 in Tern Ditch, indicating excellent baseline sediment quality. Indices improved markedly when compared to *PEL* values, suggesting few ongoing ecological effects to aquatic life at most sites.

Of the 19 metals for which a sediment quality guideline exists, 9 were not exceeded in any sediment sample collected in the Project Area in 2011 and 2012 (*i.e*., antimony, barium, beryllium, molybdenum, silver, thallium, tin, uranium and vanadium). In the 2011 and 2012 baseline samples, 10 metals had concentrations that exceeded a sediment quality guideline (*i.e.,* arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, and zinc). Overall, the baseline sediment quality in the waterbodies in the Project Area complements the water quality analysis.

Overall phytoplankton and zooplankton abundance and species diversity coincide with low WQI and SQI values. Diversity and abundance was not consistently different in samples collected from the same waterbodies in spring and fall. Seasonal changes are related to higher primary productivity and trophic status in fall as well as competition or predation and water physiochemistry. In addition, plankton communities in lakes and creeks were different from each other, in terms of abundance and species composition.

In general, the benthic invertebrate community was less diverse and abundant in sediments that were more complex (*i.e.,* fines, sand, gravel) such as in Anderson Creek. Creeks that had less flow and more organic sediments typically had less balanced benthic invertebrate communities than those with more complex sediments or flow.

In total, there were 24 orders of benthic invertebrates identified in the samples collected in September 2011. The dominant order for all waterbodies was Diptera with the exception of Nutt Lake, which was dominated by Amphipoda. The average density (total waterbody density divided by number of stations sampled in a waterbody) ranged from 86 n/m² to 21,466 n/m², for Anderson Creek and Tern Ditch, respectively. In general, the benthic invertebrate community in waterbodies that are closer to the "reference" waterbody are more similar than those that are further away.

Lakes along the former rail bed typically had less diversity and density but higher proportion of EPT taxa than Anderson Bay in Wekusko Lake. In general, EPT taxa (*i.e.,* Ephemeroptera, Plecoptera and Tricoptera) were present in low numbers, with 11 stations that had no EPT taxa. A few waterbodies along the former rail bed (*i.e.,* Arm Lake and Gaspard Lake) had higher proportion of EPT taxa, suggesting that the habitat quality is high in these areas.

Minnow traps, gill nets, and a backpack electrofisher were used to collect fish in the Project Area. In total, 17 fish species were captured during the baseline studies conducted in 2011 and 2012. No fish were captured in Nutt Lake, Unnamed Lake 1, and Unnamed Creek 1. In general, the larger waterbodies (*i.e.*, Anderson Bay and Goose Bay) had the highest species diversity. For most other waterbodies, Brook Stickleback were the most abundant (or only) species captured, typical of headwater waterbodies. In spring, several species were captured in spawning condition (*i.e.*, Yellow Perch, White Sucker, Brook Stickleback, and Pearl Dace). Large school of Young-of-Year Brook Stickleback and spawning Pearl Dace were captured and observed in Anderson Creek, adjacent to PR 392. In general, fish were in good health and condition. External parasites (white cysts or black spot) and fin erosion were present in fish from most waterbodies.

Brook Stickleback were, as predicted by regression analysis, largest in Arm Lake and smallest in Anderson Bay of Wekusko Lake. These spatial differences are due to differences in habitat availability, competition or food abundance and diversity. There were more smaller Yellow Perch in Anderson Bay and more adults in Goose Bay. A difference in length-frequency distribution suggests differences in habitat quality (*i.e.*, more suitable refuge for Age 0+ fish in Anderson Bay) or less inter- or intra-specific competition (*i.e.*, more larger adults in Goose Bay).

Ghost Lake mean concentrations were higher and significantly different from at least one of the other waterbodies for copper, iron and zinc. This higher metal load coincides with the high incidence of parasitic infestation in Ghost Lake fish. Although water quality in Ghost Lake was rated as excellent, sediment quality was rated as poor or marginal during baseline studies conducted in 2011. Benthic invertebrate diversity and density were also reduced in Ghost Lake, compared to other waterbodies along the former rail bed.

In general, the lowest mean concentrations were found in Threehouse Creek and Goose Bay. Water and sediment quality in Threehouse Creek was considered excellent and good, comparable to other waterbodies along the former rail bed. Although no baseline information was collected from Goose Bay by AECOM, environmental effects monitoring conducted by Stantec indicates that water quality is considered comparable to other bays in Wekusko Lake (*e.g.,* Berry Bay) (Stantec, 2010).

The majority of cover in the waterbodies assessed in 2011 and 2012 included vegetation (overhanging, submergent, and emergent) and cobble. All lakes provided diverse cover types and varying degrees of shoreline complexity. As several fish species were captured in spawning condition, the majority of waterbodies provided spawning and rearing habitat. Foraging habitat for large-bodied fish is predominately available in Wekusko Lake (*i.e.*, Anderson Bay and Goose Bay). Although the creeks and lakes along the proposed Lalor Concentrator pipeline alignments (along the former rail bed) provided a diversity of habitats, their shallow depth and limited connectivity to other waterbodies suggests that they cannot support populations of large-bodied fish.

In general, waterbodies potentially affected by land use activities (e.g., adjacent to the former rail bed) demonstrate reduced water and sediment quality. The current spatial patterns with respect to water and sediment quality are probably related to local releases of the elements and subsequent transport through complex aquatic systems with depositional and erosional areas. This interpretation is consistent with the land use patterns in the area, the presence of historic mining activity and natural sources of the elements in a mineral-rich region. The spatial variability in the concentrations of potential chemicals of concern needs to be considered when developing monitoring and assessment programs.

Critical fish habitat was not observed during the aquatic habitat assessments associated with the proposed pipeline alignments. Fish habitat along the proposed pipeline alignment assessed provided, at most, **Marginal Fish Habitat** (**Table 5.14**). Limited cover availability and water depth limits the habitat value at these crossings. Crossings at Threehouse Creek (off-take ditch), Gaspard Creek, Ghost Creek (off-take ditch), and Tern Ditch could provide small-bodied fish with migration habitat; however, this would be limited in low water conditions. Based on the fish studies conducted in the region, Pearl Dace appears to be unique to the riffle/run habitat found immediately upstream of PR 392 in Anderson Creek. This habitat was not observed in other waterbodies assessed during the baseline studies, where bogs and slow-moving water dominate. The locations of the existing and potential alternate pumphouses on Snow Lake are classified as **Important Habitat** due to the presence of sportfish, which are of recreational importance.

Table – 5.13: Summary of Aquatic Habitat Assessments in Project Area, 2011-2012

Area	Location ID	Habitat Classification
Lalor site	-	No Fish Habitat
Lalor Access Road	LR01	**Marginal Fish Habitat**
	LR02	No Fish Habitat
PR 395 south of the Lalor Access Road	-	No Fish Habitat
Manitoba Hydro power line corridor	LP01	No Fish Habitat
	PL01	No Fish Habitat
Former rail bed	RB01	No Fish Habitat
	RB02	**Marginal Fish Habitat**
	RB03	**Marginal Fish Habitat**
	RB04	No Fish Habitat
	RB05	No Fish Habitat
	RB06	No Fish Habitat
	RB07	No Fish Habitat
	RB08	No Fish Habitat
	RB09	No Fish Habitat
	RB10	No Fish Habitat
	RB11	No Fish Habitat
	RB12	No Fish Habitat
	RB13	No Fish Habitat
	RB14	No Fish Habitat
	RB15	No Fish Habitat
	RB16	No Fish Habitat
	RB17	No Fish Habitat
Former Anderson Mine site	AD02	No Fish Habitat
	AD03	No Fish Habitat
Snow Lake pumphouse and freshwater pipeline	Existing pumphouse	**Important Fish Habitat**
	Alternate pumphouse	**Important Fish Habitat**
	Freshwater pipeline	No Fish Habitat
PR 392 at Anderson Creek	HWYAN	**Marginal Fish Habitat**

5.6 Quality Assurance and Quality Control

5.6.1 Methodology

ALS Environmental, a Canadian Association of Laboratory Accreditation Inc. (CALA) accredited analytical laboratory, employs standard laboratory Quality Assurance and Quality Control (QA/QC) measures, performed all laboratory analyses. As part of the field QA/QC program, and as recommended by the federal *Metal Mining Effluent Regulations* (MMER) (Government of Canada, 2002) as described the technical guidance document (Environment Canada, 2002), field crews collected sediment in triplicate at each station. At least 10 m separated each sediment replicate. Due to the high cost associated with particle size analysis, the analytical laboratory analyzed only one sediment replicate per station. Field crews submitted only one of the three benthic invertebrate community replicates for taxonomic analysis enumeration and archived the remaining two replicates.

Surface water analysis included field blanks and trip blanks in association with all field programs (**Appendix B, Table - 18**). The field crew filled field blank bottles in the field with deionized water while the analytical laboratory filled the trip blank bottles prior to the field program with deionized water. Both the trip and field blanks were stored and transported with water samples. Finally, field crews collected four and two duplicate samples in the spring and fall programs, respectively (**Appendix B, Table - 18**). There were no field QA/QC samples associated with zooplankton or phytoplankton.

AECOM evaluated the quality of laboratory analytical results following the methods described in British Columbia's Ministry of Environment, Lands and Parks BC MELP (1998). There are currently no Manitoba specific guidelines for estimating the overall precision of the field techniques and laboratory analysis. When the values for replicate samples have low variability, then contamination during collection or analysis is unlikely. The recommendations in BC MELP (1998) include identifying potential contamination in field and trip blanks, and assessing precision of field techniques and analytical results in replicate samples using Percent Relative Standard Deviation (PRSD) and in duplicate samples using Relative Percent Mean Difference (RPMD). The analytical laboratory performed sample analysis for any concentrations that we flagged as suspect.

AECOM screened field and trip blank analytical results for evidence of sample contamination, *i.e.*, where any concentration exceeded five times the analytical detection limit. The laboratory results for potential outliers, transcriptional, and/or analytical errors were examined.

To quantify the precision of analytical results PRSD for replicate samples was calculated. If one of the replicate values was less than five times the detection limit, PRSD was not calculated. Precision is poor if PRSD values were greater than 18%. The formula is as follows:

$$PRSD = 100 * \{SD / \bar{X}\}$$

Where:

PRSD = Percent Relative Standard Deviation
SD = standard deviation of replicates
$\bar{X}$ = mean of replicates

Field crews collected sediment samples in replicate and not in duplicate. In this case, we used PRSD to assess the relative within station homogeneity to identify potential contamination or errors in laboratory analysis.

AECOM calculated RPMD for true duplicate (or triplicate) samples to quantify the precision of analytical results. If one of the duplicate values was less than five times the detection limit, RPMD was not calculated. Precision is poor if RPMD values were greater than 25%. The formula is as follows:

$$RMPD = 100 * \{(C_1 - C_2) / \bar{X}\}$$

Where:

RMPD = Relative Mean Percent Difference
C_1 = concentration of duplicate 1
C_2= concentration of duplicate 2
$\bar{X}$ = mean of duplicates

In addition to the above-mentioned screening indices, sediment replicate data were initially analysed using a trial version of the multivariate software package The Unscrambler 10.1 (Camo Software, Oslo, Norway) using Principal Components Analysis (PCA) to detect outliers and data errors in 2011 data.

5.6.2 Results

Field and trip blanks contained detectable concentrations of several water quality parameters. However, the majority of concentrations were less than five times the analytical detection limits (**Appendix B, Table - 18**). The concentration of dissolved antimony in a number of spring 2011 trip blanks were flagged as suspect and were reanalyzed by the analytical laboratory (**Table 5.14**). Three of the four recheck concentrations were below detection limit. Although the field blank from summer 2012 (FLB-02) showed possible contamination in several physical parameters, there were no metal concentrations greater than five times the detection limit. However, the results from the water quality analysis from Anderson Creek in summer 2012 should be interpreted with this result in mind.

Duplicate water samples had RPMD values that exceeded 25%. The analytical laboratory could not re-analyze chlorophyll *a* and pheophytin *a* due to insufficient sample volume remaining. Recheck concentrations for THL-03 and duplicate are more consistent than the original concentrations, for dissolved manganese and total silicon.

Several sediment replicates had PRSD values exceeding 18% and the analytical laboratory performed re-analysis on selected samples (**Table 5.14**). The majority of recheck concentrations were not significantly different from the original concentration with the exception of bismuth (STC-01C) and copper (ANB-02C).

Results from the PCA on sediment chemistry revealed one potential error: the only sample in which tin was detected was in Tern Ditch (11 mg/kg dry weight). However tin was below detection (*i.e.*, 5 mg/kg dry weight) in five other samples taken in the same area and is probably an erroneous measurement.

Table – 5.14: QA/QC Re-Check Results

Season	Sample ID	Parameter	Unit	DL	Original Value	Recheck Value
Trip Blank with Detectable Concentrations						
Spring	TRB-04	Dissolved Antimony	mg/L	0.0002	0.00046	0.00044
	TRB-01	Dissolved Antimony	mg/L	0.0002	0.00038	<0.0002
	TRB-02	Dissolved Antimony	mg/L	0.0002	0.00038	<0.0002
	TRB-05	Dissolved Antimony	mg/L	0.0002	0.00040	<0.0002
Field Blank with Detectable Concentrations						
Summer	FLB-02	Conductivity	mg/L	20	490	n/a
		Total Dissolved Solids	mg/L	5	308	n/a
		Turbidity	NTU	0.1	2.1	n/a
		Reactive Silica	mg/L	0.025	0.37	n/a
		BOD Carbonaceous	mg/L	6	36	n/a
		Dissolved Organic Carbon	mg/L	1	11.2	n/a
		Total Organic Carbon	mg/L	1	19.2	n/a
Duplicates; RPMD > 25%						
Spring	THC-01	Chlorophyll a	µg/L	0.1	0.53	n/a
	DUP-01 (THC-01)	Chlorophyll a	µg/L	0.1	0.81	n/a
	THL-01	Pheophytin a	µg/L	0.10	1.23	n/a
	DUP-02 (THL-01)	Pheophytin a	µg/L	0.10	0.82	n/a
Fall	THL-03	BOD Carbonaceous	mg/L	1.0	2.0	n/a
		Dissolved Manganese	mg/L	0.00010	0.00327	0.00031
		Total Silicon	mg/L	0.050	0.860	0.7877
	DUP-02 (THL-03)	BOD Carbonaceous	mg/L	1.0	5.9	n/a
		Dissolved Manganese	mg/L	0.00010	0.00042	0.00037
		Total Silicon	mg/L	0.050	1.09	0.7685
Replicates; PRSD > 18%						
Spring	STC-01C	Bismuth	mg/kg dw	0.020	0.268	0.08
	STC-02A	Zinc	mg/kg dw	10	497	469
Fall	UC1-01A	Total Organic Carbon	%	0.10	5.35	4.82
		Total Carbon by Combustion	%	0.1	5.5	4.94
	STL-01B	Iron	mg/kg dw	25	94000	85400
	GHL-03C	Lead	mg/kg dw	0.20	2.41	2.32
	GHL-02A	Bismuth	mg/kg dw	0.020	0.029	0.030
	TED-01C	Boron	mg/kg dw	1.0	22.0	23.1
	THC-01C	Arsenic	mg/kg dw	0.10	6.41	7.57
	ANB-02C	Copper	mg/kg dw	1.0	172	47.0

Notes: n/a = sample could not be re-analyzed.

All recheck values have been incorporated into appropriate appendix tables (**Appendix B, Table – 01**, **Appendix B, Table – 05**, and **Appendix B, Table – 18**).

6. Socio-Economic Environment

6.1 Protected Areas

The nearest protected area to the Project Site is Wekusko Falls Provincial Park (0.88 km^2), located approximately 15 km southeast of the Lalor site. The Park flanks the Grass River as is drops 12 m over a series of rapids and falls, known as Wekusko Falls. The Park is classified as a Recreation Park. (Manitoba Conservation, 2012b).

Grass River Provincial Park is located approximately 25 km southwest of the proposed Lalor Mine site and covers an area of 2,279 km^2. This Provincial Park is also classified as a Natural Park as its purpose is to preserve natural areas that represent the Churchill River Upland portion of the Precambrian Boreal Forest. Woodland Caribou can be found throughout the park year round, and are usually found in areas with mature forest and treed muskeg (Manitoba Conservation, 2012c).

Cormorant Provincial Forest is located approximately 80 km southwest of the proposed Lalor Mine site and is the most northern Provincial Forest in Manitoba. This provincial forest was established in 1947 and covers an area of 1,479 km^2 including Clearwater Lake Provincial Park. Provincial forests are Crown Lands managed by Manitoba Natural Resources (Manitoba Conservation, 2011b).

Clearwater Lake Provincial Park is located approximately 105 km southwest of the proposed Lalor Mine site and covers an area of 593 km^2. This Provincial Park is classified as a Natural Park as its purpose is to preserve natural areas that represent the Mid-Boreal portion of the Manitoba Lowlands (Manitoba Conservation, 2012d).

The Saskeram Wildlife Management Area (WMA) is located approximately 130 km southwest of the Project Site, occupies an area of 958 km^2, and encompasses a large portion of the Saskatchewan River delta and floodplain, providing breeding and staging area for waterfowl, and habitat for moose, wolves, black bears, and furbearers. (Manitoba Conservation, 2012e)

The Tom Lamb WMA is located approximately 85 km southwest of the Project Site and occupies an area of 2,083 km^2. Area within the WMA is flat with several limestone ridges and river levees with Aspen, jack pine, and black spruce growing along the ridges and poplar, willow Manitoba maple and green ash growing along the levees. The WMA is a breeding and staging area for waterfowl and provides habitat for furbearers, moose, wolves and black bears. Bald eagles use the WMA for feeding, staging and occasionally for nesting. (Manitoba Conservation, 2012f)

6.2 Heritage Resources

Information from the Historic Resources Branch of Manitoba Culture, Heritage and Tourism does not indicate any historic or heritage resources at Lalor Concentrator site or in the immediate surrounding area.

Approximately 20 km south of Lalor Lake is Tramping Lake, the site of one of Manitoba's largest known concentrations of aboriginal petroglyphs. At the narrows of Tramping Lake, in the southeastern part of the Grass River waterway, ancient artwork appears on a series of 14 rock faces on granite outcropping that dominates the shore. The paintings of deer, bison, moose, birds, fish, snakes, and humans is thought to have been created 1,500 to 3,000 years ago by the Algonquian-speaking ancestors of the Cree and Ojibway First Nations (Great Canadian Rivers, 2012).

6.3 Economy

6.3.1 Town of Snow Lake

The main settlement in Project Region is the Town of Snow Lake, an important mining and service centre for the surrounding area. According to the 2011 census data from Statistics Canada, Snow Lake has a population of 723 (Statistics Canada, 2012a) with the majority of these residents employed at, or supported by, the mines located throughout the area. Many other Snow Lake residents are employed in the industries and services that support the region's mining operations.

In addition to mining activities, extensive forestry operations have occurred within the region and surrounding area, with wood sent to the pulp and paper mill operation in The Pas, Manitoba. Trapping and hunting are popular activities in this region. Snow Lake offers a number of recreational opportunities, including hunting, fishing, camping, and boating.

6.3.2 City of Flin Flon

According to the 2011 census data from Statistics Canada, the City of Flin Flon has an approximate population of 5,592 people (Statistics Canada, 2012b; Statistics Canada, 2012c). The City of Flin Flon is the main mining community in northwestern Manitoba and northeastern Saskatchewan. Flin Flon is located just over 800 km north-northwest of Winnipeg, Manitoba, and 120 km west of the Town of Snow Lake. The community occupies portions of both Manitoba and Saskatchewan.

In addition to mining, Flin Flon has a strong tourism industry that includes hunting, fishing, camping, and boating.

6.4 Community Infrastructure

6.4.1 Traffic

Highways near the proposed Lalor Concentrator are shown in **Drawing - 02**. According to Manitoba Infrastructure and Transportation, the 2011 annual average daily traffic (AADT) flow for PR 392 north of Provincial Trunk Highway (PTH) 39 and south of the PR 395 junction ranges from 270 to 510 vehicles per day. The AADT for PR 395 west of the PR 392 junction is 520 vehicles per day (Manitoba Infrastructure and Transportation, 2011).

6.4.2 Town of Snow Lake

The Town of Snow Lake is situated mid-way between Thompson, and Flin Flon and The Pas. Year-round road access is provided to Snow Lake by PR 392. The community is serviced directly by Manitoba Hydro transmission lines and has telephone access through Manitoba Telecom Services Inc. Potable water is obtained from Snow Lake, and is treated in a water treatment plant located in the Town of Snow Lake.

6.4.3 City of Flin Flon

Access to Flin Flon is along paved PTH 10 from The Pas and Southern Manitoba, PTH 39 from Snow Lake and Thompson, and Highway 106 from Saskatchewan. Flin Flon is serviced directly by Manitoba Hydro transmission lines and has telephone and cellular access through Manitoba Telecom Services Inc.

6.5 Community Services

6.5.1 Town of Snow Lake

The Town of Snow Lake has various community services including a health facility that is staffed by two doctors, a grocery store, two hotels/motels, two service stations, a hockey arena, a curling rink, and a nine-hole golf course. There is an un-serviced gravel municipal airstrip located approximately 30 km east of the Lalor site along PR 393 that is designed to accommodate air ambulances for medical evacuations. Other services include a Royal Canadian Mounted Police (RCMP) station and a volunteer fire department. There are numerous recreational opportunities including camping, hiking trails, fishing, hunting, snowmobiling, and all-terrain vehicle trails (Snow Lake, 2012).

6.5.2 City of Flin Flon

The City of Flin Flon operates an airport located 20 km southeast of the city near Baker's Narrows. Other services such as a hospital, a fire hall, and a RCMP station are located in Flin Flon along with a hockey arena, curling rinks, a golf course, a public swimming pool and numerous sports fields for recreational opportunities (City of Flin Flon, 2013).

6.6 Personal/Family/Community Life

6.6.1 Town of Snow Lake

Some of the larger community events held in Snow Lake include the Winter Whoot Festival and the Sno-Drifters Radar Runs. Other events include Bingo and Texas Hold'em that are held at the Royal Canadian Legion #241 (Snow Lake, 2012).

6.6.2 City of Flin Flon

Various community events are held in Flin Flon during the year. Some of these include: The Friendship Center Sled Dog Races, Baker's Narrows Day, Phantom Lake Father's Day Picnic and the Trout Festival. Other smaller events include a Spring Breakout Program, Canada Health Day Event, Terry Fox Run and the Christmas Family Event (City of Flin Flon, 2013).

6.7 Regional Resource Use

6.7.1 Trappers

The Manitoba Conservation office in Snow Lake has confirmed that there are two registered trap lines (RTL) in the area of Cook Lake and Lalor Lake. These lines include RTL 23 and RTL 14 that are owned by Martin McLaughlin and Jim Schollie, respectively. Manitoba Conservation has confirmed that the area of Anderson Creek and Wekusko Bay is registered as RTL 13. This trap line is owned by Russell Bartlett (assisted by Greg Foord).

6.7.2 Cottages or Remote Residences

The closest cottages and remote residences to the Project Area are the cabin subdivisions on Berry Bay, Taylor Bay, and Bartlett's Landing. These road accessible cottages are all season residences used a both multi season secondary and primary residences. Five remote cabins are located on Cook Lake. These cabins have only been on the lake in the last 15 years and that five cabins are the maximum allotted to Cook Lake by Manitoba Conservation.

6.7.3 Lodge Owners

There are four lodges located in the Snow Lake region. The Diamond Willow Inn & Willow House is located in the Town of Snow Lake at 200 Lakeshore Drive and is approximately 9 km east of the Lalor site. Wekusko Falls Lodge and Tawow Lodge Ltd. (Herb Lake Landing) are located approximately 18 km and 35 km southeast of the Lalor site, respectively. Burntwood Lodge is a fly in fishing lodge located on Burntwood Lake and is approximately 60 km northwest of the Lalor site.

6.7.4 Snowmobilers

The Snow Lake area is home to the Snow Lake Sno-Drifters snowmobiling club. A map of snowmobile trails maintained by the club in the Snow Lake area is available online.

6.7.5 Forestry

The Cormorant Provincial Forest is located approximately 80 km southwest of the Lalor Mine site and covers an area of 1,479 km^2. Provincial forests are Crown lands managed by Manitoba Natural Resources on a sustainable yield basis. A licence or permit allows harvesting of trees on Crown lands and indicates the quantity of each type of trees that can be harvested. Large companies must regenerate forestlands that they have harvested according to their Forest Management License. A forest renewal fee is paid by individuals or small companies for reforestations (Manitoba Conservation, 2011b).

Tolko Industries Ltd. (Manitoba Solid Wood Division, Woodlands), located in The Pas, Manitoba has three Forest Sections (Highrock, Nelson River and Saskatchewan River) where wood is harvested. These Forest Sections include areas surrounding Snow Lake, Flin Flon, and Grass River Provincial Park (Tolko Industries Ltd., 2011).

6.7.6 Fisheries – Recreational and/or Commercial

Small to medium lakes in the Project Area include Arm Lake, Gaspard Lake, Ghost Lake, Nutt Lake, Threehouse Lake and Unnamed Lake 1. It has been determined that these lakes do not provide habitat for large-bodied fish and are therefore, limited in the recreational value. Larger lakes in the Project Area include Snow Lake and Wekusko Lake. Snow Lake and Wekusko Lake supports a variety of fish species throughout the year.

Given its proximity to the Town of Snow Lake, there are recreational opportunities such as fishing, swimming, canoeing and snowmobiling in and around Snow Lake. There was a commercial gill net fishery in Snow Lake from 1989-90 targeting Lake Whitefish but was not continued due to the high by-catch (~41% of round weight) of Walleye and Northern Pike (Grant McVittie, Regional Fisheries Manager for Manitoba Water Stewardship). Anecdotal evidence exists of a failed commercial trap net fishery in 1998 (Grant McVittie, Regional Fisheries Manager for Manitoba Water Stewardship). Wekusko Lake has had a commercial fishery since 1931 with the current limits of 65,800 kg set in 1991.

6.8 First Nations

Pukatawagan, located approximately 122 km northwest of Snow Lake, is the closest First Nation community to the Lalor site. Pukatawagan had a population of 1,478 people in 2006 (Statistics Canada, 2010). According to the 2011 census from Statistics Canada, Pukatawagan had a population of 1,826, reflecting an increase of 23.5% from the 2006 population (Statistics Canada, 2012d). Mathias Colomb Cree Nation (MCCN) has a band population of 1,576 people in 2006 (Statistics Canada, 2007).

Other First Nations that are within a similar straight-line distance to the Lalor site include:

- Nisichawayasihk Cree Nation at Nelson House (129 km).
- Mosakahiken Cree Nation at Moose Lake (131 km).
- Opaskwayak Cree Nation at Opaskwayak (137 km).
- Cross Lake First Nation at Cross Lake (155 km).
- Norway House Cree Nation at Norway House (182 km).

7. Closure

This document summarizes the environmental and socio-economic aspects that are present prior to the development of the proposed Lalor Concentrator Project. This baseline report also summarizes the terrestrial and aquatic baseline conditions at the proposed concentrator site, access road, pipeline alignments, and several waterbodies in the area. Information presented here will feed into the Environmental Assessment (EA), which will identify and assess potential impacts of the proposed project and describe mitigation measure required to offset potential negative impacts. Residual impacts, remaining following implementation of the mitigation measures will also be described.

The physical environment (*e.g.,* geology, topography, and hydrology) at the proposed Project Site is typical of the region. Terrestrial baseline assessments conducted in the area did not identify any critical or unique wildlife habitat or vegetation communities at or near the Project Site. No protected or listed species was observed during any of the surveys. Most waterbodies in the area are small lakes, creeks, wetlands, or bogs. Abundant habitat for small-bodied fish is available in many waterbodies, while habitats for large-bodied fish are limited to the largest lakes. Water and sediment quality as well as aquatic biological diversity and abundance were typical of the region. Waterbodies impacted by anthropogenic activities demonstrate elevated levels of contaminants, also typical of the region. The development of the Lalor Concentrator could present a number of positive opportunities and socio-economic benefits for the residents of Snow Lake and Flin Flon.

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